MESH REPAIR VERSUS PLANNED VENTRAL HERNIA STAGED REPAIR IN THE MANAGEMENT OF TRAUMA PATIENTS WITH ACUTE ABDOMINAL COMPARTMENT SYNDROME

Haider M. Hummadi - M.B.Ch.B, FICMS
Wassem A. Elkatib - M.B.Ch.B, FICMS, CABS, MRCS
Tharwat I. Sulaiman - M B ChB, FACS, FRCSI, FRCS (Eng), CABS

Department of Surgery, College of Medicine, University of Baghdad, Iraq
Email: Tharwat I. Sulaiman <tharwatsulaiman@yahoo.com>
Summary

Background:

The terms Intra-abdominal hypertension (IAH) and Abdominal compartment syndrome (ACS) are commonly used interchangeably; however it is important to recognize the distinction between these two terminologies. Recently, at the World Society on Abdominal Compartment Syndrome (WSACS), the threshold for IAH and ACS was established as a value ≥ 12 mmHg and > 20 mmHg respectively. Patients with either ACS (defined as a sustained intra-abdominal pressure- IAP) or IAH can be effectively managed via decompression followed by mesh repair (MR) or staged repair (SR) method.

Objectives:
This research aims to evaluate the results of mesh repair in comparison to planned ventral hernia staged repair for closure of abdominal wall defects after decompression in trauma patients with ACS.

Patients and methods: All patients with major abdominal trauma and identifiable risk factors for development of ACS presented to the first surgical unit in Baghdad Teaching Hospital between the 1ST OF March, 2005 and the 30th of September, 2008 were enrolled. IAP was measured indirectly using intravesical pressure in most casesPatients were screened for IAH/ACS risk factors during the operation and/or upon admission into the surgical ward or ICU. If one risk factor was present, baseline IAP measurement was done but If two or more risk factors were present, an additional serial IAP measurements was performed every 4-6 hr in the first 24 hours. Those with grade IV or ACS on initial measurement or during follow up urgently underwent decompression. Bogota bag was used in the initial phase of closure of abdominal wall defects. Patients were randomized into either the Mesh Repair Group (MRG) or the planned ventral hernia Staged Repair Group (SRG).
**Results:** A total of 663 patients were enrolled in this study. The mortality rate in the group with normal IAP was 3.5%, contrary to a much higher mortality rate of 19.6% in those with elevated IAP. The mortality rate in the SRG was higher than the MRG. Overall complications incidence was much higher in the SRG (85.7%), in comparison to the MRG (56.3%). The incidence of wound infection, intra abdominal collections, dehiscence and ileus with intestinal obstruction were compared in both groups. The occurrence of intestinal fistulae was higher in the SRG (28.8%) than in the MRG (6.3%) (P<0.04). The mean hospital stay was 15.2 days/patient in the MRG but 26.1 days/patient in the SRG (after adding those of the repair of ventral hernias). **Conclusion:** ACS is a serious complication in surgical wards but it is often overlooked as a case of subsequent serious complications unless it is suspected early and managed properly. The use of mesh repair to close abdominal defects after decompression for ACS reduces mortality and morbidity in comparison to the use of planned ventral hernia staged repair.

**Key words:** Intra-abdominal hypertension, abdominal compartment syndrome, mesh repair, staged repair
Introduction

The concept that the abdominal cavity can be considered as a compartment had been known since the end of the nineteenth century \(^{(1)}\) but has only recently become the subject of interest and discussions \(^{(2)}\).

The terms Intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) are commonly used interchangeably; however it is important to recognize the distinction between these terminologies. IAH exists when IAP exceeds a measured numeric parameter. This parameter has generally been set between 20 to 25 mmHg \(^{(3,4)}\). Recently at the (WSACS), the threshold for IAH was established as a value of 12 mmHg or greater while ACS, defined as a sustained IAP was established as a value > 20 mmHg with or without an abdominal perfusion pressure (APP < 60 mmHg) that is associated with new organ dysfunction or failure. However, most surgeons advocate urgent decompression if IAP exceeds 25 mmHg, in the absence of new organ dysfunction \(^{(5)}\).

Clinical confirmation of IAH requires either indirect bedside tests that measure IAP from transduction of intravesical, gastric, rectal, vaginal, and caval pressures, or direct measurement by an intraperitoneal catheter \(^{(6,7,8)}\).

The clinical triad of oliguria, hypoxia, and elevated central venous pressure in association with abdominal distension indicates a late diagnosis with impairment of one or more systems. Decompressive laparotomy, in such occasions should be done as soon as possible to prevent Multiple Organ Failure Syndrome (MOFS), without attempting at measuring IAP \(^{(9)}\).

Treatment of abdominal wall after decompression is controversial. Some advocate primary repair with mesh, however most surgeons advocate two stage repairs for abdominal wall reconstruction. Firstly, temporary closure of the abdomen is performed; which can be done by different methods such as Bogota bag, the Vacuum Assisted Closure (VAC) technique, Wittmann patch (velcro burr), silo, or absorbable mesh \(^{(9,10,11,12)}\). This study
was performed to evaluate the results of mesh repair in comparison to planned ventral hernia
staged repair for closure of abdominal wall after decompression in trauma patients with (ACS).

**PATIENTS AND METHODS**

All patients with major abdominal trauma and identifiable risk factors for
development of ACS presented to the First Surgical Unit in Baghdad Teaching
Hospital, Iraq were enrolled for this research. The following risk factors were
addressed; prolonged pre- and/or intraoperative hypotension (SBP<90mmHg), polytransfusion
>10 units blood in 24 hr, massive fluid resuscitation >5L crystalloid and/or colloid in 24hr,
retroperitoneal, intraperitoneal, and preperitoneal hemorrhage, abdominal distension (gastric
dilatation, ileus, and intestinal obstruction), tight abdominal closure, massive trauma, massive
burns, damage control surgery (hypothermia, acidosis, and coagulopathy), prolonged surgery
>4 hr, and medical co- morbidity ( obesity, ascites, ARDS, and respiratory failure).
IAP was usually measured indirectly using intravesical pressure in most cases while in few
patients the measurement was done using nasogastric tube in the stomach to measure the intra-
abdominal pressure . First Foley catheter with an appropriate size was positioned in e place,
if not already present. The urinary bladder was evacuated, and a 25-50 ml of sterile saline (1
ml/kg for children below 25kg in weight) was injected into the bladder via the aspiration port
of the catheter. The sterile tubing of the urinary drainage bag was cross-clamped distal to the
drainage port. A hand-held manometer was connected to the Foley catheter, and the pressure in
cm H₂O was recorded via the height of the water column in the manometer. This was expressed
in mmHg by dividing it by a factor of 1.36

The test was performed in supine position, at the end of expiration, and the pressure was
zeroed at the iliac crest in the midaxillary line. The pressure was measured every
30-60 seconds after instillation of saline to allow relaxation of the bladder detrusor muscle.
There should be no muscle contraction, as this could lead to a falsely high result.
Intragastric pressure was occasionally used in patients with genitourinary pathology or trauma.
Patients were screened for IAH/ACS risk factors during the operation and/or upon admission into the surgical ward or ICU. If one risk factor was present, baseline IAP measurement was done but if two or more risk factors were present, an additional serial IAP measurements were performed every 4-6 hr in the first 24 hours. If baseline IAP (i.e. <12 mmHg) or serial IAP records were normal on follow up, a close follow up for development of organ failure was done for another 24 hr. However, on a steady increase of IAP, a serial measurements of IAP were done every 2 hr. Urgent decompression was performed if two readings confirmed elevated IAP > 25 mmHg. According to the (WSACS) definition of IAH and ACS, IAH can be graded into four grades; normal (less than 12mmHg), grade I (IAP 12-15 mmHg), grade II (IAP 16-20 mmHg), grade III (IAP 21-25 mmHg) and grade IV (equivalent to ACS).

For patients in grade I, serial measurement of IAP was done every 4-6 hr, but every 2 hrs for grade II. Maintenance of normovolaemia in these two groups was imperative. For grade III patients, additional medical measures were done such as gastrointestinal decompression with NG tube, prokinetics like metaclopramide, analgesics, sedatives, and use of colloids rather than crystalloids to reduce interstitial oedema.

Those with grade IV or ACS on initial measurement or during follow up urgently underwent decompression. Abdominal decompression was also performed primarily as a prophylaxis, when very tight abdominal closure was anticipated, and as a general rule, when the intestines lie above the level of the skin in a fully relaxed patient under neuromuscular blockade of general anesthesia, IAP would be higher than 25 mmHg, if closed primarily.

Once decompression was completed, rapid but thorough examination of the abdominal cavity was performed to identify and control, if possible, any cause of IAH. The initial phase of closure of abdominal wall defects implies the use of temporary closure method. There are multiple methods for temporary closure, but Bogota bag was used in this study. It is either an IV fluid bag or more commonly 2L urinary bags that are cut-open, and sutured to the skin or fascia with a continuous heavy nylon suture. The bag is then covered with Betadine-
soaked Laparotomy packs, which are changed daily in the surgical ward or intensive care unit. Occasionally, the bag is changed, if signs of infection are present.

Cardiovascular stability and resolution of sepsis were indication to transfer patient to the theatre for removal of the bag and closure of abdominal wall defect. This phase is normally done five days to three weeks after decompression. Those who require a long period to recover, have their Bogota bag changed on a weekly basis, to reduce the risk of infection.

Patients booked for definitive closures of their abdominal wall defects were randomized into either the Mesh Repair Group (MRG), or the planned ventral hernia Staged Repair Group (SRG). Those who underwent staged repair, had their abdominal wall defects closed with skin undermining to the flanks and closing it in the midline for small defects (< 6cm wide), or secondary meshed split-thickness skin grafting, when healthy granulating tissue had covered the thin peritoneum over the bowels for larger defects (> 6cm wide). The latter was achieved in conjunction with a plastic surgeon. The second stage was performed 3-12 months later; this consists of the repair of any resultant ventral hernia.

**Statistical analysis**

Statistical analysis was performed using GraphPad InStat 3. Variables were compared using Fisher exact test with two sided P-value.

Means of continuous variables were compared using Student’s t-test. Factors contributing to the development of suture line failure were determined using logistic regression analysis. Statistical significance was defined at P < 0.05.

**RESULTS AND DISCUSSION**

A total of 536 male patients (80.8%), and 127 female patients (19.2%), were enrolled in this study. Ages of patients ranged between 10-72 years, with a mean age of 28 years (26 years for males, and 36 years for females). 52% of the patients were within the age range of
10-30 years. Eighty six patients (13%) had blunt trauma to abdomen, while 577 patients (87%) had penetrating trauma. The mean injury severity score (ISS) was 24.

IAP was normal in 566 patients (85.4%). Elevated IAP was noticed in 97 patients (14.6%) while 44 patients (6.6%) had grade IV IAH, and ultimately needed decompression. Twenty three patients (3.5%),14 patients (2.1%) and 16 patients (2.4%) had grade I IAH, grade II IAH and grade III IAH, respectively and were treated with conservative measures.

Out of those who underwent decompression, six patients died before definitive closure of their abdomen. Sixteen patients (43.2%) underwent mesh repair (The MRG). The mesh was covered with secondary skin grafting in six (38%) patients, while primary skin closure over the mesh was done in the other 10 patients (62%).

In contrast, 21 patients (56.8%) underwent staged repair SRG. Skin closure was done primarily in 16 patients (76%), while secondary skin grafting was done for the remaining 5 patients (24%). However, only 13 patients of the SRG had their ventral hernias ultimately repaired, 8 patients could not repair theirs due to either unfitness or/and unwillingness of the patients for multiple procedures. Although there was no mortality among those who underwent ventral hernia repair (VHR), complications of this operation were added to the SRG, as VHR comprises part of the staged repair of the ACS.

The MRG include 14 male patients (87.5%), and two female patients (12.5%), while the SRG had 17 male patients (81%), and 4 female patients (19%). There was no ender and the surgical procedure (P-value = 0.47).

The mean age of the MRG was 27 years (12-61 years), while the mean age of the SRG was 30 years (10-65 years). There was no statistically significant difference between the two groups (P-value=0.21).

There were no statistically significant differences between the two groups with regards to the mechanism of injury (P-value = 0.52), mean injury severity score, ISS (P-value= 0.61), and the need and duration of ICU admission before the application of definitive treatment (P-value= 0.48, and 0.84 respectively).
The mean duration between decompression and definite treatment was 8.4 days in the MRG, and 9.2 days in the SRG with no statistically significant difference between the two groups in the duration of the initial phase of treatment (P-value=0.90).

The mortality rate was 3.5% in the group with normal IAP in contrast to a mortality rate of 19.6% in those with elevated IAP (P-value < 0.0001). Those who needed decompression accounted for its major part, as the mortality rate in this group approached 36.4%. Six patients (13.6%) died in the initial phase of the treatment after decompression. Three patients (6.8%) died in the MRG while 7 patients (15.9%) died in the SRG. There was no statistically significant difference between the MRG and SRG as regards to mortality with a P-value=0.46).

The overall complications incidence was much higher in the SRG (95.2%) in comparison to the MRG (56.3%), with a P-value < 0.01 but in general there were no statistically significant differences between the two groups regarding wound infection, intra-abdominal collections (pelvic or subphrenic), dehiscence, and ileus with intestinal obstruction (Table 1).

Intestinal fistula is a serious and dreadful complication of exposed abdomen for prolonged periods. It is unavoidable and very difficult to heal. A patient (6.3%) developed intestinal fistula in the MRG while six patients (28.8%) developed intestinal fistulas in the SRG.

Intestinal fistulae were less in the MRG than in the SRG P-value<0.04). One patient in the MRG and four patients in the SRG died as a result of this complication.

T. Jernigam (?,?), in his research on 167 patients showed that 14 patients (8.4%) developed fistula amidst various kinds of management; ten out of the 14 were in the MRG. In addition Torrie 21 reported 6(9%) fistula in his study on 68 patients using only mesh repair method.

These differences in results are possibly related to the mechanism of trauma, presence of bowel injury and duration of mesh application prior to coverage of granulating wound which appears to be a major contributor to these results.

Dehiscence, another serious and difficult-to-treat complication associated with exposed abdomen occurred in two patients (12.5%) in the MRG, and was treated by removal of the
mesh, refreshing the edges, and reapplication of the Bogota bag, which was changed accordingly, until infection resolved and healthy granulation tissue was gained, when definitive treatment could be reapplied. In contrast, six patients (28.6%) developed dehiscence in SRG; those that occurred as a result of infection (three patients) were treated as previously stated, while those not related to infection, were treated by reclosing the skin (which was done in two patients) and by rectus femoris myocutaneous rotational flap, (done in one patient). There were no statistically significant difference between the two groups (P-value = 0.22). Compared to Torrie (????) who reported dehiscence in 3 cases, many patients in this study had known risk factors for dehiscence; these include raised IAP, wound infection and multiple trauma or malnutrition.

It was generally accepted that wound infection and intra-abdominal collections were mostly related to the more severe injuries, defective management in the wards, incompetent staff and lack of supplies and monitoring devices.

Mean stay-in-hospital was 15.2 days/patient in the MRG and 29.1 days/patient in the SRG (after adding the total days for the repair of ventral hernias) which was statistically significant with P-value <0.05.

**Table 1.** Comparison of outcome and overall complications between Mesh Repair Group (MRG) and Staged Repair Group (SRG).

<table>
<thead>
<tr>
<th>Complication</th>
<th>MRG No. (%)</th>
<th>SRG No. (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of cases</td>
<td>16 (43.2%)</td>
<td>21 (56.8%)</td>
<td>………</td>
</tr>
<tr>
<td>Wound infection</td>
<td>2 (12.5%)</td>
<td>4 (19%)</td>
<td>0.68</td>
</tr>
<tr>
<td>Intraabdominal Collection</td>
<td>2 (12.5%)</td>
<td>2 (9.5%)</td>
<td>0.59</td>
</tr>
<tr>
<td>Dehiscence</td>
<td>2 (12.5%)</td>
<td>6 (28.6%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Fistula</td>
<td>1 (6.3%)</td>
<td>6 (28.6%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Ileus/Intestinal obstruction</td>
<td>2 (12.5%)</td>
<td>2 (9.5%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Total complications</td>
<td>9 (56.3%)</td>
<td>20 (95.2%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mean in-hospital stay days/patient</td>
<td>15.2</td>
<td>29.1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Mortality</td>
<td>3 (18.8%)</td>
<td>7 (33.3%)</td>
<td>0.24</td>
</tr>
</tbody>
</table>
The incidence of ACS in all patients admitted to the surgical units during the period of this study was 6.6% as compared to 15% reported by Parsak (13) who carried a study on 119 patients which include 68 males and 51 females with a mean age of 55 years. There were 44 deaths for all grades; those who needed decompression which accounted for the major part approached 36.4%. Six patients died at the initial phase of the treatment after decompression, three (18.8%) from the MRG and 7 (33.3%) in the SRG, in comparison to Parsak (15) results, where 40 patients died in total, thirteen (32.5%) from those who needed decompression.

The occurrence of IAH and ACS is on the increase currently, mostly due to improved methods of diagnosis and recognition of the condition. More patients are now being investigated for IAH due to suspicion, as a high index of suspicion is imperative for optimal outcome. If not recognized and treated in time, ACS can result in multi-organ system failure and death. Studies have shown that IAP higher than 20mmHg results in ACS(5). The adverse effects are reversible with the relief of pressure, if done at the proper time.

Traditionally, IAP can be measured indirectly through the urinary bladder using a Foley catheter. This technique was adopted to avoid direct invasive techniques, and was subsequently popularized by Kron et al in 1984(14). In this study, the intravesical technique was used because it is more applicable and easier to perform than other methods. Further studies are needed to compare their accuracy.

ACS is associated with potentially high mortality that must be recognized early and managed effectively to optimize the outcome. Most deaths associated with ACS are due to sepsis or multiple organ failure. There is a direct correlation between abdominal hypertension and mortality rates(15,16,17). However, IAP is not the only factor determining survival(18,19). The presence of co-morbidity is a factor that increases mortality, which was also true for our patient population. Although other factors were not included in this study, the primary etiology, mainly trauma, together with general clinical condition of the patient greatly determine the outcome and prognosis.
complications encountered during the study include wound infection, intra-abdominal collection, intestinal fistula, dehiscence and intestinal obstruction.

Overall complication incidence in the SRG and MRG was 95.2 and 56.3%, respectively compared to 73.5% in all modality of management used by Parsak (15).

In this study, two patients both in the MRG (12.5%) and in the SRG (9.5%) developed ileus or intestinal obstruction, mostly related to adhesions. The results were comparable to those obtained by Aydin20, who also clarified no difference in adhesion formation between the two groups.

An open abdominal wound is a great challenge to a surgeon in postoperative management, due to massive fluid loss, heat dissemination and risk of infections. Frequent assessment, care of the wound and replacement of the lost fluids and electrolytes are mandatory. Strict aseptic technique is required for wound care22.

Mean in-hospital stay in this study was 22 days, 15.2 in MRG and 29.1 in SRG. This is similar to the findings of Torrie (????) and Timothy (????) with a mean in-hospital stay of 20 and 22 days, respectively.

Currently, there are no prospective studies available to show which is the best method or material. Superiority of one material over the other has not been established. The materials advocated are mesh (absorbable, non-absorbable), zipper, adhesive sheets, plastic bag (Bogota bag) and velcro analog22. Recent studies have showed that the use of vicryl mesh is preferable, to get rid of several complications encountered with other types.

Polypropylene mesh was used in this study because other types like vicryl, PTFE and polyglactin were not available and our results with this type are comparable to other workers.

However, it is still impossible to specify fixed uniform criteria for preventive use of temporary closure of abdominal cavity, because it will always depend on subjective assessment of the operator regarding the tension of abdominal cavity after approximation of the fascia edges and estimation of the amount by which the content of abdominal cavity may increase or has already increased during tamponade. Nevertheless, the questions
still remains, whether it is not more advantageous in hazard patient to carry out the primary closure of abdominal cavity with post-operation IAP monitoring and early ACS diagnostics instead of preventive temporary laparostomy²⁴.

Conclusions

ACS is not only a serious condition, but also a common scenario in surgical wards and ICU, which is often misdiagnosed as a case of respiratory failure or circulatory collapse. Most residents and some senior doctors are unaware of its lethal complications and how to diagnose it.

The results of this findings showed that the use of mesh repair to close abdominal wall defects after decompression for ACS is associated with reduced mortality and overall complications, in comparison to the use of planned ventral hernia staged repair.

References


