Abdominal Compartment Syndrome Monitoring in Major Burn Patients with Siriraj Device Catheter

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Abdominal compartment syndrome (ACS) is consistently reported to have significant morbidity and mortality. Major burn patients who receive massive fluid resuscitation are at high-risk for this condition. Close monitoring of ACS is necessary for these patients. Prolonged unrelieved intra-abdominal pressure (IAP) at greater than 20mmHg can produce significant morbidity and mortality. The most widely accepted and feasible way to measure IAP is via the draining port of a standard urinary catheter. Siriraj burn unit developed its own device from simple equipment that can be found easily in the hospital. It proved to be useful, cheap, and effective in monitoring intra-abdominal pressure. The present study described techniques of using this device for monitoring and early detection of ACS. Five major burn patients ≥ 40% Total body surface area (TBSA) was measured by IAP measurement via Foley catheter using the Siriraj device catheter compared to direct measurement via peritoneal catheter. There was no difference of IAP between the two methods (p = 0.48). This suggested that Siriraj device catheter was useful, not invasive, and effective in reflection of actually IAP. Siriraj burn unit suggested IAP measurement in all major burns ≥ 40% TBSA to early recognize and treat intra-abdominal hypertension (IAH) that can lead to ACS. Early detection of this syndrome might decrease the adverse effects after increasing abdominal pressure that can cause organ dysfunction.

Keywords: Abdominal compartment syndrome, Burn, Siriraj device catheter

Consistently reported to have significant morbidity and mortality. One quick and simple way to assess intra-abdominal pressure is to use an existing Foley catheter to measure intra-cystic pressure (ICP) as described in previous studies. The intra-abdominal pressure transmitted to the bladder will generally correlate well with intra-abdominal pressures. The pressure trend can also provide information regarding the clinical progression. The present study describes the technique for measuring intra-abdominal pressure in severe traumatic or major burn patients by using the equipment developed by the Trauma Division, Department of Surgery, Siriraj Hospital.

Material and Method

**Diagnosis of abdominal compartment syndrome**

Abdominal compartment syndrome (ACS) should be suspected in all major burn patients who receive massive fluid resuscitation. The ACS exists
when IAH is associated with organ dysfunction that is reversible upon abdominal decompression. The diagnosis can be confirmed by the bedside measurement of intra-abdominal pressure through the foley catheter. The criteria for diagnosis of abdominal compartment syndrome have been described by Burch et al(1).

**Measuring Intraabdominal Pressure**

There are two primary techniques for measuring intra-abdominal pressure (IAP) in humans: direct or indirect method(8). The direct measurement technique is done by inserting the intraperitoneal catheter directly into the peritoneal cavity and connecting the peritoneal catheter to the pressure manometer(1). The indirect measurement can be done by measuring IAP via a nasogastric tube or foley catheter(8). Previous literature has reported that this technique has excellent correlation with directly measured IAP(10). In clinical practice, the most widely accepted and feasible way to measure IAP is the indirect method via the draining port of a standard urinary catheter, originally described by Kron et al(11). The technique is simple as critically ill patients who benefit from IAP measurement already have urinary catheters in situ, no further invasive interventions are necessary. The usual technique involves clamping the foley catheter just distal to the aspiration port. A 50 ml of sterile normal saline is then instilled into the urinary bladder at every separate measurement(10). The needle is then connected to an electric transducer or filled water manometer with the mid-axillary line of the patient or the pubic tubercle as the zero point(10). The water level in the manometer falls until the pressure in the bladder (which is essentially the same as the intra-abdominal pressure) equals the pressure reflected by the water level in the manometer.

**Siriraj Device Catheter for Measuring Intra-abdominal Pressure**

Siriraj Burn Unit, Trauma division, Department of Surgery at Siriraj Hospital has developed the Siriraj device catheter for measuring intra-abdominal pressure. Generally, the authors performed this procedure in major burn patients who had > 40% total body surface area (TBSA). This device was created from the simple equipment that can be found easily in the hospital such as suction tube, extension tube, and 3-way stopcock. The total cost was just approximately 20 baht (0.5 US dollar).

The setup of the continuous intra-abdominal pressure monitoring technique is described in Fig. 1 including (1) 18-Fr standard urinary catheter, (2) urine drainage connector port, (3) proximal part of suction tube #14 for connection to urine drainage connector port and 3 way connector, (4) 3-way stopcock connect to an extension tube, (5) Extension tube.

Prior to measuring bladder pressure, the catheter remains open to continuous drainage, therefore, the bladder should be empty. The method was performed through the drainage port of the three-way stopcock by filling the bladder with 50 mL of sterile normal saline. The intra-abdominal pressure measurements were measured immediately via a 3-way stopcock connector inserted into the extension tubing (Fig. 2). The zero point was set up at mid-axillary line or
pubic symphysis of the patient. It was measured as cm
H2O (1mmHg = 1.36 cmH2O). This procedure can be
displayed on the bedside or can measure the bladder
pressure directly by connecting this device to the
pressure manometer as shown in Fig. 3a-b.

**Patients**

Five cases of major burn patients > 40% TBSA
who were admitted to the Siriraj burn unit, trauma divi-
sion, department of surgery from August 2005 to April
2006 were enrolled in the present study. Intra-abdomi-
nal pressure measurement was performed in all of them
by both methods including indirect measurement via
foley catheter using the Siriraj device catheter compared
to direct measurement by the inserted intraperitoneal
catheter directly into the peritoneal cavity. The dif-
fERENCE of intra-abdominal pressure between the two
methods was compared by Mann-Whitney U test, p-
value < 0.05 was considered statistically significant.

**Results**

The mean age was 35 ± 22 years (range 9
months-58 years) and 80% of the patients were men
(4 male, 1 female). The average % TBSA burn and %
depth burn were 61 ± 21 (range 40-90%) and 55 ± 22
(range 35-80%), respectively. The indirect measure-
ment of intra-abdominal pressure (IAP) via the foley
catheter was 36 ± 21 (range 10 to 60) mmHg. The direct
measurement of intra-abdominal pressure via the peri-
toneal catheter was 29 ± 18 (range 7 to 49) mmHg. The
data of both methods is compared in Table 1. There
were no significant differences of pressure (mmHg)
between both methods (p = 0.58, Graph 1).

**Discussion**

ACS is a poorly appreciated complication of increased IAP. Prolonged, unrelieved elevation of IAP
can produce pulmonary compromise, renal impairment,
cardiac failure, central nervous dysfunction, shock, and

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**Table 1. Data of all patients**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/Sex/Wt</th>
<th>Injury /% TBSA burn</th>
<th>Indirect measurement of IAP (mmHg)</th>
<th>Direct measurement of IAP (mmHg)</th>
<th>Abdominal decompression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45/Female/65</td>
<td>Flame/90%</td>
<td>60</td>
<td>49</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>58/Male/50</td>
<td>Flame/58%</td>
<td>29</td>
<td>23</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>43/Male/68</td>
<td>High electrical voltage injury/75%</td>
<td>56</td>
<td>45</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>9 month/Male/9</td>
<td>Scale/42%</td>
<td>10</td>
<td>7</td>
<td>N</td>
</tr>
<tr>
<td>5</td>
<td>28/Male/49</td>
<td>Flame/40%</td>
<td>25</td>
<td>20</td>
<td>N</td>
</tr>
</tbody>
</table>
The incidence of ACS varies between 15 and 38% of all surgical patients admitted to intensive care units. A high index of suspicion is imperative for optimal outcome. If this condition is not recognized and treated in a timely manner, ACS can result in multi-organ failure and death. Several investigators demonstrated altered hemodynamics associated with elevation in IAPs above 20 cmH2O. The adverse effects are reversible with the relief of pressure, if done at the proper time. Several clinical reports have emphasized the importance of early recognition of this syndrome. The measurement of IAP can be done bedside by transduction of pressures from indwelling femoral vein, rectal, gastric, and urinary bladder catheters. Of these methods, measurement of urinary bladder is the most common clinical application.

In the present study, the authors validated the methodology of IAP measurement via using the Siriraj trauma device for measuring intra-abdominal pressure. The authors found that this device is useful, cheap, and easy to apply to the patients. Burch et al developed a grading system of Intra-abdominal hypertension into 4 grades including:
- Grade I, 10-15 cmH2O
- Grade II, 15-25 cmH2O
- Grade III, 25-35 cmH2O
- Grade IV, greater than 35 cmH2O

The decision to intervene surgically is based on the clinical decision that improvement in organ dysfunction can best be accomplished by abdominal decompression.

In the authors’ institute, the definitive management of ACS is based on optimal timing and staging of abdominal decompression described by Meldrum et al. The authors performed simple bedside decompression for bladder pressures by either percutaneous decompression when the pressure reached 26 to 35 mmHg and performed formal abdominal exploration with pressures greater than 35 mmHg in anticipation of significant intra-abdominal ischemia. In the present study, two patients were treated by abdominal compression as both of them had intra-abdominal pressure higher than 35 mmHg. There was no difference of pressure (mmHg) between the two methods of measurement. This suggested that indirect measurement of intra-abdominal pressure via foley catheter using the authors’ self-constructed Siriraj catheter device was really useful and effective in reflection of actually intra-abdominal pressure. The authors’ institute recommends...
self-constructed Siriraj trauma catheter device for measuring IAP is convenient, inexpensive, and safe. The authors recommend early measurement of intrabladder pressure in all major burns ≥ 40% TBSA in order to early recognized intra-abdominal compartment syndrome and perform early effectively management of this condition.

After abdominal decompression, coverage of the abdominal contents with skin closure with absorbable mesh or plastic bag has to be done (Fig. 4). Generally, the abdomen of these patients should be closed by a staged closure (Fig. 5a-b).

This may include fascial closure after a period of 7-10 days or placement of split thickness skin grafts on a granulating surface followed by delayed repair of the resulting abdominal wall hernia after several months.[16]

Several studies have reported that ACS is a condition with a potentially high lethality[4,5,18,19]. It must be recognized early and effectively managed in order to optimize outcome. Sepsis or multiple organ failure cause the most deaths associated with ACS. Mortality associated with this condition has been reported in 10.6-68% of patients[3]. The key to effective management of this condition includes identification of patients at risk, early recognition, and appropriately staged and timed intervention.

Conclusion

The abdominal compartment syndrome is defined as intra-abdominal hypertension associated with organ dysfunction. Continuous monitoring and proper management of this condition is necessary. Diagnosis of IAH by measurement of intrabladder pressure is the most common clinical applications. The authors’ self-constructed Siriraj trauma catheter device for measuring IAP is convenient, inexpensive, and safe. The authors recommend early measurement of intrabladder pressure in all major burns ≥ 40% TBSA to early recognize and treat IAH that can lead to abdominal compartment syndrome. Early detection of this syndrome might decrease the adverse effects of increased abdominal pressure, which can cause organ dysfunction.

References

Fig. 5a-b The growth of granulation tissue over the abdominal contents in a case that staged closure was planned (5a). Skin graft was placed over granulation tissues in a patient who was treated with staged closure (5b)
ภาวะป้องกันของช่องท้องเป็นการหนึ่งที่ทำให้เพิ่มภาวะทุพพลภาพและความตายในผู้ป่วยบาดเจ็บไฟไหม้รุนแรง ที่ได้รับการช่วยเหลือโดยการให้สารน้ำทางหลอดเลือดดำปริมาณมากเป็นกลุ่มป่วยที่มีปัจจัยเสี่ยงต่อการเกิดภาวะนี้ ดังนั้นจึงมีความจำเป็นที่จะต้องเฝ้าระวังการเกิดภาวะป้องกันของช่องท้องอย่างใกล้ชิดในกลุ่มป่วยเหล่านี้ การเพิ่มขึ้นของความดันช่องท้องในระดับที่มากกว่า 20 มิลลิเมตรปรอทเป็นระยะเวลานานโดยไม่ได้รับการแก้ไข จะทำให้เพิ่มภาวะทุพพลภาพและความตายได้ วิธีที่ได้รับการยอมรับกันมาที่ใช้ในการวัดความดันของช่องท้องคือ การวัดความดันของท้องผ่านทางสวนปัสสาวะ หมอไฟไหม้โรงพยาบาลศิริราชได้สร้างเครื่องมือในการวัดความดันของช่องท้องโดยใช้วัสดุอย่างง่ายที่สามารถหาได้ง่ายในโรงพยาบาล ซึ่งได้รับการพิสูจน์แล้วว่าสามารถนำมาใช้ประโยชน์ได้ดี ราคาที่ต่ำ และมีประสิทธิภาพในการวัดความดันของช่องท้อง การศึกษานี้เปรียบเทียบเทคนิคการวัดความดันของช่องท้องโดยใช้วัสดุแบบนี้ที่มีผลิตภัณฑ์การเฝ้าระวังและให้การวินิจฉัยภาวะป้องกันของช่องท้องในระยะแรกที่มีป่วยไฟไหม้มากกว่า 40% ของพื้นที่ผิวของร่างกายจำนวน 5 ราย โดยใช้วิธีการวัดความดันของท้องผ่านทางสวนปัสสาวะโดยใช้เครื่องมือสารสนเทศศิริราช เรียบเทียบกับการวัดความดันของท้องโดยตรงผ่านทางสวนปัสสาวะของโรงพยาบาลศิริราช ในทบทวนความแตกต่างของการวัดความดันของท้อง ระหว่าง 2 วิธีของการวัด (p = 0.48) นอกจากนี้การนี้แสดงถึงว่าสามารถวัดความดันของท้องได้ดีและมีประสิทธิภาพ การวินิจฉัยภาวะป้องกันของช่องท้องผ่านทางสวนปัสสาวะของโรงพยาบาลศิริราช แล้วจะทำให้การวินิจฉัยภาวะป้องกันของช่องท้องในผู้ป่วยไฟไหม้ทุกท่านที่ได้รับบาดเจ็บไฟไหม้มากกว่า 40 แปลงของท้อง เพื่อที่จะมีการร่างกายเพื่อทำให้การวินิจฉัยและรักษาภาวะการเพิ่มขึ้นของความดันของท้องได้อย่างรวดเร็วและมีประสิทธิภาพ เพราะการวินิจฉัยภาวะป้องกันของช่องท้องได้ การวินิจฉัยภาวะนี้ได้ต้องเป็นการตรวจเชิงกลวิทยาศาสตร์ต่าง ๆ ที่เกิดจากการการเพิ่มความดันของท้องซึ่งเป็นสาเหตุที่จะทำให้การทำงานของอวัยวะต่าง ๆ บกพร่องได้