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Peritoneal Lavage in the Diagnosis of Acute Surgical Abdomen following Thermal Injury

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Intraperitoneal sepsis is difficult to diagnose in thermally injured patients. We reviewed the use of diagnostic peritoneal lavage (DPL) in burn patients suspected of having intraperitoneal infection. Seventeen patients were identified in whom celiotomy, autopsy, or complete recovery could be used to validate the lavage results. A lavage was considered positive if there were greater than 500 white blood cells per mm^3 or if microorganisms were present on Gram stain. Six patients had a positive DPL and 11 patients had a negative DPL. There were six true positive, no false positive, ten true negative, and one false negative studies resulting in a sensitivity of 0.86, specificity of 1.00, and diagnostic accuracy of 94%. No complications related to the DPL occurred. This procedure is safe and will rapidly and reliably discriminate between patients needing urgent celiotomy and those requiring further investigation to identify a source of sepsis.

Acute abdominal conditions requiring surgery occur in 1% of patients following a major burn.[1] Diagnosing acute intraperitoneal disease in this population is difficult because of the frequency of extra-abdominal infection and a lack of reliable physical signs secondary to sedatives, analgesics, neuromuscular blockers, abdominal wall burns, mechanical ventilation, and patient obtundation. Despite the availability of sophisticated noninvasive diagnostic technology, the question of whether or not the cause of a patient's deteriorating clinical state is in the abdomen often remains unanswered.

Since 1965, when Root[2] introduced diagnostic peritoneal lavage (DPL), this procedure has become widely accepted and practiced in the evaluation of patients with abdominal trauma. Veith[3] first described the utility of DPL in nontraumatic acute abdominal disease in 1967. This clinical review evaluates the use of DPL in critically ill burn patients to identify those with nontraumatic acute surgical disease.

MATERIAL AND METHODS

The clinical records of 3061 consecutive patients admitted to the U.S. Army Institute of Surgical Research from 1978 through 1991 were reviewed. Of these, 21 patients underwent DPL for evaluation of suspected intraperitoneal sepsis. Patients evaluated by DPL for the evaluation of associated blunt trauma were not included. The clinical findings and factors obscuring the abdominal examination that influenced the decision to perform DPL were recorded.

To determine the clinical utility of DPL in these patients, a correlation with celiotomy findings, autopsy findings, or complete resolution of abdominal signs and symptoms without specific treatment was required. Three patients with negative lavages died without celiotomy or autopsy and the lavage fluid analysis was not recorded for one patient. The records of 17 of the 21 patients were complete and formed the basis of this study. A lavage was considered positive if there were greater than 500 white blood cells (WBC)/mm^3, greater than 100,000 red blood cells (RBC)/mm^3, or if microorganisms were present on Gram stain. A lavage was considered a true positive if surgical disease was found at celiotomy or autopsy. A lavage was considered a true negative if intraperitoneal surgical disease was absent at celiotomy or autopsy, or if the patient recovered without specific treatment for intra-abdominal disease.

RESULTS

There were 15 males and 2 females, with an age range of 21 to 82 years and a mean age of 45.5 years. The percentage of total body surface area burned ranged from 11.1 to 89.5, with a mean burn size of 51%. Eight patients had inhalation injuries. All DPLs were performed using the open technique[4] between the second and 220th day after the burn (mean postburn day = 39). The common clinical findings and factors that complicated the physical examination leading to the decision to perform a DPL appear in Table 1.

Six patients had a positive DPL, and five of those patients had abdominal exploration revealing surgical disease. The sixth patient with a positive DPL was unstable and died before an operation could be performed. The celiotomy and autopsy findings are summarized in Table 2. Eleven patients had a negative DPL, eight of whom had nonsurgical findings at autopsy. Two patients recovered uneventfully without specific treatment for intra-abdominal disease. The remaining patient had a negative DPL, but a changing physical examination with the development of right upper quadrant guarding led to celiotomy revealing acalculous cholecystitis. Thus, there were one false negative, no false positive, ten true negative, and six true positive lavages, yielding a sensitivity

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TABLE 1. Factors influencing decision to perform DPL

	Number of Patients
Clinical findings	
Sepsis syndrome	13
Abdominal distension	11
Ileus	7
Acidosis	7
Hypotension	4
Jaundice	4
Fever	3
Factors altering physical exam	
Analgesics/sedatives	17
Mechanical ventilation	15
Abdominal wall burns	14
Obtundation	13
Neuromuscular blockade	8

of 0.86, specificity of 1.0, and diagnostic accuracy of 0.94. No complications occurred as a direct result of the peritoneal lavage.

Fourteen of the 17 patients died, a mortality rate of 82%. One of the patients with a positive lavage and two with a negative DPL survived. Only one of the six patients requiring operation had residual peritonitis on postmortem examination, and the remaining deaths were associated with overwhelming pulmonary sepsis or multisystem organ failure. The predicted number of deaths in this group, based on a logistic regression analysis relating mortality to the age and extent of burn of all burn admissions during the study period,[5] would be 7 out of 17 patients (95% confidence limits of 4–10 patients) or 41%.

DISCUSSION

Despite the popularity of DPL in the evaluation of blunt and penetrating abdominal trauma, its use in the diagnosis of intraperitoneal inflammatory diseases is not widely practiced. Even so, the most commonly described indication for the use of DPL in evaluating nontraumatic disease has been in elderly, debilitated patients and chronic intensive care unit patients in whom the classic physical findings associated with peritoneal irritation are often unreliable.[6,7] The critically ill burn patient may be difficult to evaluate for intra-abdominal infection due to coexisting organ failure, sedation, painful abdominal burn wounds, an altered sensorium, and the need for mechanical ventilation.

TABLE 2. Intraoperative and autopsy findings in patients with positive DPL

Patient	Intraoperative Findings	Autopsy Findings
1	Cecal perforation	Residual peritonitis
2	Ileal gangrene and perforation Secondary to *Actinomyces*	No peritonitis
3	Acute cholecystitis, pancreatitis	Cytomegalovirus colitis (nonsurgical)
4	Acalculous cholecystitis	No peritonitis
5	Too unstable for operation	Necrotizing enterocolitis
6	Jejunal necrosis and perforation	Survived, no autopsy

Since Veith first described the use of DPL in nontraumatic acute abdominal disease, others[6,8–15] have confirmed his findings. Hoffman[16] reviewed the literature on the use of DPL in the diagnosis of nontraumatic acute abdomen in 1987. He identified 577 published cases in which DPL was used in this context. The accuracy of DPL ranged from 66% to 100% (mean 93%), which is similar to that reported in the trauma literature.[4] Our results in this series of critically ill thermally injured patients are similar, with a diagnostic accuracy of 94%.

The criteria for a positive DPL in this study were those classically described in the evaluation of blunt trauma.[17] The use of lower WBC counts with attention to the WBC differential has been reported[18] but has not been used in our institution. The one false negative DPL in our study occurred in a 56-year-old man with an 85% body surface area burn who developed sepsis, ileus, and abdominal distention 98 days following injury. Lavage fluid analysis showed only 2 WBC/mm^3. Right upper quadrant tenderness and guarding developed 24 hours later and celiotomy revealed acalculous cholecystitis that was effectively walled off from the peritoneal cavity by the greater omentum. The difficulty in diagnosing biliary disease with DPL has been previously described.[6] Conversely, the DPL may be falsely positive due to conditions not requiring surgical intervention such as primary bacterial peritonitis, mesenteric adenitis, nonperforated diverticulitis, and pancreatitis;[16] however, these conditions are rare in most reported series[1,2,6,9–14,16–18] and were not encountered in this study.

The open technique of DPL is preferred in these patients to insure proper intraperitoneal catheter placement and avoid injury to viscera that may be inflamed or adhering to the abdominal wall. This proved to be a safe method without local or intraperitoneal complications in this series.

Diagnostic laparoscopy in the intensive care unit has recently been described as a useful, minimally invasive means of diagnosing occult intra-abdominal sepsis in critically ill patients.[19] The added advantage of visualizing the viscera may be particularly useful in diagnosing cholecystitis, but comes at the expense of increased preparation time, procedure time, personnel and equipment requirements, and cost. Once the decision to perform DPL has been made, the results are obtained in less than one hour. In addition, abdominal insufflation may be more difficult in the presence of abdominal wall burns, cicatrices, and skin grafts, and more hazardous when ventilatory requirements are increased because of smoke inhalation injury and the hypermetabolic response to burn injury.

The mortality rate in this group of patients is greater than that predicted on the basis of age and extent of burn. This emphasizes the severity of illness in this subset of patients in which DPL was considered and suggests that more liberal use of this procedure, which is safe and reliable, might afford the earliest possible intervention when intra-abdominal sepsis is present. Additionally, for the eight patients not surgically explored, the negative DPL prevented an unneeded celiotomy

which historically has been associated with increased morbidity and mortality in these critically ill patients.[1]

CONCLUSION

This series represents the first report of the use of DPL in the evaluation of nontraumatic surgical abdomen in thermally injured patients. The diagnostic accuracy of 94% is similar to that reported for other critically ill patients in whom classical diagnostic methods prove unreliable. However, in the presence of classical signs of peritoneal irritation or the development of such following a negative DPL, the decision to perform a celiotomy should be based on the clinical exam and not the lavage fluid analysis. The open lavage technique is preferred, and no complications of this procedure occurred. DPL is helpful in diagnosing or excluding intraperitoneal inflammation as the source of sepsis in thermally injured patients with unreliable physical findings, thus allowing appropriate surgical intervention when findings are positive or avoiding unnecessary celiotomy when negative.

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