Case Report

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*

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Abdominal compartment syndrome (ACS) is defined as the adverse physiologic consequence of acutely increased intra-abdominal pressure (IAP) that leads to intra-abdominal hypertension (IAH)[1] It can occur in major burn patients who have received massive fluid resuscitation, and critically ill trauma patients who have undergone intra-abdominal operations, or whose abdominal surgical wound closure are under tension[2]. Numerous studies have described adverse physiologic effects of elevated intra-abdominal pressure including impaired cardiac function, decreased pulmonary compliance, and renal perfusion[1-4]. Prolonged, unrelieved increased IAP at greater than 20 mmHg can produce pulmonary compromise, renal impairment, cardiac failure, and shock. This is consistently reported to have significant morbidity and mortality [5]. 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[2,6]. 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[7]. 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.

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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

Fig. 1 The simple device for measuring IAP was created from (1) 18-Fr standard urinary catheter, (2) Urine drainage connector port, (3) Proximal part of suction tube #14, (4) 3 way stopcock, (5) Extension tube

Fig. 2 The complete setting of Siriraj device for measuring intraabdominal pressure (IAP)

a b

Fig. 3a-b Direct measurement of intrabladder pressure by connecting the 3 way stopcock directly to a pressure transducer manometer (3a). It was measured as mmHg and shown on the monitor. This technique can be used for continuous monitoring of intraabdominal pressure (3b)

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 division, department of surgery from August 2005 to April 2006 were enrolled in the present study. Intra-abdominal 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 difference of intra-abdominal pressure between the two methods was compared by Mann-Whitney U test, p-value < 0.05 was considered statistically significant.

Results

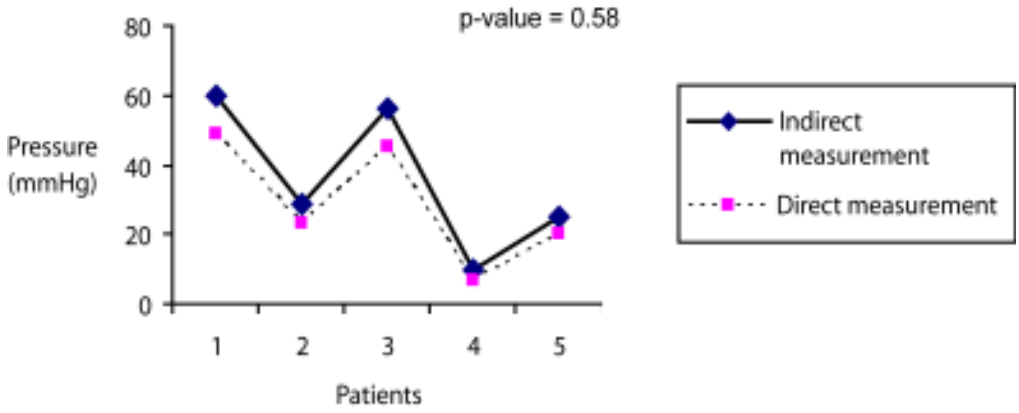
The mean age was 35 ± 22 years (range 9 months-58 years) and 80% of the patients were men (4 male, 1 female). The average % TBSA burn and % deep burn were 61 ± 21 (range 40-90%) and 55 ± 22 (range 35-80%), respectively. The indirect measurement of intra-abdominal pressure (IAP) via the foley catheter was 36 ± 21 (range 10 to 60) mmHg. The direct measurement of intra-abdominal pressure via the peritoneal 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

Table 1. Data of all patients

Patient	Age/Sex/Wt	Injury /% TBSA burn	Indirect measurement of IAP(mmHg)	Direct measurement of IAP (mmHg)	Abdominal decompression
1	45/Female/65	Flame/90%	60	49	Y
2	58/Male/50	Flame/58%	29	23	N
3	43/Male/68	High electrical voltage injury/75%	56	45	Y
4	9 month/Male/9	Scale/42%	10	7	N
5	28/Male/49	Flame/40%	25	20	N



Graph 1. No significant difference of intraabdominal pressure between the 2 methods of measurement

death[11-13].

The incidence of ACS varies between 15 and 38% of all surgical patients admitted to intensive care units[14]. 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 cmH_2O[15,16]. 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[15-17]. 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[18].

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:

- o Grade I, 10-15 cm H_2O
- o Grade II, 15-25 cm H_2O
- o Grade III, 25-35 cm H_2O
- o Grade IV, greater than 35 cm H_2O

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[19]. 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

Fig. 4 The abdominal contents were covered with a temporary plastic bag after abdominal decompression procedure

a b

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)

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.

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การเฝ้าระวังภาวะบีบรัดของช่องท้องในผู้ป่วยไฟไหม้รุนแรงด้วยสายสวนศิริราช

พรพรหม เมืองแมน, สายพิณ เมืองแมน, สุภาพรรณ สุวรรณโชติ, รัชนี เบญจธนัง

ภาวะบีบรัดช่องท้องเป็นภาวะหนึ่งที่ทำให้เพิ่มภาวะทุพพลภาพและความตาย ในผู้ป่วยบาดเจ็บไฟไหม้รุนแรงที่ได้รับการช่วยเหลือโดยการให้สารน้ำทางหลอดเลือดดำปริมาณมากเป็นกลุ่มผู้ป่วยที่มีปัจจัยเสี่ยงต่อการเกิดภาวะนี้ ดังนั้นจึงมีความจำเป็นที่จะต้องเฝ้าระวังการเกิดภาวะบีบรัดของช่องท้องอย่างใกล้ชิดในกลุ่มผู้ป่วยเหล่านี้ การเพิ่มขึ้นของความดันช่องท้องในระดับที่มากกว่า 20 มิลลิเมตรปรอทเป็นระยะเวลานานโดยไม่ได้รับการแก้ไข จะทำให้เพิ่มภาวะทุพพลภาพและการตายได้ วิธีที่ได้รับการยอมรับกันมากที่ใช้ในการวัดความดันของช่องท้องคือ การวัดความดันช่องท้องผ่านทางสายสวนปัสสาวะ หน่วยไฟไหม้โรงพยาบาลศิริราชผลิตเครื่องมือในการวัดความดันช่องท้องโดยใช้วัสดุอย่างง่ายที่สามารถหาได้ง่ายในโรงพยาบาล ซึ่งได้รับการพิสูจน์แล้วว่าสามารถนำมาใช้ประโยชน์ได้ดี ราคาต้นทุนวัสดุต่ำ และมีประสิทธิภาพในการวัดความดันช่องท้อง การศึกษานี้บรรยายเทคนิควิธีการใช้เครื่องมือชนิดนี้ในการเฝ้าระวังและให้การวินิจฉัยภาวะบีบรัดของช่องท้องในระยะแรกเริ่มผู้ป่วยไฟไหม้มากกว่า 40% ของพื้นที่ผิวร่างกาย จำนวน 5 รายได้รับการวัดความดันช่องท้องผ่านทางสายสวนปัสสาวะโดยใช้เครื่องมือสายสวนศิริราช เปรียบเทียบกับการวัดความดันช่องท้องโดยตรงผ่านทางสายสวนช่องท้องเพอริโตเนีย ไม่พบความแตกต่างของความดันช่องท้องระหว่าง 2 วิธีของการวัด ($p = 0.48$) ผลการศึกษานี้แสดงถึงว่าสายสวนศิริราชที่ประดิษฐ์ขึ้นนั้นสามารถนำมาใช้ประโยชน์ได้ดี และมีประสิทธิภาพและสะท้อนถึงความดันในช่องท้องอย่างแท้จริง หน่วยไฟไหม้โรงพยาบาลศิริราชแนะนำให้ทำการวัดความดันช่องท้องในผู้ป่วยไฟไหม้ทุกรายที่ได้รับบาดเจ็บไฟไหม้มากกว่า 40 เปอร์เซ็นต์ของพื้นที่ผิวของร่างกายเพื่อที่จะให้การวินิจฉัยและรักษาภาวะการเพิ่มขึ้นของความดันช่องท้องได้อย่างรวดเร็วตั้งแต่ระยะแรก เพราะภาวะนี้อาจนำไปสู่การเกิดภาวะบีบรัดช่องท้องได้ การวินิจฉัยภาวะนี้ได้ตั้งแต่ระยะแรกเริ่มอาจลดผลเสียต่าง ๆ ที่เกิดจากภาวะการเพิ่มความดันช่องท้องซึ่งเป็นสาเหตุที่จะทำให้การทำงานของอวัยวะต่าง ๆ บกพร่องได้