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Open versus closed diagnostic peritoneal lavage: a comparison on safety, rapidity, efficacy

G. C. VELMAHOS, D. DEMETRIADES, M. STEWART, E. E. CORNWELL III, J. ASENSIO, H. BELZBERG AND V. BERNE

Department of Surgery, Division of Trauma and Critical Care, University of California and LAC/USC Medical Center, Los Angeles, California, USA

There is considerable debate between the proponents of open and closed diagnostic peritoneal lavage (DPL). A prospective study was undertaken on 130 patients submitted to DPL. We performed 55 (42.3%) closed and 75 (57.7%) open lavages with sensitivity and specificity of 100 and 96.6% for the former and 92.2 and 100% for the latter. The mean time for insertion of the catheter and initiation of fluid infusion was significantly less in the closed DPL group, and so were the number of cases with prolonged procedures. No intra-abdominal or wound complications were detected with either method, but there were 10 DPL failures due to inability to conclude the procedure successfully and derive a definite result. Eight of these (10.6%) belonged to the open group and two (3.6%) to the closed ($P < 0.05$). Our findings suggest closed DPL is as equally sensitive and specific as closed DPL, but is more expeditious and offers inconclusive results less often. Both procedures are useful and should be parts of surgical training.

Keywords: peritoneal lavage, trauma.

Since its original description,[1] diagnostic peritoneal lavage (DPL) continues to provide useful information in the evaluation of blunt trauma victims. However, the development of computed tomography which, it is argued, carries comparable sensitivity and superior specificity,[2] has limited the contribution of DPL in the diagnosis of unstable trauma victims who need immediate discovery of possible intra-abdominal haemorrhage, or of patients who need to be urgently transported to the operating room for neurosurgical or orthopedic procedures. Therefore, it seems that DPL is mostly required for the critically injured patient.

The open technique, recommended by the American College of Surgeons Committee on Trauma,[3] is considered to be a reasonably safe method, with high sensitivity rates but relatively long times for completion of the procedure. On the other hand, the percutaneous technique is a much faster procedure but safety and sensitivity has potential limitations due to the possibility of intra-abdominal organ injury and catheter malposition.[4]

We decided to analyse our experience in a prospective fashion by comparing the sensitivity and specificity, the complication rate, and the time required for completion of the procedure between the two techniques.

MATERIALS AND METHODS

All patients who underwent a diagnostic peritoneal lavage during the 9-month period from September 1994 to June 1995 were included in this study. Blunt trauma patients with unreliable abdominal physical examination were evaluated by CT scan. For unstable patients or patients requiring emergent extra-abdominal operations, DPL became the diagnostic procedure of choice.

Open DPL was performed according to the standard described method.[5] Closed DPL was performed either by the trocar method, according to which a dialysis catheter was advanced towards the pelvis over a percutaneously placed trocar,[6,7] or by the Lazarus-Nelson method[8] according to which a soft catheter was advanced over a flexible J-wire, introduced through a percutaneously placed 18-gauge needle. Two operators were required for the open technique but only one for the closed one. All procedures were done by junior or senior level residents under direct supervision from an experienced trauma surgeon. The choice of technique was left at the discretion of the individual surgeon. Two of the authors (G.C.V., D.D.) used closed DPL with a different technique each. The remaining authors performed open DPL in the majority of their cases.

Aspiration of 10 mL of blood, a red blood cell count (RBC) higher than 100.000/cc for blunt trauma victims or higher than 5.000/cc for penetrating trauma patients, a white blood cell count (WBC) higher than 500/cc, elevated amylase, elevated bilirubin, food particles and high bacterial count in the effluent were consistent with a positive test. An effluent volume of at least 250 mL, as previously described,[9] was required for reliable conclusions. In any other case the DPL was considered to be inconclusive and further diagnostic tests were ordered.

The time from incision of the skin to the initiation of unrestricted infusion of fluid into the abdomen and the amount of retrieved effluent was recorded. Complications were defined as intra-abdominal injuries or wound infections directly related to the DPL. Failure was defined as inability to retrieve adequate effluent volume or inability to conclude the procedure due to technical difficulties. All DPL failures were followed by abdominal CT scan and/or diagnostic laparotomy.

Correspondence: George Velmahos, MD, PhD, LAC.USC Medical Center, Department of Surgery, 1200 N. State St, Rm 9900 Los Angeles, CA 90033, USA.

Laparotomies were classified as either therapeutic, if sutures, drains or electrocoagulation was used, or non-therapeutic, if no therapeutic intervention for existing intra-abdominal injuries was required, or negative, if no intra-abdominal injury was identified.

All patients were followed prospectively until discharge from the hospital or death.

The Yates corrected Chi-square analysis and Fisher exact 2-tailed test were used for statistical analysis. The student's *t*-test was used for continuous variables. All DPL failures were excluded from the sensitivity-specificity calculations but were reported separately. One more case of a therapeutic laparotomy (nephrectomy) after a negative DPL was not taken into account in sensitivity calculations, as the injury was limited to the retroperitoneum with no intraperitoneal blood found.

RESULTS

One hundred and thirty patients with a mean age of 35.5 years were included in the study. Two of them presented with penetrating injuries (one gunshot wound, one stab wound), while all the others suffered blunt trauma. The mortality for the whole group was 19.2% (25 patients). The mean injury severity score was 23.

In thirty-seven cases (28.5%) the test was positive, providing overall sensitivity of 97.2% and specificity of 98.8%. Gross blood was aspirated in 86.2% of all positive tests. Forty-five patients were submitted to laparotomies, of which 33 were therapeutic, seven non-therapeutic and five negative. All patients with a positive lavage underwent surgical exploration, except for one who was declared brain dead by the time the DPL was concluded and for whom, therefore, further intervention was deemed unnecessary. Eight more patients were explored due to deteriorating clinical signs despite a negative or inconclusive DPL (Table 1). One additional patient underwent laparotomy before completion of the DPL, as he became haemodynamically unstable during the procedure.

A closed DPL was performed in 55 (42.3%) patients and an open in 75 (57.7%) patients. The two groups were identical in terms of mean age, mean injury severity score (ISS), mortality rates and mean effluent volume (Table 2). However, there were significant differences between the two groups with regard to mean time required for insertion of the catheter (particularly among patients with positive DPL), number of cases with long DPL procedures and number of cases with inadequate effluent retrieval.

There were no false negatives in the closed DPL group. We recorded one false positive in a patient who sustained a gunshot wound to the flank and presented with minimal peritoneal tenderness; despite the fact that only 2 mL of blood were aspirated during paracentesis, a low threshold for exploration was maintained and the patient underwent a negative laparotomy. In the open DPL group there were no false positives but we found two false negatives; one patient underwent splenectomy for a bleeding splenic laceration after acute hemodynamic decompensation, while the other underwent a non-therapeutic laparotomy due to a non-bleeding liver injury with minimal perihepatic blood. Thus, closed DPL demonstrated sensitivity of 100% and specificity of 96.6%, while the same values were 92.2 and 100% respectively for open DPL (P = ns).

The number and kind of laparotomies in the two groups are shown in Table 3.

No complications were detected. One closed DPL was converted to open due to difficulties in insertion of the guidewire. Ten cases were considered to be failures due to inability to conclude successfully the selected technique; in seven of them the fluid return was inadequate and in three more we were unable to enter the abdomen. Two of these cases (20%) belonged to the closed group and eight (80%) to the open group (Table 4).

No differences were noted at any aspect between the trocar and the Seldinger technique within the closed DPL group.

DISCUSSION

The open technique, as originally described by Root *et al.*,[1] is the preferred method of performing deep peritoneal lavage in most trauma centers. The main reason for this choice is the proposed safety of the procedure.[6] Inserting the lavage catheter under direct visualization provides the operator with a certain sense of security. However, opening of the abdominal cavity in the emergency room through a very small incision and with suboptimal illumination and instruments may pose significant difficulties. The time required for open DPL is also of particular concern. As most stable blunt trauma victims are recently evaluated by computed tomography, DPL is

Table 1 Explorations after negative or inconclusive DPL

DPL	Time for catheter insertion (min)	Volume of effluent returned (mL)	Reason for laparotomy	Procedure
Open	5	900	Haemodynamic instability	Non-therapeutic (non-bleeding liver laceration)
Closed	0.5	600	Haemodynamic instability	Nephrectomy (also, heart rupture repair)
Open	20	200	Abdominal tenderness	Negative
Open	10	50	Haemodynamic instability	Negative
Closed	20	800	Haematocrit drop	Negative
Open	4	50	Haemodynamic instability	Splenectomy
Open	4	500	Haematocrit drop	Non-therapeutic (pelvic haematoma)
Closed	1	100	Abdominal tenderness	Intraperitoneal bladder rupture repair
Open	15	—	Abdominal tenderness	Small bowel and colon repair

Table 2 Comparison between closed and open DPL in 130 patients

	Closed DPL ($n=55$)	Open DPL ($n=75$)	*P* values
Mean age	35.9 yrs	35.1 yrs	P = NS
Mean ISS	23.3	22.6	P = NS
Mean time	2 min ± 5	11 min ± 8	P < 0.0001
Range of time	0.5–20 min	3–40 min	—
Number of DPL over 10 min	3	44	P < 0.0001
Number of DPL over 20 min	0	13	P = 0.003
Mean time (in positive DPL)	1 min ± 3	6.5 min ± 5	P < 0.0001
Mean effluent returned	750 cc.	750 cc.	P = NS
Number of cases with less than 250 cc effluent returned	1	6	P = NS
Sensitivity	100%	92.8%	P = NS
Specificity	96.6%	100%	P = NS

Table 3 DPL results and laparotomies performed

		Laparotomy			
		Therapeutic	Non-therapeutic	Negative	No laparotomy
Closed DPL	Positive	18	4	1	—
	Negative	1*	—	1	28
	Inconclusive	1	—	—	—
Open DPL	Positive	11	2	—	—
	Negative	—	1	1	52
	Inconclusive	1	—	2	3

Three cases are not included in this table due to inability to insert the lavage catheter and derive a DPL result. * The injury was in the retroperitoneal space (kidney laceration).

reserved for patients who present with a haemodynamic instability and/or require urgent surgical intervention for associated extra-abdominal injuries. In this group of trauma patients every minute counts, and expeditious decision making followed by rapid intervention is the only way to provide optimal results.

The method of closed DPL with the use of a trocar has been invented with the purpose of expediting and simplifying the standard procedure.[10,11] In 1979, a modified Seldinger technique was described in order to decrease the risk of complications from blind insertion of the trocar.[8] The percutaneous DPL was performed significantly faster than the open method in two prospective randomized studies.[7,12] In addition, a retrospective review of 395 patients who underwent closed DPL suggested that it is a safe and accurate method with a sensitivity of 99% and a specificity of 98%.[13] On the other hand, in a prospective randomized study the percutaneous method was associated with major intra-abdominal complications.[6]

In our study no complications were detected with any of the methods that we used, proving the safety of both techniques when there is adequate senior supervision. However, DPL failed to provide conclusive information in 10 cases. Inadequate lavage fluid retrieval was the reason for failure in seven cases and inability to insert the catheter in the remaining three. The majority of failures (eight of ten) were associated with the open technique.

Sensitivities and specificities were similar in the two groups and ranged from 92.2 to 100%, reconfirming the high diagnostic yield which is to be expected by both methods. The time required for each technique, however, was significantly different between the two groups. We elected to choose time from incision of the skin to the initiation of unrestricted fluid infusion, rather than to completion of fluid infusion for various reasons. Estimation of the total time up to completion of the full procedure can be logistically difficult, if the patient is taken to the CT scanner or the angiography suite. Even more important is the fact that no certain endpoint for termination of the procedure can be defined. Some DPL may be terminated after a reasonable amount of fluid is retrieved, if other priorities need to be resolved. In other cases the waiting period may be prolonged until retrieval of all infused fluid.

Table 4 Failures of DPL

DPL	Reason for failure	Subsequent work-up	Result
Closed	100 mL effluent returned	Laparotomy (due to haemodynamic instability)	Bladder rupture
Closed	Inability to insert guidewire	Converted to open	Negative
Open	*200* mL effluent returned	—	Expired during resuscitation Autopsy: Severe head injury, no intra-abdominal pathology
Open	200 mL effluent returned	CT abdomen	Negative
Open	100 mL effluent returned	CT abdomen	Negative
Open	50 mL returned	Laparotomy (due to abdominal tenderness)	Negative
Open	Inability to penetrate fascia due to firm adhesion from previous operation	CT scan	Negative
Open	Difficulty in catheter insertion	Laparotomy (due to abdominal tenderness)	Small bowel—colon perforation
Open	50 mL fluid returned	Laparotomy (due to haemodynamic instability)	Splenic laceration
Open	200 mL fluid returned	Laparotomy (due to abdominal tenderness)	Negative

We found that the mean time required for placement of the catheter and initiation of fluid infusion was significantly shorter in the closed DPL group. Prolonged and tedious DPL procedures occurred more frequently in the open DPL group. Moreover, closed DPL was faster precisely in the population in which rapidity in information acquisition was essential: patients with grossly positive aspirates who need immediate transportation to the operating room.

In one case a closed DPL was converted to open due to inability to feed the guidewire, showing the need for flexibility in using both techniques. We certainly agree with Lopez-Viego *et al.*[14] that the two methods are not mutually exclusive but should rather compliment each other. Multiple attempts are not advisable and a low threshold for conversion to the other method or to other diagnostic modalities should be maintained. The closed technique is safe and more rapid and should be the procedure of choice for the haemodynamically unstable blunt trauma victim. Both methods can be taught safely and should be included in the surgical training.

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