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Vol. 2 No.2 JULY 1999

TRAUMA Grapevine

Contents:

Introduction

Rapid provision of appropriate trauma care is a key factor in trauma outcomes. While it is appropriate to remember Dr Trunkey's "Golden Hour", the time has come to shorten it. Minimizing time to definitive care is particularly important in penetrating trauma. The review of penetrating abdominal trauma in this issue highlights this. It is time to look to the Platinum "30 Minutes" in unstable trauma patients with penetrating trauma. This "30 minutes" should allow no more than 5 minutes scene time (once the scene has been declared safe), 10 minutes maximum in resuscitation room, 5 minutes setting up in the operating theatre, allowing the achievement of surgical haemostasis within 30 minutes of injury in the urban environment. These times may seem a little ambitious but put yourself on the resuscitation trolley, having sustained an epigastric stab wound, with a BP of 80! You might be brave enough to speculate that the time to haemostasis was in fact too long!

In Australia we have excellent training to develop advanced airway skills, but occasionally one meets an airway challenge and Dr Hunt and Fletcher have provided some more practical advice for us on airway care.

It will be wonderful to have Dr's Trunkey Boffard and Hodgetts back for SWAN 7 to debate these type of issues, and to be joined by Margaret Knudson (San Francisco), Jorie Klein (Dallas) and Don Jenkins (San Antonia) will make it a meeting never to be forgotten!
There are still some places left you can book through Thelma (02) 9828 3928.

Michael Sugrue

Tracheal Intubation in Head Injury: A Practical Guide

Part 2. Intubation in head injury- How?

Cameron Hunt BSc, MB BS Anaesthetic Department, Liverpool Hospital
Stephen Fletcher MB BS, FRCA, MRCP Intensive Care Unit, Liverpool Hospital

Introduction

The first part of this article discussed the rationale behind tracheal intubation in head injury, complications of intubation and choice of anaesthetic agents. The second part gives practical advice on the conduct of intubation.
The task of the trauma team is to prevent secondary brain injury, particularly by avoiding hypotension and hypoxia, which are independent predictors of a worse neurological outcome [1,2]. Tracheal intubation helps prevent hypoxia, but must be conducted in such a way as to avoid hypotension.

The rapid sequence induction

Trauma, pain and the use of opioids reduce gastric emptying. Large amounts of blood can be swallowed from upper airway injuries; blood is highly emetogenic. All trauma patients are therefore assumed to be at risk from regurgitation and aspiration. The rapid sequence induction (RSI) aims to minimise the risk of aspiration by keeping the period between 'full' consciousness and intubation as short as possible. Consciousness should be presumed to be affected as soon as the anaesthetic agent enters the vein. For this reason also, slow titration of anaesthetic agents against conscious level is inadvisable; the dose of anaesthetic should be predetermined and given as a bolus.

Preparation

Ideally, there will be an airway doctor to perform intubation, a second person to apply cricoid pressure, a third person for manual inline immobilisation of the cervical spine and a fourth to administer drugs. A team member should be identified who is ready and able to create a 'surgical' airway. The team leader should be free to supervise proceedings and watch the monitors.
A useful mnemonic to aid preparation is: 'SALT MINE'

Suction. Check this is working and conveniently located. Consider, if there is extensive bleeding, preparing a second suction line in case the first blocks at a crucial time.

Airway. An appropriate sized Guedel (oropharyngeal) airway and range of nasopharyngeal airways

Laryngoscope. A selection of blade sizes and shapes is fine but in a stressful or difficult intubation the best blade may be the most familiar one. Always check the adequacy of the light and tighten any loose bulbs.

Intubation in head injury - How?

Continued

Tube. Check the cuff and pilot balloon remain inflated with the syringe removed. Have a full range of sizes immediately to hand.

Monitoring. Oximetry, blood pressure, ECG and capnography. Check that this is attached, working and review the values and trends.

IV line. Ensure that this is securely taped, running freely and the fluid in the bag is not just about to run out.

Need help? Think about whether a difficult intubation can be anticipated from the patientís anatomy or injuries. Do you need to call for a more experienced person? Have an introducer and gum elastic bougie ready. Where is the cricothyroidotomy set and who will perform one if necessary? Remind yourself of your failed intubation drill.

Explain. Make sure everyone knows what his or her role will be. Ensure the cricoid cartilage has been correctly identified and pressure maintained until instructed. Ensure the manual in-line immobilisation is correctly applied. Ensure that the person administering drugs knows how much and what to give and when to give it. If the patient is conscious explain to them what is happening.

The induction sequence is:

Pre-oxygenation. This is important to fill the functional residual (lung) capacity with oxygen to act as a reservoir during apnoea. Whilst reassuring under ideal conditions, (a young person can remain apnoeic for some minutes before desaturating), ideal conditions are rarely met in the emergency situation. As mentioned above, extremes of age, acute or chronic lung disease, pregnancy and obesity markedly reduce tolerance of apnoea. Pre-oxygenation should be done using 100% oxygen given by Ambu or Laerdal bag and mask. The mask should be closely applied to prevent entrainment of air. If the patient is clearly hypoventilating then it is appropriate to assist inspiration manually.

Cervical spine control. Manual in-line cervical spine immobilisation should be performed along ATLS/EMST guidelines. In general, the anterior portion of the cervical collar should be removed to allow full mouth opening.

Give the drugs. These should be given as boluses; decide on the dose and give it. There is no time for careful titration of drugs. Give a flush after each bolus.

Apply cricoid pressure. As soon as the patient starts to lose consciousness or sooner if already obtunded, apply force equivalent to five kilograms vertically down onto the cricoid.

Wait. Wait until the patient is fully anaesthetised and relaxed. Do not remove the bag/mask until ready to intubate. When using suxamethonium, onset of fasiculation usually indicates jaw relaxation. Do not manually ventilate the patient during this time unless desaturation occurs; any matter in the upper airway will be blown into the lungs.
Intubate. If the airway doctor is less experienced, it is helpful if they calmly describe their view of the larynx as they obtain it. It is useful for the team leader to know how things are going so as to know if help should be offered sooner rather than later.

Inflate the cuff and confirm the position of the tube. Resist the temptation to insert the tube too far. Note the distance of the tube at the teeth and hold onto the tube yourself.
Observe normal chest expansion and confirm bilateral equal breath sounds, the absence of gastric bubbling sounds, and no leak around the cuff when the balloon is inflated. Check the capnograph pattern and look again at the capnograph after 30 seconds to ensure the trace is still present. Monitor oxygen saturation. If there is any doubt, perform laryngoscopy again to check the position of the tube: 'If in doubt, take it out'. Cricoid pressure can be removed when endotracheal tube placement is confirmed.

What next?

Commence positive pressure ventilation by bag and check chest movement, breath sounds, oxygen saturation and end-tidal carbon dioxide. Beware the development of a pneumothorax; a small pneumothorax can become large with the onset of positive pressure ventilation. Insert an orogastric tube and decompress the stomach. Obtain a chest x-ray; the tip of the endotracheal tube should sit around three centimetres above the carina.

Mechanical ventilation should be instituted once the situation is stable. Use an Oxylog or similar portable ventilator. Typical initial settings for a 70 kilogram adult might be a tidal volume of 700 millilitres, respiratory rate of 12 to 14 breaths per minute and, initially, an inspired oxygen fraction of 1.0 ('No air mix' on the Oxylog). The value of positive end expiratory pressure (PEEP) is debated. Set PEEP to zero unless there is arterial desaturation despite a high inspired concentration of oxygen; then apply PEEP of two to four centimetres of water. Minute ventilation should be titrated against the carbon dioxide tension as determined by blood gas analysis (end-tidal carbon dioxide analysis may not correlate with arterial carbon dioxide tension). Normocarbia (40 mmHg) is the aim.

Sedation is mandatory in all patients except the extremely shocked. An infusion of morphine and midazolam is acceptable. Propofol is widely used. Use relaxants after intubation to facilitate mechanical ventilation and avoid ICP rises associated with coughing and straining.

What if I cannot intubate the trachea?
Remember that it is failure to ventilate and oxygenate not failure to intubate that will cause patient harm. For a detailed flow chart showing what to do in the event of failure to intubate see Williamson et al. [3].

As a brief guide, in case of failure to intubate on the first attempt:

Maintain cricoid pressure.

Three C's: Call for help, Check pulse, colour, saturation, ECG and Clock; be aware of the passing seconds.

Are there any simple manoeuvres that will improve conditions? Will suctioning or external manipulation of the larynx bring the glottis into view?

Consider further attempts at intubation. An introducer can be used to adjust the shape of the tube. A bougie can be passed into the trachea (blindly, if necessary, placement confirmed by feeling the tracheal rings as it is advanced). The tracheal tube is passed over the bougie and into the trachea by using a twisting motion. Only give further anaesthetic or relaxant drugs if you are totally confident that intubation will be successful immediately thereafter.

At the first sign of desaturation or if time is passing, the patient should be ventilated manually with 100% oxygen using standard manoeuvres and aids to maintain the airway. There is a risk of aspiration when doing this, but the risk from failure to oxygenate is obviously greater.

Get expert anaesthetic help at this stage, whilst continuing to maintain ventilation and

LETTER TO THE EDITOR

To the Editor

I refer to the 'case of the month' in the last issue of your Trauma Department publication. This involved the 46 year old MB rider involved in a high speed accident. The diagnosis was 'intimal flap in subclavian artery with associated brachial plexus injury'.

It has been my experience that the arterial injury in these patients is often best treated conservatively. As you would be aware it is the severity of the brachial plexus injury which is the major prognostic factor in these patients. In fact in the very extreme case the earlier these patients can be convinced to have an upper limb amputation the better!

Generally subclavian artery injury, of the type mentioned, is well collateralised and it is my experience that the arm is usually not severely ischaemic. This combined with the fact that the first part of the subclavian artery is not very accessible surgically, suggests that it may be better to defer urgent vascular surgery and consider re-vascularisation at a later date if there are in fact claudication type of symptoms in the upper limb which recovers reasonable neurological function. Proximal control of the subclavian artery is difficult and frequently requires a sternal split and in the presence of major trauma operation in this area can be extremely hazardous.

Fortunately the injury is rare but I have never had to personally operate on any of the cases with which I have been associated.

I would value your comments on the above.

Yours sincerely,
STUART HAZELTON
VMO, Liverpool Hospital

Comment
Having established the arm is viable a non-operative approach is an acceptable option. There are few good reports on the topic and in a "ilarge" series of 15 patients with blunt subclavian injuries, 8 were critically ischaemic requiring urgent surgery and 4 were successfully managed non-operatively(1). Each patient can therefore be managed on his or her clinical signs.

1. Costa MC Robbs JV 'Non penetrating subclavian artery trauma" J Vas Surg 1988; 8:71-75.
Editor

To the Editor,

It was interesting reading your review of BAI in the TRAUMA Grapevine (we call it TAR- traumatic aortic rupture).There are a few points that I don't quite agree on though.

BAI is not necessarily a full thickness "3 layer". If it is, then death or a large haematoma with instability and early death results. More commonly, in those arriving alive, only intima and media are torn with adventitia "bulging" but intact - which gives the classic angiographic appearance. The intima and media ends separate. These patients need surgery as other system injuries permit. This injury also causes turbulent blood flow readily seen on TOE. They can be missed and form late aneurysms.

Rarely only an intimal tear may occur, such as the case you reported. In years gone by many of these were probably never seen, and they probably heal without problem. Newer imaging modalities make these easier to diagnose. If the media is intact probably nothing need be done other than follow up imaging.

You seem very keen on CT imaging, however this is not as good as you think. It is useful to diagnose haematomas, but you can have a TAR without any haematoma. Its convenient if they need abdo or head CT. TOE is a very useful tool as it can be done at the bedside saving transporting unstable patients. It also gives great assessment of myocardial function, ascending aorta and pulmonary vessels. It does miss the distal ascending aorta (a very rare site for TAR) and cannot assess the great vessels. If you want to go with only one imaging modality you will make mistakes: pick the modality that fits the clinical setting.

Yours sincerely
Hugh Wolfenden
VMO Cardiothoracic Surgeon Liverpool Hospital

Comment
There is no doubt that CT, TOE and Arch Aortography all have limitations. CT requires special cuts and careful reporting and TOE is very operator dependent. As Dr. Wolfenden points out, unless one is vigilant mistakes will be made.

Meetings

SWAN 7 will be held on the 5th & 6th of August, 1999, bringing to you six (6) of the world leaders in Trauma care from overseas.

Dr. Don Jenkins, San Antonio, USA
Dr. Peggy Knudson, San Fransisco, USA
Dr. Ken Boffard, Johannesburg, Sth Africa
Dr. Don Trunkey, Oregan, USA
Ms Jorie Klein, Dallas, USA
Lt. Col. Tim Hodgetts, Aldershot, UK

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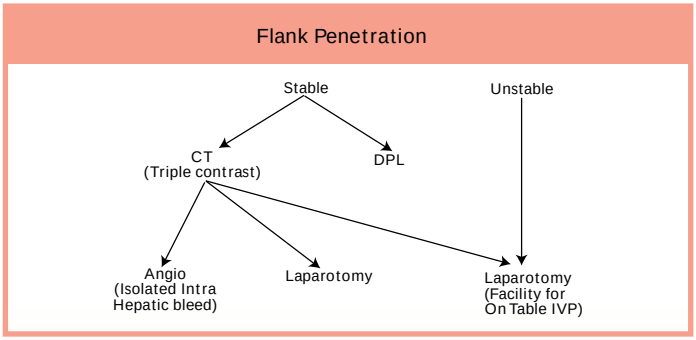
Penetrating abdominal trauma

Continued



Diagnostic Peritoneal Lavage

Since its introduction in 1965, diagnostic peritoneal lavage has proven to be an accurate and simple method of determining the need for abdominal surgery. It is perhaps over sensitive. It is essential for penetrating trauma, that the following values be used:
Positive red blood cells >10,000/mm3 (1/10 Blunt Trauma Value)

Focused Abdominal Sonography in Trauma (FAST)

FAST is very useful to determine the presence of intra-abdominal fluid. At this stage it will not advise you of specific organ injury. Presence of intra-abdominal fluid following penetrating trauma mandates a laparotomy. A limitation of the technique is that it is not specific or sensitive for detecting small bowel injury. It may be useful in prioritising decision making about which cavity to enter first in the emergency setting in patients with thoraco-abdominal wounds.

Laparoscopy

Laparoscopy has a definite role in penetrating trauma. At Liverpool we have reduced our negative laparotomy rate by 20% with the introduction of laparoscopy in abdominal stab wounds. Ivatury has evaluated laparoscopy in 100 patients with penetrating abdominal trauma(6). Laparoscopy was accurate for haemoperitoneum, solid organ injury and diaphragmatic injuries. However, gastro-intestinal injury was detected in only 2 of 9 patients.

CT scan

Evidence indicating the presence of peritoneal penetration include:

- Pneumoperitoneum
- Free intra peritoneal fluid
- Documented solid organ injury
- Extravasation of contrast material
- Obvious peritoneal penetration

The triple contrast technique involves the following:
25mls of diatrizoate megluminie in 725ml via nasogastric tube
2ml/kg Iversol
25ml dm (gastroview) in 250ml rectally.

Remember your Radiologist's needs to report on film.

Summary and Recommendations
Penetrating abdominal injuries are uncommon in Australia.
Individual surgical exposure limited.
Early haemorrhage control is essential.
Unstable patients require surgery < 10 minutes of arrival in hospital.
Stable patients with stab wounds should undergo laparoscopy, if positive - proceeding to laparotomy.
Gunshot wounds to the flank may be selectively managed with triple contrast CT and diagnostic peritoneal lavage.
Care must be taken to avoid missed injuries, particularly to vascular structures and the rectum.

If in doubt, explore.

In conclusion, the triage and early management of penetrating abdominal trauma patients must be rapid with no errors in decision making or surgical technique to avoid poor outcomes and potential mortality.

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Case of the Month

A 24 year old male stabbed at a football match.

Pre-Hospital information

Mechanism	(M) Stab
Injury	(I) Anterior chest, 4th intercostal space, lateral to sternal border
Signs	(S) P 90/m, BP 100 mmHg, GCS 15
Treatment	(T) Oxygen, IV Fluids, Morphine

Resus Room:

Primary Survey
On arrival, the patient was conscious, but while being transported into the resuscitation area deteriorated becoming unconscious with an at-risk airway. Airway entry was faint. Pulse 110/m, BP not palpable. Patient was responding only to painful stimuli. Prehospital IV in place.

What is your plan of action?

What is the most likely diagnosis?

Find out the patient's outcome next month!

oxygenation. If there is no one who can intubate then allow the drugs to wear off and the patient to re-establish spontaneous ventilation.

What if I can not intubate or ventilate?
Try oral and nasal airways.
Consider using a laryngeal mask to ventilate while cricoid pressure is maintained.
Cricothyroidotomy or transtracheal jet ventilation. ATLS/EMST guidelines suggest that this should be done early. As ever, local expertise should be applied.

Documentation

Record physiological trends, drugs and dosages, size of tracheal tube, laryngoscopic view obtained, distance of the tube at the teeth and whether cricoid pressure and manual inline immobilisation were used. If difficult or failed intubation occurred, state why.

Conclusion

Tracheal intubation helps in the management of patients with severe traumatic brain injury by preventing the secondary brain injuries which are so important in determining outcome. The major causes of secondary brain injury are hypoxia and hypotension. It is therefore vital that these are avoided when managing tracheal intubation.
Use of the agents with which we are most familiar, preoccupation with maintaining arterial oxygenation, maintenance of normotension (ideally with a mean pressure of 90 mmHg or above), training in the techniques of intubation and close teamwork will help optimise the outcome for these critically ill patients.

Acknowledgement

We thank Dr Michael Parr, Staff Specialist in Intensive Care, Liverpool Hospital, for his advice in preparing the manuscript.

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3 Williamson JA, Webb RK, Szekely S, Gillies ERN, Dreosti AV. Difficult intubation: An analysis of 2000 incident reports. Anaesth Intens Care 1993;21:602-607.

Review of last issue's case of the Month

A 20 year old motor vehicle passenger was involved in a high speed frontal MVA.

Pre-Hospital information

Mechanism	(M) Back seat passenger, wearing a seat belt.
Injury	(I) Pain in Lumbar spine Abdominal pain and seat belt mark
Signs	(S) RR 24, Pulse 84/m, Systolic BP 120 mmHg GCS 15
Treatment	(T) Oxygen, C-Collar,

Resus Room:

Primary Survey

Airway	(A) Clear
Breathing	(B) Unassisted RR 15/m, SaO2 96% on 8L O2
Circulation	(C) Pulse 70/m, BP 74/47mmHg
Disability	(D) GCS 15

Immediate fluid resuscitation commenced. 2L over the first hour with good response.

Secondary Survey

Abdominal examination revealed seat belt marks from the right upper to the left lower quadrants. There was peri-umbilical tenderness but no guarding or rebound tenderness. Bowel sounds were present.

Examination of his spine showed a tender, boggy swelling at the level of L3/L4 with no neurological deficit.

Urgent x-rays of the cervical spine and chest showed no abnormalities. Spinal x-rays revealed a compression fracture of L2.

What would you do now?

What is the potential diagnosis?

The risk with this type of injury is small bowel perforation, in particular duodenal injury, and pancreatic injury. There are two key questions.

Is there a potential duodenal injury?

If you belief so then a CT with oral contrast is ideal and an early DPL is not sensitive due to the retro peritoneal position of the duodenum.

If the injury is in the proximal jejunum (usually with more associated abdominal signs) then a DPL with have the edge over the CT scan. Serum amylase is unreliable in determining the presence of traumatic pancreatitis.

It would be reasonable to obtain a double contrast CT. Evidence of free fluid in the absence of injury to the liver or spleen would be an indication for a laparotomy. The patient underwent serial examination with increasing abdominal signs at 2 hours, a DPL was positive for elevated WCC and a laparotomy revealed a perforated jejunum close to the DJ flexure. Other injuries that could account for the signs include omental and transverse colonic injuries.

TRAUMA Grapevine

Penetrating Ab

Michael Sugru

INCIDENCE

Penetrating abdominal injuries are relatively uncommon in Australia, and when they occur, are predominantly due to stab wounds, with a mixture of gun shot and impaling injuries making up the remainder. In regions of North America, penetrating trauma has given rise to the majority of abdominal injuries with one series from Houston reporting that the cause of abdominal injuries were gun shot wounds in 65%, stab wounds in 25% and blunt abdominal trauma in 10%.

At Liverpool 2,200 patients were admitted with Trauma between 1995 and 1997(1). Of those 206 patients 9.6% had penetrating injuries and of these, 90 (44%) had penetrating injuries to the abdomen. This resulted in 55 trauma laparotomies of which 43 (78%) were considered therapeutic and 12 (22%) were non-therapeutic. It can be seen that in the Australian environment, penetrating abdominal injuries are uncommon and as such may pose a technical and decision making challenge for the attending Trauma Team.

HISTORY

The first published report that has successfully treated wounds to the abdomen is in the Persian expedition. In the 19th century, laparotomy was used for the first time to treat penetrating trauma. By the end of the 19th century, it was noted that laparotomy for abdominal trauma improved survival rate significantly when compared to non-operative management which resulted in mortality rates between 70 and 80%. However, laparotomy with exploration of the abdominal cavity did not become part of the surgical strategy until World War 1, and it was not until the Korean war that the mortality from penetrating trauma fell below 50% (Table 1).

Table 1: American Military Experience with Survival followin Penetrating Injury.

Conflict	Year	Mortality %
American Civil War	1876	100.0
World War 1	1927	80.0
World War II	1946	55.9
Korean War	1955	41.2

PRESENTATION

It is crucial in the management of penetrating abdominal trauma patients that there is clear communication from pre-hospital personnel to the Resus area. Scene time must be less than 5 minutes. This should include minimal IV fluids in normotensive patients enroute to hospital. As a general procedure, patients with a penetrating injury and a blood pressure < 90 should have pre-arrival notification to the attending surgeon, allowing the surgeon to be present in the resuscitation room, when the patient arrives, or shortly thereafter.

Pre-arrival preparation is essential, including the lead-gowning of the trauma team members and clear communication to facilitate prompt radiology, availability of operating theatre and staff, blood bank and blood(2). The priorities in the management of penetrating abdominal trauma patients are to establish the history, determine if the patient is unstable, and evaluate the potential underlying injuries in line with EMST/ATLS principles.

Patterns of Organ Injury in Penetrating Trauma

Potential intra-abdominal injuries inflicted by stab wounds are usually self-evident by the location of the wound. Particular care should however be noted in relation to the stab wounds in the region of the diaphragm or the thoraco-abdominal section of the abdomen. The typical pattern of organ injury one can anticipate in gunshot wounds to the abdomen is shown in Table 2.

Table 1: Typical Organ Injury pattern following gunshot wounds to the abdomen.

Injuries sustained in patients undergoing laparotomy			
Organ	%	Organ	%
Liver	40	Kidney	14
Diaphragm	40	Spleen	13
Colon	30	Duodenum	8
Small bowel	25	Pancreas	5
Stomach	15	Bladder	4

Investigations and Management

Clinical examination is often more reliable in penetrating than blunt trauma, as often injuries are isolated and the presence of abdominal tenderness is usually a reliable sign.

Initial management should fall into guidelines of EMST/ATLS principles with control of airway, relief of breathing problems and early control of the bleeding. It is vital that a secondary survey is completed to avoid missing additional entry and exit points, other stab wounds or the presence of associated blunt trauma(3). Rectal examination may have importance in determining the presence of blood, indicating a bowel injury. There are however certain pitfalls in abdominal examination. Bull has reported a false positive rate of 18% and false negative rate of 23% for physical examinations for patients with penetrating trauma(4).

Unstable Patient

All unstable patients need urgent surgery. Ideally this should be undertaken within 10 minutes of arrival in the resuscitation/emergency area. Fluid resuscitation should be limited unless the patient is profoundly hypotensive and will not make it to the operating theatre. Occasionally there may be a role for resuscitative thoracotomy with cross clamping of the descending thoracic aorta. In general, however, this is not a good idea. Exceptions may include patients with multiple previous abdominal incisions and presence of stomas. A proposed algorithm for the management of anterior abdominal stab wounds is shown in Figure 1.

dominal Trauma

FRCSE,FRACS,

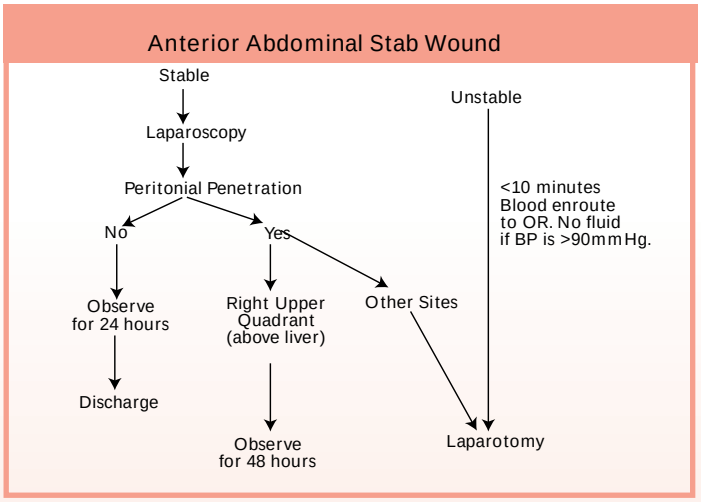


Figure 1:

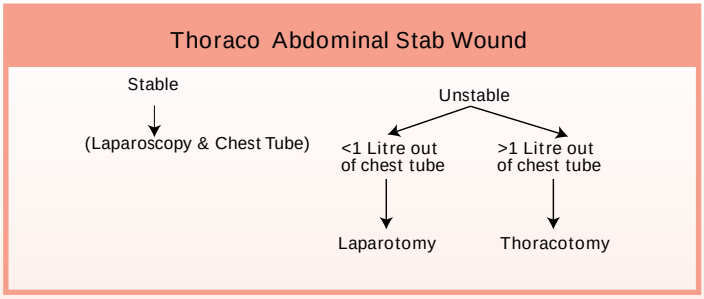
Stable Patient

The key to managing the stable patient is determination of the presence or absence of peritoneal penetration. 25% of anterior abdominal stab wounds are not associated with peritoneal penetration. Therefore determining peritoneal penetration will eliminate 25% of unnecessary laparotomies, (that is if one adopts a mandatory exploration policy). The mandatory exploration policy may be the safest one in the Australian environment. The addition of laparoscopy therefore will have significant implications. Some centres offer a policy of selective laparotomy based upon clinical examination. While this is an acceptable option, it poses some challenges in Australia because of our lack of experience and the short rotations of registrars. Up to 17% of patients with initially negative examinations may show late signs of injuries of the colon, small bowel and liver.

There are several ways to determine peritoneal penetration. Local wound exploration can determine whether the anterior sheet or fascia is penetrated prior to proceeding to laparotomy. The technique of local wound exploration is not really applicable to gunshot wounds of the abdomen because of the potentially extensive missile tract and the possibility of inducing a free communication with the pleural cavity in thoraco-abdominal wounds. Stabograms and abdominal paracentesis have really little part to play. Poking a gloved unsterile finger into the patientís stab wound has no part to play in the management plan.

My preferred approach is laparoscopy to determine if there is peritoneal penetration. A 2, 5 or 10mm scope can be used. It is preferable to have an angled 30o scope to allow optimum view. If there is evidence of peritoneal penetration the patient should really proceed to laparotomy. A non-therapeutic laparotomy will result in approximately 25% of these cases who proceed. However, failure to perform a laparotomy in the presence of penetration will result in approximately 20-25% significant missed injury rate relating to the retroperitoneum, pancreas and small bowel. There is perhaps one exception to this and that is penetration in the right upper quadrant where there is obviously penetration through the liver only with a small haematoma under Glissonís capsule. Particular care should be undertaken where there is thoraco-abdominal penetration to avoid a tension pneumothorax and a chest drain should be inserted pre laparoscopy. An algorithm is shown in Figure 2, for the management of thoraco-abdominal stab wounds.

Figure 2:



A decision to undertake either a laparotomy or thoracotomy in an unstable patient with thoraco-abdominal wound will be dictated by the presence of a haemothorax or the potential for a pericardial tamponade.

Flank Penetration

The management of flank penetration poses significant challenges. Again unstable patients require immediate laparotomy and an IVP should NOT be undertaken in this group until the haemorrhage has been controlled. One shot IVP's are time consuming and often of poor quality. In a stable patient, a triple contrast CT guided approach can be used. This may either require supplementation by diagnostic peritoneal lavage, laparoscopy or laparotomy. Recent studies involving a review of over 100 patients with tangential gunshot wounds to the abdomen and flank suggest that estimation of the trajectory of gunshots should allow patients to be managed safely using CT scan to determine if peritoneal penetration has occurred. This approach requires the use of skin markers and triple contrast, however caution should be exercised in the use of this in an Australian setting.

Nagy and his colleagues from Cook County Hospital in Chicago advocate the use of diagnostic peritoneal lavage to determine the presence of peritoneal penetration(5). In a 4 year period 429 consecutive DPL's were performed for gunshot wounds to the abdomen. 150 were positive, only 6 of these patients were found to have a false positive result, the remaining 144 with positive DPL's were found to have operative injuries. There were only 2 false negatives in this series. They recommend in patients with gunshot wounds in whom the presence of peritoneal penetration is unclear, DPL is a sensitive specific, an accurate test to determine the need for laparotomy. It is vital to realise the values used for DPL in penetrating trauma are different from blunt trauma. A red cell count of >10,000 RBC's per cubic millimetre is considered positive. Using this threshold for DPL, Nagy and colleagues have kept their negative laparotomy rate to an 'acceptable' 4%. This is a staggering achievement and perhaps, in Australia, we should aim for a negative laparotomy rate approaching 10%.