

# Diagnostic Peritoneal Lavage: an obituary?

Kevin Cassar

## Abstract

Diagnostic peritoneal lavage (DPL) has been used as a diagnostic procedure in patients with blunt abdominal trauma for almost a century. Its accuracy and reliability are high. However DPL is an invasive procedure and carries a small but significant risk of iatrogenic intra-abdominal injury. Besides, false positive rates as high as 24% have been reported with DPL. This results in unnecessary laparotomies in patients least able to withstand further insult. Ultrasonography used for the diagnosis of patients with intra-abdominal injury from blunt trauma is at least as sensitive and specific as DPL. Its positive predictive value is better than that of DPL. Besides ultrasound provides more information and can be performed rapidly. More importantly, it is non-invasive and therefore free of the complication rate associated with DPL. It is therefore no surprise that the use of DPL is declining both in Europe and the United States. Ultrasonography should be used in preference to DPL in the context of blunt abdominal trauma. Institutions receiving patients with such injuries should have 24-hour ultrasonographic facilities.

## Keywords:

Peritoneal lavage; ultrasonography; abdominal injuries

**Kevin Cassar** MD(Aberdeen), FRCS(Intercoll)  
University of Aberdeen, Aberdeen Scotland  
Email: k.cassar@abdn.ac.uk

## Introduction

Since being first fully reported in 1926<sup>1</sup>, diagnostic peritoneal lavage (DPL) has been accepted as an essential diagnostic procedure in the “haemodynamically abnormal patient with multiple blunt injuries”.<sup>2</sup> A recent article has again advocated its use<sup>3</sup> and the manual for Advanced Trauma and Life Support for Doctors (ATLS) still recommends DPL in the hemodynamically abnormal patient with multiple blunt injuries.<sup>2</sup> The enthusiasm for DPL however is rapidly waning, with the increasing availability of ultrasound (U/S), computed tomography and other diagnostic modalities. More and more institutions are accepting that “DPL may become obsolete”<sup>4</sup> and that ultrasound should be “the objective initial evaluation method of choice on a routine basis.”<sup>5,6</sup>

## Accuracy of DPL and ultrasonography

In Europe ultrasonography has displaced DPL in this context<sup>7</sup>, but the move has been slower in the United States.<sup>6</sup> The reluctance to accept U/S over DPL is partially due to the fact that DPL has enjoyed a reputation for accuracy and reliability. The specificity and sensitivity of DPL has been quoted as between 82.8% and 100%.<sup>8-13</sup> Those of U/S on the other hand had not been fully evaluated until recently for the purposes of assessment of blunt abdominal trauma.

Despite the high sensitivity and specificity rates described for DPL, Sozuer *et al*<sup>8</sup> showed that the false positive rate of DPL can be as high as 23.9% with a positive predictive value of only 76.1%. In their study out of 2010 patients with blunt abdominal trauma, 719 had a positive DPL. Of these, 156 (21.7%) underwent a non-therapeutic laparotomy. This has to be evaluated in the context of the morbidity and mortality associated with a negative laparotomy. A morbidity rate of 22% and a mortality of 6% have been reported in patients with blunt trauma undergoing a negative laparotomy.<sup>14</sup>

Ultrasound has now been shown to be as least as accurate as DPL in detecting free intraperitoneal fluid with a sensitivity and specificity quoted at between 73% and 93%, and 88 to 99.5% respectively.<sup>9,10,15-26</sup> Indeed in a recent study comparing the accuracy of ultrasonography, computed tomography and diagnostic peritoneal lavage in patients with abdominal trauma, ultrasound was found to have a higher accuracy (95%) than DPL (92%).<sup>27</sup> The positive predictive value of ultrasonography is also higher than that of DPL<sup>9,28</sup> which explains the lower negative laparotomy rate when ultrasound is used. Indeed the introduction of U/S to various institutions has produced a

significant drop in non-therapeutic laparotomies.<sup>9,28</sup>

Ultrasonography has the added advantage of being able to define intraperitoneal organ injuries and also detect retroperitoneal and even intrathoracic injuries. It also allows guided aspiration of fluid.

### Technical issues with DPL and ultrasonography

Performing DPL in obese patients and patients with previous abdominal surgery is difficult and often impossible. A meta-analysis of diagnostic peritoneal lavage for abdominal trauma found that technical difficulties occurred in more than 10% of cases.<sup>29</sup> The results of DPL in these situations may be unreliable and these patients are more likely to develop complications.

This situation is often compounded by the limited experience of surgical and emergency care staff in performing the procedure. The dwindling experience of surgical residents in the United States with the technique has been highlighted in an article by Davis *et al.*<sup>30</sup> They showed that the introduction of U/S in the teaching institutions diminished resident experience from 22 to 3 DPLs/resident/year. Similarly in the United Kingdom, 60% of surgical trainees and consultants working in major trauma units have performed less than 10 DPLs throughout the whole of their careers.<sup>31</sup> Furthermore the ATLS guidelines recommend that if gross blood or gastrointestinal contents are not aspirated, lavage is performed with 1000ml of warmed Ringer's lactate solution. The effluent is then sent to the laboratory for estimation of red cell and white cell count as well as a Gram's stain and these results determine whether the result is positive, mandating laparotomy. A recent survey of 40 British trauma units showed that less than a quarter of these units had "out of hours" facilities to analyse DPL samples.<sup>31</sup> Therefore even in those centres where surgical staff have the necessary experience with DPL, it is unlikely that the samples obtained could be analysed. Even when DPL is carried out successfully and samples analysed, the duration of the procedure may be unacceptable. Hodgson and colleagues found that the mean procedure time (i.e. excluding laboratory sample analysis and transport time) to perform DPL was 26.8 minutes.<sup>29</sup> In the context of the haemodynamically unstable patient this amounts to a considerable length of time.

Ultrasonography of course has problems of its own. The availability of ultrasonography and an experienced ultrasonographer is a problem in some countries. Until June 1999, Davis *et al.*<sup>30</sup> reported that in the United States only 10% of the graduating residents had ultrasound available after leaving their training institution. In other centres an experienced ultrasonographer may not be available outside normal working hours. Most hospitals in the United Kingdom receiving emergency admissions with abdominal trauma have full radiological cover. The exceptions are the smaller hospitals in remote and rural areas where use of DPL may still be justified. Han *et al.*<sup>32</sup> however showed that surgical trainees can learn essential U/S principles to allow them to detect free

intraperitoneal fluid in abdominal trauma patients. This has been confirmed by various studies, which have shown that surgical trainees at different levels of training can accurately interpret emergency ultrasound examinations for blunt trauma at a comparable level to attending radiologists after a short period of training.<sup>16,19,33,34</sup> A training programme has been developed at Emory University and Grady Memorial Hospital for educating surgical trainees in ultrasound techniques.<sup>35</sup>

Furthermore obesity and subcutaneous air can compromise the use of ultrasound but the proportion of indeterminate U/S scans in patients with blunt abdominal trauma has been shown to be minimal.<sup>36</sup>

The equipment used for ultrasonography is portable and ultrasonography can be performed in the resuscitation area while other procedures are going on. A hand-held ultrasound device (Sonosite 180) has been successfully used as the primary investigation in the acute evaluation of blunt abdominal trauma.<sup>37</sup> The time required to perform ultrasonography is much shorter than that for DPL and the result is immediately available. The average time to carry out the study was 10.6 minutes according to a prospective study by Healey *et al.* (38) and 2.6 +/- 1.2 minutes in another by Boulanger *et al.*<sup>15</sup>

### Complications

DPL is a relatively safe procedure but being invasive it is not without its complications. The rates reported for complications of DPL vary from 1.5%<sup>8</sup> to 2.3%<sup>11</sup> and include intra-abdominal injuries, such as bowel and bladder perforations, vascular injuries and even a pelvic kidney laceration.<sup>39</sup> The cumulative incidence of major complications after DPL across studies evaluated in a meta-analysis was 0.6%.<sup>29</sup> Although the rates are acceptably low, this has to be compared against the complete safety of the non-invasive U/S.

### Cost

The cost impact of utilising ultrasonography in the evaluation of patients with blunt abdominal trauma in a major trauma centre has been assessed by McKenney *et al.*<sup>40</sup> By effectively using ultrasonography in the evaluation of these patients a reduction in expenditure of 43% was achieved mainly as a result of an eight-fold reduction in the use of DPL and a two-fold reduction in the use of computed tomography. Similarly Thomas *et al.*<sup>17</sup> calculated the cost savings with the use of ultrasound evaluation against standard diagnostic evaluation in their institution to be of the order of \$100,000 per annum. Arrilaga *et al.*<sup>41</sup> also showed that the total procedural cost was 2.8 times higher in patients in a non-ultrasound group than in an ultrasound group.

With the availability of ultrasonography which is faster, safer, more cost-effective and at least as accurate as DPL, it is difficult to justify the use of DPL in the patient with blunt abdominal trauma. Institutions receiving patients with blunt abdominal injury should either have 24-hour radiological cover or train their surgical staff in ultrasonography.

## References

1. Neuhof H, Cohen I. Diagnostic Peritoneal Lavage. *Ann Surg.* 1926; 83:454
2. Advanced Trauma Life Support Student Course Manual for Doctors: American College of Surgeons Committee on Trauma 1997
3. Parks RW, Chrysos E, Diamond T. Management of liver trauma. *Br J Surg.* 1999; 86:1121-35
4. Wherett LJ, Boulanger BR, McLellan BA, Breneman FD, Rizoli SB, Culhane J et al. Hypotension after blunt abdominal trauma: the role of emergent abdominal sonography in surgical triage. *Journal of Trauma-Injury Infection and Critical Care.* 1996;41(5):815-20
5. Akgur FM, Tanyel FC, Akhan O, Buyukpamukcu N, Hicsonmez A. The place of ultrasonographic examination in the initial evaluation of children sustaining blunt abdominal trauma. *J Pediatr Surg.* 1993;28(1):78-81
6. McKenny KL. Ultrasound of blunt abdominal trauma. *Rad Cl N Am.* 1999;37(5):879-93
7. Kretschmer KH, Hauser H. Radiologic diagnosis of abdominal trauma. *Radiologie.* 1998;38(8):693-701
8. Sozuer EM, Akyurek N, Kafali ME, Yildirim C. Diagnostic peritoneal lavage in blunt abdominal trauma victims. *Eur J Emerg Med.* 1998;5(2):231-4
9. Bain IM, Kirby RM, Riwarri P, McCaig J, Cook AL, Oakley PA, Templeton J, Braithwaite M. Survey of abdominal ultrasound and diagnostic peritoneal lavage for suspected intra-abdominal injury following blunt trauma. *Injury.* 1998;29(1):65-71
10. Singh G, Arya N, Safaya R, Bose SM, Das KM, Khanna SK. Role of ultrasonography in blunt abdominal trauma. *Injury.* 1997; 28:667-70
11. Falcone RE, Thomas B, Hrutkay L. Safety and efficacy of diagnostic peritoneal lavage performed by supervised surgical and emergency medicine residents. *Eur J of Emerg Med.* 1997;4(3):150-5
12. Rhiner R, Riedtmann-Klee HJ, Aeberhard P. The value of diagnostic peritoneal lavage in emergency situations. *Swiss Surgery.* 1997;3(2):85-91
13. Nagy KK, Roberts RR, Joseph KT, Smith RF, An GC, Bokhari F, Barrett J. Experience with over 2500 diagnostic peritoneal lavages. *Injury.* 2000;31(7):479-82
14. Ross SE, Dragon GM, O'Malley KF, Rehm CG. Morbidity of negative coeliotomy in trauma. *Injury.* 1995;26(6):393-4
15. Boulanger BR, McLellan BA, Breneman FD, Wherret L, Rizoli SB, Culhane J, Hamilton P. Emergent abdominal sonography as a screening test in a new diagnostic algorithm for blunt trauma. *J of Trauma-Injury Infection and Critical Care.* 1996;4(6):867-74
16. Kern SJ, Smith RS, Fry WR, Helmer SD, Reed JA, Chang FC. Sonographic examination of abdominal trauma by senior surgical residents. *Am Surg.* 1997;63(8):669-74
17. Thomas B, Falcone RE, Vasquez D, Santanello S, Townsend M, Hockenberry S et al. Ultrasound evaluation of blunt abdominal trauma: program implementation, initial experience and learning curve. *J of Trauma-Injury Infection and Critical Care.* 1997;42(3):384-8
18. Porter RS, Nester BA, Dalsey WC, O'Mara M, Gleeson T, Pennell R et al. Use of ultrasound to determine need for laparotomy in trauma patients. *Ann Emerg Med.* 1997;29(3):323-30
19. McElveen TS, Collin GR. The role of ultrasonography in blunt abdominal trauma: a prospective study. *Am Surg.* 1997;63(2):184-8
20. Ingeman JE, Plewa MC, Okasinski RE, King RW, Knotts FB. Emergency physician use of ultrasonography in blunt abdominal trauma. *Academic Emerg Med.* 1996;3(10):931-7
21. Lentz KA, McKenney MG, Nunez DB jr, Martin L. Evaluating blunt abdominal trauma: role for ultrasonography. *J of Ultrasound in Medicine.* 1996;15(6):447-51
22. McKenney MG, Martin L, Lentz K, Lopez C, Sleeman D, Aristide G et al. 1000 consecutive ultrasounds for blunt abdominal trauma. *J of Trauma-Injury Infection and Critical Care* 1996; 40(4):607-10
23. Boulanger BR, Breneman FD, McLellan BA, Rizoli SB, Culhane J, Hamilton P. A prospective study of emergent abdominal sonography after blunt trauma. *J of Trauma-Injury Infection and Critical Care.* 1995;39(2):325-30
24. McKenney M, Lentz K, Nunez D, Sosa JL, Sleeman D, Axelrad A et al. Can ultrasound replace diagnostic peritoneal lavage in the assessment of blunt trauma? *J of Trauma-Injury Infection and Critical Care.* 1994;37(3):439-41
25. Akgur FM, Aktug T, Kovanhkaya A, Erdag G, Olguner M, Hosgor M et al. Initial evaluation of children sustaining blunt abdominal trauma: ultrasonography vs diagnostic peritoneal lavage. *Eur J Paed Surg.* 1993;3(5):278-80
26. Jehle D, Guarino J, Karamanoukian H. Emergency department ultrasound in the evaluation of blunt abdominal trauma. *Am J Emerg Med.* 1993;11(4):342-6
27. Al-Salamah SM, Mirza SM, Ahmad SN, Khalid K. Role of ultrasonography, computed tomography and diagnostic peritoneal lavage in abdominal blunt trauma. *Saudi Med J.* 2002;23(11):1350-5
28. Shih HC, Wen YS, Ko TJ, Wu JK, Su CH, Lee CH. Noninvasive evaluation of blunt abdominal trauma: prospective study using diagnostic algorithms to minimize therapeutic laparotomy. *World J Surg.* 1999;23(3):265-9
29. Hodgson NF, Stewart TC, Girotti MJ. Open or closed diagnostic peritoneal lavage for abdominal trauma? A meta-analysis. *J of Trauma-Injury Infection and Critical Care.* 2000;48(6):1091-1095
30. Davis JR, Morrison AL, Perkins SE, Davis FE, Ochsner MG. Ultrasound: impact on diagnostic peritoneal lavage, abdominal computed tomography and resident training. *Am Surg.* 1999;65(6):555-9
31. Maxwell-Armstrong C, Brooks a, Field M, Hammond J, Abercrombie J. Diagnostic Peritoneal Lavage analysis: should trauma guidelines be revised? *Emerg Med J.* 2002;19(6):524-5
32. Han DC, Rozycki GS, Schmidt JA, Feliciano DV. Ultrasound training during ATLS: an early start for surgical interns. *J of Trauma-Injury Infection and Critical Care.* 1996;41(2):208-13
33. Buzzas GR, Kern SJ, Smith RS, Harrison PB, Helmer SD, Reed JA. A comparison of sonographic examinations for trauma performed by surgeons and radiologists. *J of Trauma-Injury Infection and Critical Care.* 1998;44(4):604-6
34. McKenney MG, McKenney KL, Compton RP, Namias N, Fernandez L, Levi D et al. Can surgeons evaluate emergency ultrasound scans for blunt abdominal trauma? *J of Trauma-Injury Infection and Critical Care.* 1998;44(4):649-53
35. Rozycki GS. Surgeon-performed ultrasound: its use in clinical practice. *Ann Surg.* 1998;228(1):16-28
36. Boulanger BR, Breneman FD, Kirkpatrick AW, McLellan BA, Nathens AB. The indeterminate abdominal sonogram in multisystem blunt trauma. *J of Trauma-Injury Infection and Critical Care.* 1998;45(1):42-6
37. Brooks A, Davies A, Connolly J. Prospective evaluation of handheld ultrasound in the diagnosis of blunt abdominal. *J of the Royal Army Med Corps.* 2002;148(1):19-21
38. Healey MA, Simons RK, Winchell RJ, Gosink BB, Casola G, Steele JT et al. A prospective evaluation of abdominal ultrasound in blunt trauma: is it useful? *J of Trauma-Injury Infection and Critical Care* 1996; 49(6):875-83
39. Barba CA, Kauder D, Schwab CW, Turek PJ. Pelvic kidney laceration: an unusual complication of percutaneous diagnostic peritoneal lavage – case report. *J of Trauma-Injury Infection and Critical Care.* 1994;36(2):277-9
40. McKenney MG, McKenney KL, Hong JJ, Compton R, Cohn SM, Kirton OC et al. Evaluating blunt abdominal trauma with sonography: a cost analysis. *Am Surg.* 2001;67(10):930-4
41. Arrilaga A, Graham R, York JW, Miller RS. Increased efficiency and cost-effectiveness in the evaluation of the blunt abdominal trauma patient with the use of ultrasound. *Am Surg.* 1999;65(1):31-5