Indications

To gain access to the circulation in an infant where intravenous cannulation is not rapidly obtainable. In the trauma setting this is often in the child with hypovolaemic shock but may be required in other circumstances e.g. head injury. Rule of thumb: >2 failed attempts or 90 seconds without access in a shocked infant should lead to intraosseous access.

Equipment

- Sterile gloves.
- Gown and drape.
- Dressing pack.
- Chlorhexidine.
- 1% Lignocaine with a 5ml syringe.
- 24g needle.
- Intraosseous needle.
- Paediatric extension tubing.
- 5ml N/S flush.
- Thin brown tape.
- Clear plastic cup.

Technical Aspects

1. The needle is inserted with a sterile technique. It is important that one nurse assists in keeping the leg still and whose sole responsibility is to look after the line.

2. Insertion is best performed at the proximal tibia approximately 1cm below the tibial tuberosity medially on the tibial plateau. Alternative site is 1cm proximal to the medial malleolus.

3. Prepare site with chlorhexidine and drape.

4. Inject a few mls of local anaesthetic down to the periosteum.

5. Use a twisting action to screw the needle into the bone. Entrance to the bone marrow is felt with a “give”.

6. The trocar is then removed and the metal cannula will stand unsupported in the bone.

7. Bone marrow may then be aspirated to confirm position. Fluid should be able to be injected with constant pressure without swelling of the tissues.

8. Cannula is then secured with brown tape turned around the base and a plastic cup is taped over the cannula to protect it from accidental dislodgment.

9. Attach flushed T extension tubing to allow safe injecting of the cannula without dislodgment.

TIPS

- Make sure the leg is kept immobile during the procedure and that looking after the cannula is the sole duty of one specific person.
- Insertion, especially in the older infant, requires stronger screwing forces.
- Make the decision early to use an intraosseous needle rather than as a “last ditch effort”.
- Aspiration of bone marrow may occasionally be impossible or take considerable force. Free injection without swelling can then be used to confirm position.
- Intraosseous cannulae should be removed after good IV access is established following resuscitation.

Risks / Complications

- Avoid inserting through areas of infection, burns or fractures.
- Dislodgment may cause soft tissue swelling and the possibility of compartment syndrome.
- Fat and bone emboli occur commonly but are seldom of clinical significance.
- Osteomyelitis may occur but is uncommon.

LIVERPOOL HOSPITAL IS TRIALLING AN ADULT INTRAOSSEOUS INFUSION DEVICE – BIG™. INDICATIONS ARE SIMILAR

ARTERIAL LINES

Non invasive blood pressure (NIBP) recording devices have significant limitations for critically ill trauma patients. Invasive blood pressure (IBP) recordings provide an invaluable amount of information, which is more specific and sensitive than other commonly applied monitors (e.g. ECG, SaO_2, NIBP, etc).

The clinical value of IBP increases in proportion to the seriousness of the patient's injuries. It should never create a delay to definitive, often surgical, therapy. Preparation is essential (cables, pressure transducer and tubing readily available). There are rare indications for its use in resuscitation.

Indications

1. Need for beat to beat blood pressure recording and evaluation (e.g. unstable physiological conditions: need for real time therapeutic intervention / decision making).

2. Need for frequent arterial blood sampling and analysis.

3. NIBP techniques unavailable, unreliable or inappropriate: eg. NIBP impossible / difficult due to injury or intravenous cannula site. The latter is especially important if intermittent disruption of drug administration would be of clinical concern.

Absolute Contraindications

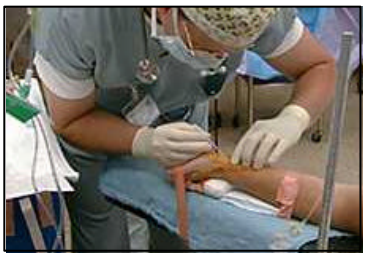
- Insertion into a traumatised artery.
- Insertion proximal to the site of critical limb perfusion.
- Insertion into an arterial graft or surgically repaired artery.
- Insertion through a proposed urgent angiography site.
- Insertion through an infected skin site.
- Perfusion to limb distal to site of insertion can not be clinically monitored.

Relative Contraindications

- Proximal or end artery
- Coagulopathy.

Techniques (in order of preference)

1. Seldinger.
2. Flush back, following insertion through only the anterior wall of artery.
3. Flush back, following insertion through anterior and posterior arterial walls.



- No matter what the technique, it should be done under sterile conditions (betadine and chlorhexidine skin preparation, sterile gloves, drapes and tray).
- For adult patients, use a 20G cannula (the longer the better, especially for femoral arterial access).
- For children use a 22 or 24G cannula.
- Do not suture the cannula to the skin.
- Secure cannula and monitoring tubing thoroughly with a transparent dressing.
- For monitoring tubing use low compliance, transparent, short, minimum volume tubing clearly differentiated from other vascular

tubing (usually a red line, tape or label) and with no intravenous drug injection port.

- Appropriate transducer and cable.
- Normal saline intravenous fluid bag as the source of the flush solution (no need to add heparin or other anticoagulant to it) Intravenous fluid, pneumatically controlled pressure infuser (pressurize to at least 20+ mmHg above arterial pressure – commonly set at 300 mmHg).

Pressure Monitoring

1. Check position of transducer, in reference to the level at which you wish to record blood pressure (commonly at level of cannulated artery) and zero reference (to atmosphere) prior to recording.
2. Examine the arterial trace for over and under damping effects, which can lead to misleading measurements and trace interpretation.
3. Monitor trace continuously.

In the 1970's it was popular to use a Nelson Empyema Trochar and Cannula with insertion of a Malecot or a De Pezzer catheter through the cannula. Dr. Cliff Pollard designed the Pollard intercostal catheter forceps, allowing a Seldinger type insertion of a chest tube through a metal dilating forceps[1]. More recently, Waksam and colleagues have advocated the use of an endoscopic trocar cannula for chest drain insertion [2].

THE OPEN TECHNIQUE OF INSERTION IS THE SAFEST.

Complications that occur are related to insertion in 20% of cases, residual pneumothorax in 25% and infection in 55% [3].

NOTE: Inappropriate placement - left chest drain is too low.

Outlined below are the 9 S's of successful, safe chest tube insertion:

- **Sedation:** it is essential that the patient receive adequate analgesia and perhaps amnestic agents (of course tailored to the patient's haemodynamic stability).
- **Site:** a safe area above the nipple level posterior to the anterior axillary fold should be chosen.
- **Sensitive:** finger dissection will reduce insertion complications.
- **Sterility:** is paramount, with single-dose antibiotic prophylaxis[4].
- **Suturing:** to fix drain and place purse-string using a heavy silk suture.
- **Suction:** should be applied to the drain (~ 20cm H_2O).
- **Seal carefully:** on removal of chest tube.
- **Side effects:** are related to poor technique [5].
- **Sessions:** with cardiothoracic operating list will improve the technique.

The technique for chest tube insertion must be safe, thoughtful and may involve, on occasion, the use of adjuncts such as a flexible introducer, Pollard intercostal forceps or an endoscopic insertion.

TIPS

- Know the name of the Procedure Nurse.
- Be familiar with the chest trolley in resus.
- If you are taking more than 5 mins - get help.
- Use antibiotic prophylaxis.
- Do not insert too far.
- Rarely use a thoracocentesis needle.
- Do not insert too low or over internal mammary artery.

WHEN DO YOU USE A THORACOCENTESIS NEEDLE?

When you get caught unaware:

- CT scan
- Lift!

It indicates that you are out of control.
You should be able to place an ICC just as quickly – IF NOT, PRACTISE!

REMEMBER THE 3 GREAT CHEST DRAIN LIES

- "I will only put it in a little bit"
  (in >8cm will kink!)
- "It will not take long"
  (often takes >5 minutes)
- "There will be no problems"
  (>10% complication rate)

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FOCUSED ABDOMINAL SONOGRAPHY IN TRAUMA (FAST)

Chapter 8

INTRODUCTION

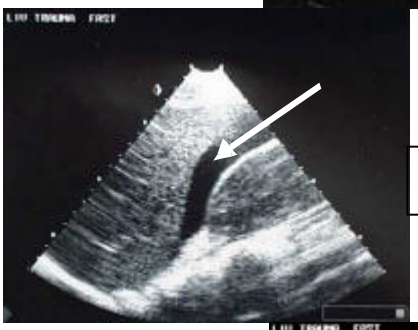
The use of ultrasound in the evaluation of abdominal trauma continues to evolve. Much has been written as to the utility of ultrasound in both blunt and penetrating abdominal injury[1-4]. In many centres, FAST has largely replaced diagnostic peritoneal aspiration (DPA) in the immediate abdominal evaluation of the haemodynamically unstable patient in the resuscitation room.[5-7]. The procedure is performed by an accredited person and the information used to decide on subsequent investigations or operations. The areas examined include the hepatorenal space, splenorenal recess and the retrovesical space. When indicated the pericardium should also be evaluated. FAST can also be used to evaluate the pleural space for evidence of effusion.

APPLICATIONS / INDICATIONS

FAST is currently used in the rapid evaluation of the abdomen for evidence of free fluid. This is of course most useful in the haemodynamically unstable patient suffering multiple system blunt injury to quickly determine whether the patient should proceed to immediate laparotomy. It is also useful in the evaluation of a haemodynamically stable patient suffering blunt abdominal injury, but results should not be used to make a decision to operate immediately in this particular situation as CT scanning is more specific and provides more information.

Penetrating abdominal trauma can be assessed with FAST but its sensitivity for small amounts of free fluid or hollow viscus penetration is poor. FAST is most useful in penetrating trauma to assess the pericardium in wounds near the heart for evidence of pericardial effusion or tamponade.

LUQ - No free fluid



RUQ - large amount of free fluid

Large pericardial effusion

ADVANTAGES OF FAST

- Rapid.
- Repeatable.
- Non-invasive.
- The investigation of choice in pregnant women.

LIMITATIONS OF FAST

- Operator dependent.
- Poor sensitivity in penetrating trauma.
- Misses hollow viscus (bowel) injuries.
- Does not evaluate retroperitoneal organs or retroperitoneal space for bleeding.
- Does not assess specific organ injury or function.
- Subcutaneous emphysema and bowel gas limit sensitivity.
- After hours availability.
- Hard to do when patient is on spine board.

ACCREDITATION / QUALIFICATION

Accreditation varies between institutions and countries. Currently FAST at Liverpool Hospital can be performed by any doctor who has met certain requirements. These include completion of a recognised course in the application of ultrasound in the emergency department or trauma setting. The course will include technical information on ultrasound mechanics and theory as well as procedural and machine variations. The course should also include real-time examinations of live patients, some of which have positive findings.

Once the course is completed, accreditation includes the examinations of at least 30 patients, of which at least half must be indicated in trauma and ten percent must have positive findings. The accuracy of the FAST examination is proportional to the experience of the individual user and the frequency of examinations. Each provider utilising FAST should maintain a record of examinations for ongoing QA purposes.

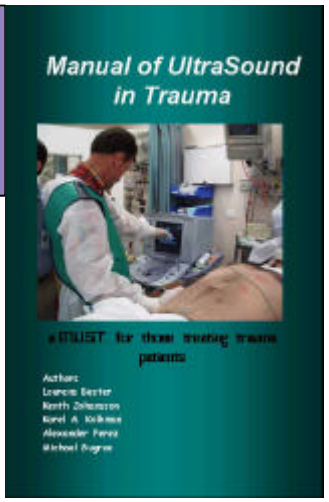
REPORTING

Results should be reported as positive or negative.

- All pertinent areas must be adequately visualised to make this determination.
- If the bladder is empty then it should be distended with 150-200 mls of sterile normal saline.
- If unable to visualise all areas then another examination (DPL or CT) should be performed to adequately assess the peritoneal cavity.
- The result is to be recorded by the scribe nurse in the patient's resuscitation record along with the name of the accredited doctor performing the examination.

Examinations by unaccredited users should not be reported, nor the information used in clinical decision-making.

PS: If you would like a free copy of our MUST (FAST) Manual - contact the Trauma Department at Liverpool Hospital.



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DIAGNOSTIC PERITONEAL ASPIRATION (DPA) / DIAGNOSTIC PERITONEAL LAVAGE (DPL)

DPL has been around since 1965. It is a good test, with some limitations and should be used in Liverpool for the unstable blunt trauma patient or patients with suspected bowel injuries.

Remember DPL is NOT an antiquated test – there were 383 DPLs performed between 1995 and 1999 at Liverpool of which 30% were positive.

BLUNT TRAUMA

The choice of definitive investigation in blunt trauma rests with DPL, FAST, CT scan and laparoscopy. The choice depends on two key factors:

1. Patient's stability
2. Prediction of underlying organ injury.

DIAGNOSTIC PERITONEAL ASPIRATION (DPA) / DIAGNOSTIC PERITONEAL LAVAGE (DPL)

In the presence of **haemodynamic instability**, a DPA or FAST is ideal in determining the presence of haemoperitoneum and the need for immediate laparotomy. Remember, up to 50% of patients with suspected intra-abdominal injury are hypotensive due to a non-abdominal cause. Therefore rapid assessment of the abdomen is essential.

A further key issue in the **stable** patient is whether one will adopt an operative or non-operative approach as indicated by the mechanism of injury. If one is tending to a non-operative approach, such as in a patient following contact sport trauma with potential splenic injury, DPA is contraindicated as a positive result in terms of RBC will increase the pressure for operative management, which in a stable patient is inappropriate.

If one has a high index of suspicion of small bowel injury, DPL is the test of choice. DPL has, in the past, been a gold standard for evaluation of haemoperitoneum. It is highly sensitive in detecting the presence of intra-peritoneal blood. It has the disadvantage however of not predicting the need for laparotomy *per se* and will increase non-therapeutic laparotomy rate. It has been extensively validated.

PITFALLS OF DPA / DPL

1. Technique – closed technique, increased risk of bowel perforation. Over 8 mins required for infusion of fluid if standard IV used. All catheters tend to plug with omentum resulting in restriction of effluent return. Frequent adjustment of catheter is required to get return.

   The Liverpool Hospital open technique using a large bore catheter is much quicker[1]. (see Figure 1)

FIGURE 1 – Large Bore DPL Catheter

2. Interpretation of DPL.
   Whilst over 50% of surgeons utilise bedside interpretation of DPL effluent for RBC count, this is fraught with hazards. Ability to read print through IV tubing is an inaccurate art. The effluent should be sent for objective laboratory analysis.

The following constitute a positive DPL in blunt trauma:

- Red cell count > 100,000/mm^3.
- White cell count > 500/mm^3.
- Alkaline phosphatase > 20 IU/L.
- Amylase > 20 IU/L.

The use of Gram stain and detection of vegetable matter is not a particularly useful technique. Recently it has been suggested that quantitative white blood cell criterion for detection of intestinal injury, supplemented by an adjusted white cell count/red cell count ratio, will decrease non-therapeutic laparotomy rate associated with DPL. It is suggested that the white cell count to red cell count ratio of 150 or greater, indicates a gastrointestinal tract perforation requiring surgery.[2]

DISADVANTAGES OF DPA / DPL:

- Oversensitive RBC count – giving rise to non-therapeutic laparotomies.
- Does not provide organ specific diagnosis.
- Misses retroperitoneal haematomas.
- Invasive.
- Painful in conscious patients.

Sequential DPL is very useful particularly in multi-system trauma patients undergoing multi-cavity surgery where the DPL catheter can be left in place and repeat DPL performed (See Figure 2). Remember that 25-30mls of frank intraperitoneal blood in a patient with a normal haemoglobin will result in a DPL fluid red cell count of 100,000/mm^3.

FIGURE 2 – Sequential DPL

Special concerns have been raised in the past in performing DPL in pregnant women, children and in patients with pelvic fractures.

- FAST is superior in pregnancy.
- In paediatric trauma, the problem with DPL is its over sensitivity and the tendency to lead to non-therapeutic laparotomies, particularly with solid viscus injuries.
- In pelvic fractures, care must be taken as false positive rates of up to 30% have been reported.

The reported high false positive rate in DPL in the presence of pelvic fractures have been attributed to many factors:

1. Dissection of the retroperitoneal pelvic haematoma.
2. Direct placement of the catheter into the retroperitoneal haematoma.
3. Extravasation of blood from the retroperitoneal haematoma.
4. Time dependent diapedesis of red cells across the peritoneum.

It is important to undertake DPA or DPL early in patients with pelvic

fractures (< 30 minutes post arrival). The haemodynamically stable patient with a positive diagnostic peritoneal lavage may be treated non-operatively in certain circumstances, particularly in the presence of a normal white cell count, alkaline phosphatase or amylase. Therefore, in a stable patient, the only definite indication for DPL is a high index of suspicion for bowel injury.

DPL is useful in penetrating trauma but we recommend laparoscopy to determine if there is peritoneal penetration (see page 108).

LIVERPOOL TECHNIQUE OF DPA / DPL

1. Use an assistant.
2. Umbilical approach.
3. 10mm incision: use 2 cats paw retractors.
4. Through umbilical cord into peritoneal cavity.
5. This is an avascular plane-no diathermy required.
6. Use a big bore catheter.
7. Attempt to aspirate blood (> 10mls frank blood = +ve DPA)
8. Infuse 1L warm normal saline through a TURP giving set.
9. Remember to send and GET the results of the DPL before discarding effluent.
10. You can leave the catheter in to repeat later.

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