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Comparison of the Amount of Fluid Returned from the Diagnostic Peritoneal Lavage for the Diagnosis of Intra-abdominal Injury

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Abstract **It is still controversial about the appropriate volume of returned DPL fluid. A study was carried out in 30 adult patients with blunt or penetrating abdominal injury who underwent DPL with 1 litre of crystalloid lavage to compare RBC counts in different volume of returned DPL fluid. RBC counts of the lavage fluid collected at 200 ml, 400 ml, 600 ml and 800 ml were compared using paired T-test. Mean RBC count of the lavage fluid collected at 200 ml was 12,469.13 cells/ml, at 400 ml was 13,792.77 cells/ml, at 600 ml was 17,082.13 cells/ml and at 800 ml was 20,168.57 cells/ml. Mean RBC counts of the lavage fluid at 200 ml, 400 ml and 600 ml were statistically different from mean RBC count at 800 ml. The RBC count of returned DPL fluid regularly increases as more fluid was recovered. One of the 30 patients had negative DPL at 200 ml and 400 ml but positive with increased amount of returned fluid. Using Chi-square test, we found that the volume of effluent fluid was not statistically different for the interpretation of the lavage fluid. However, we recommend collecting DPL fluid at least 600 ml to avoid false negative results.**

Trauma remains a leading cause of death in the young. Abdominal trauma is a major reason for emergency operation which is associated with high morbidity and mortality. Mechanism of injury can be blunt or penetrating. Rapid diagnosis with proper management is essential to minimize morbidity and mortality. Blunt abdominal trauma usually occurs in association with multi-system injury, making its diagnosis and management more complex and challenging. Abdominal injury may be diagnosed by physical examination, diagnostic peritoneal lavage, diagnostic laparoscopy, ultrasonography and/or computed tomography.

Diagnostic peritoneal lavage (DPL) is one of the principal methods used for the detection of intra-abdominal injury. Root et al[1] in 1965 reported this technique and showed a dramatic decline in the number of deaths from unrecognized intraperitoneal injury when DPL was used to evaluate the abdominal trauma patients. DPL is primarily helpful for the diagnosis of hemoperitoneum and also reveals a hollow viscus injury by enteric contamination. The advantages of this technique include safety, low cost, quick to perform and not requiring radiologist for interpretation. DPL has been widely used for the diagnosis of intra-abdominal injury. The procedure is performed by insertion of a catheter into the pelvic cavity, followed by aspiration to detect intraperitoneal bleeding. If no blood is aspirated, 1 litre of crystalloid fluid is instilled into the peritoneal cavity. The returned fluid is then collected for red blood cell (RBC) quantitative analysis.

With inexperience, the DPL catheter may be in the incorrect position or displaced from the proper position. The amount of returned fluid may be too little and not reliable for the diagnosis. The amount of the returned lavage fluid for proper RBC count remains controversial. The reported amount of acceptable lavage fluid varied from 100 to 900 ml[2-5].

The purposes of this study were to compare the RBC count from 200 ml, 400 ml, 600 ml and 800 ml of returned DPL fluid and to determine the minimal amount of returned lavage fluid necessary for correct interpretation.

Materials and Methods

From June 2000 to December 2003, adult patients with blunt abdominal trauma or penetrating injury of the lower chest and/or abdomen admitted in the Division of Surgery, Somdej Prapinklao Hospital were enrolled in this study. Penetrating injury of the abdomen is defined as injury to the area bounded superiorly by costal margin, laterally by anterior axillary lines, and inferiorly by groin creases. Thoraco-abdominal injury is defined as penetrating trauma between the nipples and costal margin.

Patients with abnormal physical findings shown by peritonitis, shock, pneumoperitoneum, evisceration, or other suggestions of intraperitoneal injury were taken directly to the operating room and were excluded from this study. The indications for DPL in blunt trauma patients included equivocal abdominal signs, unexplained blood loss, altered mental status or unreliable abdominal examination and prolonged anesthesia for other associated injuries.

Patients with penetrating wounds but without indications for immediate surgery were treated according to the following guidelines. If the wound located below costal margin, a formal local wound exploration was performed in the emergency room. If the end of the stab wound tract was clearly visualized and penetration of fascia and muscular layers could be ruled out, the wound was then irrigated with sterile normal saline and managed as for superficial stab wound. These patients were followed up on an outpatient basis. If the end of the tract was not seen or if the wound entered the peritoneal cavity, the wound exploration was considered positive. DPL was performed on all patients with anterior stab wound if physical examination remained normal and local wound exploration were either equivocal or positive. Patients with wound located above costal margin with penetration into muscle underwent DPL.

Indications for DPL were determined by senior residents or attending staff. All lavage procedures were performed by well-trained surgical residents or surgical staff. The procedure was performed in supine position with open or semi-open technique depending on surgeons's preference. All patients had nasogastric tubes and Foley's catheters placed before DPL to decompress the stomach and urinary bladder, thus minimizing the likelihood of penetrating these organs by the lavage catheter. After preparation with povido-iodine solution and standard drape of the abdomen, 5 to 10 mL of 1% lidocaine with epinephrine was injected periumbilically. An approximately 2 cm longitudinal infraumbilical incision was used; supraumbilical incision was selected in patient with pelvic fracture. If open technique was chosen, the fascia and peritoneum were incised under direct visualization. The JMS peritoneal dialysis catheter was inserted into pelvic cavity and the abdominal fluid was aspirated. If the semi-open technique was selected, fascia was incised and then the dialysis catheter was blindly advanced into the peritoneal cavity. If initial aspirated fluid was not grossly positive for blood (10 ml or more of blood), 1 litre of normal saline was instilled into the peritoneal cavity and then retrieved. Fascial closure was performed with running 1-0 absorbable suture, the skin was closed with interrupted 3-0 nylon. The lavage fluid was collected at 200 ml, 400 ml, 600 ml and 800 ml and sent for analysis. Patients were excluded from the study if collection of all 4 specimens were not completed. The DPL fluid at 800 ml or last volume returned was used to make the decision for operation.

A positive lavage was defined as a red blood cell count of greater than 100,000 cell/mm^3 for blunt injury or greater than 10,000 cell/mm^3 for penetrating thoraco-abdominal and abdominal injury. The presence of a positive lavage mandated an exploratory laparotomy. If the lavage was negative, the patients were then observed for at least 24 hours. If the patients developed signs of intra-abdominal injury during this period, they then underwent an exploration.

Data Collection

Data collected for each patient included age, sex,

mechanism of injury, amount of diagnostic peritoneal fluid returned, operative finding and associated injury.

Statistical Analysis

Mean RBC count was compared with paired T-test. Statistical analysis was performed by using the SPSS software for Windows version 11.01. A value of $p < 0.05$ was considered statistically significant.

Results

Thirty patients who had indications for DPL and were negative for gross blood at initial aspiration were enrolled into this study. Twenty two patients were male and eight were female. Mean age was 30.80 ± 12.07 years. Mechanism of injury included blunt abdominal injury in 11 patients (36.7%), penetrating abdominal injury in 10 patients (33.3%), penetrating thoraco-abdominal injury in 9 patients (30%). Summary of patient demography is shown in Table 1.

Six patients with blunt abdominal injury had head injury. Four patients with penetrating injury had pneumothorax. One patient with blunt abdominal injury had head injury and pneumothorax. Associated injuries are shown in Table 2.

Ten (33.3%) of these patients had positive lavage at 800 mL and were sent for operation. The remaining nineteen patients had negative lavage. None of these patients in negative DPL group had delayed diagnosis of injury after closed observation for at least 24 hours. One patient (3.33%) died from blunt abdominal trauma. She had severe head injury and fracture pelvis. Her lavage was negative. A summary of the intra-abdominal organ injuries is shown in Table 3.

Mean RBC count collected at 200 ml was 12,469.13 cells/ml, at 400 ml was 13,792.77 cells/ml, at 600 ml was 17,082.1 3 cells/ml and at 800 ml was 20,168.57 cells/ml.

Using paired samples T-test, mean RBC counts collected at 200 ml, 400 ml, and 600 ml were statistically different from the final mean counts measured at 800 ml.

One patient with blunt abdominal injury had negative lavage at 200 ml and 400 ml but positive at 600 ml and 800 ml. After exploratory laparotomy, splenic injury was found in this patient.

Chi-square was used to compare returned volume and DPL results. We found that the volume and lavage results had no correlation. ($p = 0.98$)

There were four patients with WBC counts more than 500 cells/ml, one patient died from associated CNS injury and fracture pelvis, the remaining 3 patients had perforation of the stomach, jejunum and splenic injury.

Both RBC and WBC counts met the criteria for celiotomy in two patients. The other had only positive WBC count.

Table 1 Summary of patient demography

Patients	
Male	22
Female	8
Total	30
Mechanism of injury	
Blunt	11
Penetrating	
Abdomen	10
Thoraco-abdomen	9
Age (years)	30.80 ± 12.07

Table 2 Associated injuries

Right kidney injury
Severe head injury, fracture pelvis
Right pneumothorax
Moderate head injury
Mild head injury, fracture right femur
Severe head injury
Severe head injury, Left pneumothorax
Mild head injury
Right hemothorax
Left hemothorax
Right hemothorax

Table 3 Intra-abdominal organ injuries

No.	Intraabdominal organ injury
3	Hematoma at falciform ligament
4	Perforation of jejunum
5	Tear serosa of jejunum
6	Bleeding from DPL wound
7	Stomach
8	Bleeding from penetrating wound
10	Stomach
15	Liver, stomach
20	Splenic laceration, retroperitoneal hematoma zone II
29	Liver laceration

Discussion

DPL is a diagnostic tool for the evaluation of blunt and penetrating abdominal trauma. It is a reliable and safe method for detection of occult intra-abdominal injury in patients with blunt trauma and in selected patients with penetrating trauma. Many reports showed accuracy as high as 97%, with complication rates ranged from 0-1.6%. Indications for DPL in blunt abdominal injury include associated CNS injury, unexplained shock, equivocal abdominal signs and patients who required prolonged anesthesia.

In this study, most common injuries were penetrating injury. Blunt abdominal trauma was associated with central nervous system injury more often than penetrating injury. Penetrating thoraco-abdominal injury was associated with hemothorax. Most common indication for DPL in blunt trauma was altered sensorium. Seven patients had intra-abdominal organ injury. Two patients had unnecessary exploration and one patient (3.33%) had complication from trocha insertion. Jorge et al, in 1990 reported complication rate of 1% especially for closed technique.

One patient died from associated CNS injury and pelvic fracture without significant intraperitoneal bleeding. Problem with fluid return after DPL has been reported by many authors. There are few data and no consensus has been established in the literature, regarding the volume of lavage effluent necessary to define an adequate peritoneal lavage.

Root and associate[1] in 1965 mentioned that 90 % of peritoneal infusate was usually recoverable. Grigg and Masterson reported 700-800 ml as the volume of fluid commonly returned during an adequate DPL.[6] Henneman et al in 1990 and McAnena et al in 1991 reported a return of at least 75% of the infused fluid to be reliable. Drost et al in 1991 defined an adequate lavage effluent return as a volume greater than 650 ml.[7] Chistopher et al in 1998 reported that volume return of 682 ml (open technique) and 555 ml (closed technique) were adequate. Sullivan et al in 1997 reported that it was important to collect over 600 ml of effluent to avoid misleading, low RBC counts and misclassification of patients.[5] Sokya et al in 1990 and McLellan et al in 1985 required a minimum return volume of only 200 ml and 300 ml respectively.[8,9] Sweeney et al in 1994 concluded that with 100 ml of lavage effluent return, negative results were highly predictive of a negative DPL (98%), though 250 ml of lavage effluent was required to predict a negative DPL (100 %).[4]

In our study of 30 patients, the mean RBC counts collected at 200 ml, 400 ml, 600 ml were significantly different from mean RBC count collected at 800 ml. Mean RBC counts was regularly increasing as more fluid was recovered. With lavage of 200 ml and 400 ml, only one patient with initial negative DPL subsequently became positive. Chi-square was used to test correlation between volume and DPL results. We found that volume of effluent fluid has no statistically different in the interpretation.

We conclude that the returned fluid of at least 600 ml is suggested for the diagnosis of intra-abdominal injury to avoid low RBC count.

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