



Positive Predictive Value of Alkaline Phosphatase in Diagnostic Peritoneal Lavage (DPL) for the Need of Further Surgery in Patients with Torso Trauma

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Abstract

Background: Diagnostic Peritoneal Lavage (DPL) is a routine method for evaluating internal organ damage in patients with blunt or penetrating torso trauma. Internal organ damage can lead to elevated alkaline phosphatase (ALP) levels in the DPL fluid. In this study, the researchers aimed to assess the prognostic value of elevated alkaline phosphatase levels and the need for laparotomy.

Methods: In this study, the researchers evaluated 42 patients with torso trauma (18 penetrating and 24 blunt traumas). The ALP was positive for all the patients in DPL (2 IU/mL <). The hemodynamic status was stable, and there were no other positive findings in their DPL. All the patients underwent diagnostic laparoscopy to evaluate the Positive Predictive Value (PPV) of ALP in DPL.

Results: There were only three patients with significant laparoscopic findings, none of which required laparotomy. The PPV of ALP in DPL fluid for the diagnosis of internal organ damage was 7.1%.

Conclusions: Elevated DPL alkaline phosphatase levels have no predictive value to warrant for further laparotomy in hemodynamically stable patients, who had torso trauma, which had no other positive finding in their DPL.

Keywords: Diagnostic, Lavage, Peritoneal, Alkaline Phosphatase, Trauma, Torso

1. Background

Torso Traumas are one of the most common problems in patients referring to trauma centers, and debates remain over their treatment, especially in patients, who have no significant physical findings and are hemodynamically stable (1, 2). Because of the main concern of late diagnosis of internal organ damages in hemodynamically stable patients, laparotomy is a routine procedure in all patients with penetrating torso wounds at many centers (3). This attitude leads to 15% to 53% unnecessary and non-therapeutic laparotomies (1-3).

Accordingly, because of high unnecessary laparotomies and their complications, reported up to 41% (3), and for resolving delayed diagnosis of internal organ damages, selective operative management has been proposed (1, 2). In the recent decades, different therapeutic protocols have been suggested for treating hemodynamically stable patients requiring laparotomy (2). These protocols include serial physical examinations, local wound exploration with diagnostic peritoneal lavage, laparoscopy fol-

lowed by laparotomy, and CT scans (1, 3, 4). Furthermore, DPL is the accepted proper procedure for evaluating a patient with blunt and penetrating torso trauma (1), with 95% < accuracy in these patients (5). However, there are still patients undergoing emergent laparotomy because of abdominal trauma, which proves to be unnecessary according to surgery findings. One of the parameters that can reveal the need for laparotomy after DPL is to measure alkaline phosphatase (ALP) levels in DPL fluid. In this study, the researchers evaluated the diagnostic value of ALP in DPL as the prospects for further surgery.

2. Methods

This cross-sectional study included 42 patients with penetrating or blunt torso trauma referred to Imam Hossein hospital (a referral trauma center of Tehran, Iran) during 2012 to 2013. All these patients fulfilled the study criteria and signed an informed consent. This study was compatible with the ethical standards of the responsible

committee on human experimentation (institutional or regional) and with the Helsinki declaration of 1975 (revised in 2000). This study was registered and accepted at Shahid Beheshti University of medical sciences ethical committee (reference number 95919) 9/2012 (6).

This study excluded the following patients, who required emergent laparotomy:

- Hemodynamically unstable patients
- Peritonitis signs in physical examination (rigidity, rebound tenderness, generalized tenderness, and overt tenderness in the areas far from the penetration site)
- Evisceration
- Positive free fluid in FAST sonography
- Rectal bleeding and hematemesis
- Visible abdominal air in the plain abdominal or upright chest X-rays

This study also excluded patients requiring laparotomy due to positive DPL results other than ALP levels, Table 1 (7). The patients, who did not consent to laparoscopy or for whom anesthesia was harmful were excluded from the study.

To evaluate the need for emergent laparotomy, the researchers performed a thorough physical examination at the admission for all patients referred for torso trauma. In cases of definite need for emergent laparotomy, the study excluded patients from the study. Otherwise, all stable patients, who were susceptible to internal organ damages, according to the physical examination, underwent DPL. As mentioned above, this study excluded patients if the DPL result was positive for any criteria other than ALP (Table 1). This study only evaluated patients, whose ALP level was above 2 IU/mL. Patients were transferred immediately to the operating room for prompt diagnostic laparoscopy, and the need for further laparotomy was evaluated according to laparoscopic findings. Other patients were observed at the emergency ward for 24 hours for assessment of hemodynamic status, and if there was no change in the hemodynamic state, they were discharged.

2.1. DPL Procedure Explanation

At the supine position, the infra umbilicus region was prepped with betadine and draped with sterile drapes. A local anesthetic (2% xylocaine) was injected in the subdermal region below the umbilicus, in the middle. Three- to four-centimeter incisions were made at the midline below the umbilicus. The abdominal layers were incised, sharply and bluntly opening the peritoneum. A Peritoneal catheter (16 or 18 Fr Nelaton catheter) was introduced to the pelvic region inside the peritoneum. If 10 cc fresh blood was aspirated from the catheter, the DLP was considered positive. Otherwise, 1-L normal saline was lavaged inside the peritoneal cavity, making sure that the fluid reached all of the peritoneal cavity regions. Then 10 ccs of the lavage fluid aspirated from the catheter and was sent in three test tubes

for the biochemical and microscopic examinations of the desired items (as mentioned in Table 1). If any of the criteria criteria resulted in the lab exam, the researchers considered the DPL positive. For example, if there was > 100,000 red blood count (RBC) in microscopic examination of the penetrating abdominal stab wounds or > 10,000 RBC in thoracoabdominal penetrating stab wounds, the DPL was considered positive. The DPL was positive if there was > 500 white blood count (WBCs), > 19 IU/mL or bilirubin > 0.01 mg/dL in the aspirated lavage fluid (7).

2.2. Laparoscopy Procedure Explanation

Proper prepping and draping was done under general anesthesia in the supine position. A 10-mm port was introduced through the DPL incision in the peritoneal cavity. Insufflation was done with 13 mmHg CO₂. The camera was introduced through this port and thorough exploration accomplished with changing the patient's position. Then, one or two 5-mm was inserted to aid the comprehensive exploration of the abdomen. Finally, data was collected in prepared forms and analyzed to determine the positive predictive value of alkaline phosphatase levels in diagnostic peritoneal lavage (DPL) and the need for further surgery in patients with blunt torso traumas.

The ALP positive predictive value in DPL fluid was calculated from the following formula:

$$ALP \text{ Positive predictive value} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

3. Results

Among these 42 patients, there were 18 patients (42.80%) with penetrating and 24 (57.2%) with blunt torso trauma. There were four females (9.5%) and 12 males (90.5%). Mean age of all patients was 27.6 ± 8.6 SD (Range: 16 to 57 years old). The average age of a patient with penetrating injuries was 25.8 ± 6.8 SD (Range: 17 to 45 years old). Mean age of patients with blunt trauma was 28.9 ± 9.6 SD (Range: 16 to 57 years old).

Mean ALP Level was 10.6 ± 5.2 IU/mL (Range: 1 to 26) in all patients. The average ALP level was 11.56 ± 7.06 IU/mL (Range: 1 to 26) in penetrating and 9.29 ± 3.04 IU/mL (Range: 3 to 15) in blunt torso trauma. The difference between ALP concentrations in these trauma groups was not statistically significant (P = 0.216).

According to this study, the researchers noticed that among 42 patients with positive DPL results based an ALP levels, there were only three patients (7.1%) with significant laparoscopic findings, and none of them needed a laparotomy. All of these patients had blunt torso traumas. One had a hematoma in falciform ligament of the liver, and the other two had subtle injuries to mesenterium of the small intestine.

Table 1. Criteria for "Positive" Finding on Diagnostic Peritoneal Lavage (7)

	Anterior Abdominal Stab Wounds	Thoracoabdominal Stab Wounds
Red blood cell count	> 100,000/mL	> 10,000/mL
White blood cell count	> 500/mL	> 500/mL
Amylase level	> 19 IU/L	> 19 IU/L
Alkaline phosphatase level	> 2 IU/L	> 2 IU/L
Bilirubin level	> 0.01 mg/dL	> 0.0 mg/dL

The researchers calculated the positive predictive value of the ALP in DPL fluid (Based on the cut-off point of ≥ 2 IU/mL) as 7.1%.

4. Discussion

The most important outcome based on this study was that measuring ALP levels alone in DPL fluid could not determine the need for further laparotomy, because of low positive predictive value and this is in contrast with previous researches.

Furthermore, DPL is mostly used for internal damages after abdominal trauma, and in a number of studies, many benefits have been reported. Pham et al. in their retrospective study, evaluated 177 patients with torso trauma based on physical examination, and they declared that sensitivity and specificity of DPL in patients requiring laparotomy was 92% and 83%, respectively. They also compared the results with triple-contrast CT scan. They concluded that CT Scan has greater diagnostic value than the DPL in these cases (8).

Cothorn et al. evaluated the diagnostic value of DPL and local wound exploration (LWE) in need for further laparotomy in patients with penetrating abdominal injuries (Stab wounds), which had no indication for emergent laparotomy. They concluded that LWE and DPL are still effective procedures for evaluating the need for further laparotomy in the future (9). Recently, Hashemzadeh et al. studied the diagnostic value of RBCs in DPL fluid in 388 patients with a thoracoabdominal and abdominal stab wounds in Iran. All the Patients were hemodynamically stable and had no indication for emergent laparotomy. They reported valuable results from their research (10).

Salimi et al. studied 800 patients with abdominal trauma over 36 months at Sina hospital, Tehran, Iran during years 1990 to 2000. Overall, 111 of the patients needed DPL for further evaluation of internal organ damages, according to their study. They calculated the positive predictive value of DPL as 84% for the diagnosis of internal organ damages (11).

Another study by Zareh et al. evaluated 135 cases with abdominal trauma over 24 months during years 1999 to

2001. All of the cases underwent DPL and they calculated the positive predictive value of DPL as 90% (12).

It was reported that the value of alkaline phosphatase in peritoneal lavage has a very low sensitivity in the diagnosis of hollow viscus organs (13).

Marx et al. in 1983 proposed to measure ALP in DPL fluid for elevating the diagnostic value of this procedure. They investigated the diagnostic values of enzymes in DPL fluid in 29 dogs. They declared that ALP levels could play a major role in the diagnosis of isolated intestinal injuries, which could not be assessed based on WBCs and RBCs count (14).

Nowadays, it is mentioned in all surgery books that ALP levels higher than 2 IU/mL could indicate serious internal organ damages and is an indication for diagnostic laparotomy.

Some researchers have studied the diagnostic value of ALP in DPL fluid for the diagnosis of internal organ damages, and they came to different and sometimes paradoxical results. Contrary to this study is Jaffin et al.'s study. They investigated the diagnostic value of ALP in 672 patients with abdominal trauma, who underwent DPL, for the diagnosis of hollow organ damages. They noticed that ALP levels were greater than 10 IU/mL in all the 12 patients with small intestine trauma and three of the four patients with large intestine trauma. There was only one patient with ALP levels more than 10 IU/mL, who had no significant pathology. Jaffin et al. mentioned that ALP of more than 10 IU/mL in DPL could predict the need for future laparotomy with 99.8% specificity and 94.7 sensitivity. They suggested measuring ALP in patients, who had equivocal DPL findings, and they did not have a definite indication for laparotomy. They also noted that this method could cause an early diagnosis of patients with intestinal damages, without any rise in treatment costs (15).

In another study by Kapiszka et al., the diagnostic value of enzymes in DPL fluid for the diagnosis of internal organ damages was investigated. They studied 84 patients and measured Aspartic Transaminase (AST) and Alanine Transaminase (ALT) in DPL fluid. They came to the conclusion that enzyme levels above 10 IU/mL could be an indicator of liver damage and ALP above 3 IU/mL could be an indicator of damages of small-intestine, large-intestine, and mesenterium (16).

McAnena et al. also evaluated the diagnostic value of ALP levels in DPL of the patients with blunt or penetrating abdominal trauma in 1969. They noticed that in 28 patients with negative DPL based on RBCs count and ALP levels above 20 IU/mL, there were 13 patients with significant clinical injuries requiring laparotomy. Furthermore, 77% of these patients had small bowel injuries. In this study, the sensitivity, specificity and positive predictive value of amylase levels above 20 IU/mL for the diagnosis of internal organs injuries were 87%, 75%, and 46%, respectively. In three patients, amylase levels were above 20 IU/mL and Alp levels were above 3 IU IU/mL. They calculated sensitivity, specificity, and positive predictive value of these enzymes for the diagnosis of internal organ injuries, as 54%, 98%, and 88%, respectively. These researchers finally declared that elevated amylase above 20 IU/mL and Alp above 3 IU/mL in DPL fluid was highly suggestive of small-bowel damages and necessitates laparotomy. They also mentioned that elevation in each of these enzymes could be due to hollow viscus organs injuries, thus non-surgical follow-ups are not enough for these patients (17). Megison and Weigelt et al. came to the same conclusion in their study. They studied the diagnostic value of ALP in the diagnosis of significant internal organs injuries. In this study, they evaluated 292 DPL fluids of patients. Among these DPLs, there were 25 positives based on laboratory findings, and 66 were grossly positive. Furthermore, 13 patients had apparent intestinal injuries, four had grossly positive DPLs and four had positive DPLs bases on laboratory findings. Three of the latter patients had elevated ALP, Bill, and WBCs in their DPL fluid. In the one remaining, bowel injury was diagnosed based on bilirubin alone while the ALP was normal. Other patients were monitored for five days and discharged if they had no other injuries proven. They also concluded that ALP had no superiority over the other determinants of DPL, for the diagnosis of hollow viscus injuries. Furthermore, ALP was not diagnostic for the diagnosis of hollow organs injuries, and laparotomies based on ALP levels alone could lead to two unnecessary laparotomies (13).

To concede ethical issues in this study, the researchers only evaluated the patients, who were hemodynamically stable and had no other findings except positive ALP levels. All of these patients underwent laparoscopy; there were only three patients with positive findings, none of whom required laparotomy. Thus, according to the current investigation, elevated ALP in DPI fluid alone, has a low positive predictive value and the researchers could not take ALP into consideration as the need for laparotomy alone.

It should be emphasized that determining higher cut-off points for ALP alone, as in other studies, could lead to more accurate diagnostic and positive predictive value of this item and it needs further studies. Furthermore, considering elevated ALP levels with other DPL parameters (like elevated amylase levels) concurrently, it might raise

the diagnostic value of the ALP as the need for laparotomy. This subject also requires further investigations.

One of the major limitations of this study was considering ethical issues and the prospective nature of this study. The other limitation was evaluating only patients with ALP levels higher than 2 IU/mL, thus, specificity and negative predictive value (NPV), could not be calculated. Future studies with a greater sample size would be helpful in obtaining more accurate results that could be generalized to the entire society.

4.1. Conclusion

Based on the results of this study, ALP levels higher than 2 IU/mL in DPI fluid of hemodynamically stable patients, who had penetrating or blunt torso trauma, and had no other positive DPL criteria, had no positive predictive value for the need of future laparotomy. Performing an operation only based on elevated ALP levels greater than 2 IU/mL could impose unnecessary and excessive financial treatment, human and emotional costs on patients, their families, and healthcare services.

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