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TRAUMA Grapevine

Contents:

Introduction

Australia is recognised as having some of the best Intensivists, Emergency Physicians, Surgeons, Anaesthetists, Nurses and Ambulance Officers in the world. We are leaders in many aspects of health care. The question we might ask is, "Are we world leaders in trauma care?" Are there aspects of our trauma system that need to be changed and other areas where new initiatives are required. There are many in Australia trying to improve our trauma systems. They are going to need our good will and support.

The prompt and effective response by Australian Defence Force in support of the recent PNG Tsunami disaster is an excellent demonstration of such capability. 264 surgical procedures were conducted in 10 days by a small mobile surgical team, deployed within 24 hours of a formal request from the PNG Government. It was a combined health facility, airforce and army personnel and 1 Parachute Surgical team and 1 Field Hospital. Lt Col Crozier led the surgical team and we all should be proud of their achievements.

This issue will review the complexities involved in the early management of open tibial fractures and trauma in pregnancy. We have introduced a new regular feature, PIT, to replace recommendations from our weekly trauma audit. These are produced by Dr Karel Kolkmann, our new Trauma Fellow.

I would like to thank everyone for their positive feedback about the Grapevine. I hope that you continue to enjoy it. I would welcome the submission of articles of viewpoints or trauma dilemmas that you may wish to share with our readers throughout Australasia and around the world.

Please remember if you wish to visit us in Liverpool our door is always open.

Michael Sugrue

The Early Management of Open Tibial Fractures

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Objectives:
-To demonstrate the complex nature of open tibial fractures.
-To highlight the need for the early involvement of both orthopaedic and plastic surgery consultants experienced in lower limb trauma.
-To encourage early transfer to a specialist centre if local facilities are not optimal.

INTRODUCTION

A review of 1,000 consecutive open fractures of all types occurring between January 1988 and March 1994 in Edinburgh, UK(1) suggests that open tibial fractures occur with a frequency of about 7 per 100,000 per year (or about one per week in the area covered by South Western Sydney Area Health Service). Of the open tibial fractures reviewed, it was shown that 75% were of Gustilo types II and III(2) and of these 70% required soft tissue reconstruction. In the group IIIb(3) (29% of total) 70% required flap reconstruction.

It can therefore be seen that these injuries are frequently complex and inadequate or inappropriate primary management will lead to complications which are not only potentially devastating for the patient but are very expensive. In an effort to improve outcome from these severe injuries, the British Orthopaedic Association and the British Association of Plastic Surgeons established a working party to make recommendations of best practice. This paper draws on conclusions from their report(4).

RECOGNISING A SEVERE INJURY

The severity of the initial injury is directly related to the amount of energy transferred to the limb and recognising a high energy injury is essential if sub-optimal care is to be avoided. If high energy transfer is suspected, assessment of the injury by a senior clinician experienced in lower limb injuries is mandatory.

The evaluation of injury severity follows the classical process of history, examination and appropriate special investigations. All information should be clearly and methodically documented. Within the scope of this paper, it will be

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The Early Management of Open Tibial Fractures

Continued

assumed that the general management of the patient has followed ATLS/EMST guidelines.

History

Always remember to nail the paramedic's feet to the floor until you have all the information you require. The patient is often unlikely to be able to give a good history. The mechanism of injury will provide a useful indication of the level of energy transfer. Specific features in the history are:
Any road traffic accident; drivers, passengers or pedestrians.
Falls from over three metres.
Any form of crush.
Missile wounds.
Entrapment or lying immobile on the limb for a prolonged period.
Any suggestion of limb ischaemia.
Remember to use the **M.I.S.T.** information transfer system in the resuscitation room. (**M**echanism of injury, **I**njury, **S**igns, and **T**reatment given).

Examination

A systematic examination should look for the following features:

Skin
Large or multiple wounds.
Extensive contamination.
Imprints or tattooing.
Crush or burst wounds.
Closed degloving, often difficult to diagnose.

Signs of Compartment Syndrome
More pain than expected, particularly if still present after the fracture is splinted and opioid analgesia administered.
Pain on passive stretching of motor groups.
A tense swollen limb.
Sensory disturbance of the foot.
Remember, strong peripheral pulses can still be palpable even in the presence of compartment syndrome.

Signs of Vascular Injury
Absence of peripheral pulses or reduced capillary refill after adequate resuscitation and correction of gross deformity.

Signs of Nerve Injury
Abnormal sensation is more a sensitive and earlier sign than motor loss.
Always compare both sides.
Check all peripheral nerve territories, the plantar surface of the foot in particular.

Special Investigations

Plain Radiology
Along the lines of "the more bits, the harder it was hit", the fracture pattern often provides the truest picture of energy transfer. Important features are:
Multiple bone fragments.
Wide displacement of fragments.
Segmental fractures.
More than one fracture in the same limb.
Also look for air in the tissues.

Underestimating the energy transfer will lead to a lack of appreciation of the extent of the tissue damage and then to inadequate initial care. It is important that senior staff be involved in the assessment stage so that an appropriate management plan can be started.

INITIAL DECISION MAKING

Once the presence of a high energy tibial fracture has been recognised, it is essential that the patient be managed by Consultants who have both the experience and facilities to adequately treat such complex injuries. If necessary, to achieve this the care of the patient should be transferred to an appropriate colleague just as might occur with a spinal injury. Both orthopaedic and plastic surgery Consultants need to be informed without undue delay, i.e. during the assessment stage, so that any such referrals can occur early. The orthopaedic and plastic surgery Consultants who will be managing the patient then need to jointly establish a timetable for the different aspects of early treatment. Specific points that need to be considered are:
Other injuries or pathologies.
Time for initial wound surgery.
Time for and type of skeletal stabilisation.
Time for and type of soft tissue reconstruction.

Multiple Injuries

The Edinburgh study showed that 19% of open tibial fractures occur in multiply injured patients. The patient's other injuries need to be appropriately treated but should not alter the approach to the severe tibial fracture. It has been shown that early skeletal stabilisation improves outcome in the multiply injured(5).

Compartment Syndrome

It is a fallacy that compound fractures do not produce compartment syndrome. The four compartments surrounding the tibia are particularly susceptible to this complication and even though a compartment may be open, the muscle underlying intact fascia may still develop a high compartment pressure. Clinical suspicion must remain high and the signs outlined above sought. The full discussion of compartment syndrome would take a paper in its own right. The reader is therefore encouraged to read the work of McQueen(6,7,8) for an accurate state of the art view. The incidence of this complication is much higher than many surgeons realise and it is a fundamental message that if there is any doubt about the presence of compartment syndrome, immediate four compartment fasciotomy must be performed.

Prevention of Wound Infection

Removal of contaminants and inoculants from the injury will occur at initial wound surgery. The greatest threat, however, comes from organisms in the hospital environment that often exhibit complex antibiotic resistance. After the initial assessment the wound should have a polaroid photograph taken of it and then be covered with a betadine swab or cling film. This dressing should be left until initial wound surgery is performed. The patients should be given broad spectrum antibiotics and tetanus prophylaxis following local guidelines.

Timings

All high energy tibial fractures must be considered surgical emergencies and initial wound surgery should be undertaken within six hours of injury. As has been seen, outcome is improved if skeletal stabilisation is achieved early. It is advisable therefore to perform fracture fixation as part of initial wound surgery. It is accepted that wound coverage does not need to occur immediately and indeed waiting to confirm adequacy of debridement, reduction in swelling, reduced chance of compartment syndrome and the completion of definitive bony fixation increases the success of soft tissue reconstruction. It has, however, been shown that complication rate following microvascular reconstruction is significantly higher if performed after five days and it is important that wound cover is complete before then, preferably sooner(9,10).

A proposed plan would therefore be:
Initial wound surgery and fracture fixation within six hours.
A second look procedure at 48 hours with soft tissue reconstruction if possible.
If not then a third look with soft tissue reconstruction definitely before five days.

The exact timings of the last two phases can be decided at initial wound surgery. Complex soft tissue reconstruction is highly resource dependent and it can take a while to organise for appropriately skilled anaesthetists, theatre staff and surgeons to be available at the same time for a whole day.

The decision to Amputate

Simply preserving length in a severely injured limb is not the aim of reconstruction. The limb must also function and be pain free. In the presence of prolonged ischaemia, crush or nerve damage, functional outcome maybe poor despite multiple procedures carried out over many months. This can be devastating to a patient's morale and often leads to psychological morbidity. A late decision to amputate after failed reconstruction also produces unfavourable outcome with poor patient motivation and development of complex regional pain syndromes.

PIT
Practical Issues in Trauma

Introduction:
PIT addresses issues raised in trauma audit meetings held every Thursday morning. PIT will go into detail and provide relevant literature or advised reading material. If PIT presents an opinion it is the personal opinion of the author based on relevant literature and clinical judgement.

(1) CARDIAC ECHO IN PENETRATING CHEST TRAUMA

(2) CONSERVATIVE TREATMENT OF PNEUMOTHORAX

Background:
A patient presented with multiple stabbings to the chest in the parasternal area (the "Box"). The stabbing had occurred 6 hours before presentation at midnight to Liverpool ED. The patient was haemodynamically stable, with a normal primary survey and CXR showed a pneumothorax of about 5mm. Decision was made to observe, repeat CXR after 6 hours and to perform a cardiac echo in the morning. This CXR showed progression of the pneumothorax to > 10 mm. A chest tube was inserted, cardiac echo done (no abnormalities) and the patient admitted.
Two issues were raised: (1) the timing of performing a cardiac echo and (2) conservative management of a traumatic pneumothorax.
A patient with a perforating injury in the area of the chest described as "the box" should have a cardiac echo without undue delay. Even a time interval of several hours does not rule out cardiac damage especially if there has been a period of hypotension. Physical examination may be extremely difficult to interpret, especially when attempting to evaluate the presence of Beck's triad. (J. David Richardson in Penetrating Trauma, 1996, William and Wilkins). There is no place for probing of wounds.

There is very little literature about the conservative management of traumatic pneumothoraces. There are no controlled trials but there are several more or less anecdotal papers even about outpatient management of drained pneumothoraces. In a large South African series 41.4% of pneumothoraces were managed conservatively. If the pneumothorax was 1.5 cm or smaller (measured from the anterior bony end of the third rib) 10% of these patients later needed a chest tube inserted because of enlargement of the pneumothorax1 . Johnson2 retrospectively studied 54 pneumothoraces of which 29 were initially managed conservatively, 27 successfully. In this group however there were only 4 penetrating traumas of which 2 were managed conservatively. In a study by Enderson et al3 40 trauma patients with an occult pneumothorax (detectable on CT, not on CXR) were randomized to tube thoracostomy or observation. 8 of the 21 observed had progression of their pneumothoraces under positive pressure ventilation.

Conclusion: There is a place for very carefully selected patients to undergo conservative treatment of their pneumothorax where the pneumothorax is 1.5 cm or smaller. In general every patient with a pneumothorax will need a chest tube. All patients with a pneumothorax undergoing positive pressure ventilation need a chest tube. Echo cardiograms should be performed without delay and reported by a cardiologist.

Literature:

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LETTER TO THE EDITOR

Request for clarification of Issue in Trauma Grapevine Vol 1 No 12. Small Bowel Injury

Dear Michael,
I note from your recommendations from the Trauma Audit that patients with seat belt marks who on examination have tenderness over the area of the marks, rather than throughout the abdomen can be observed? I wonder whether this advise was based on science or prejudice?
Thanking you,

Peter Campbell
Visiting Surgeon Liverpool Hospital

Peter,
Thank you for your enquiry about the evidence to support my claim "in general patients with safety belt marks (on their abdomen) who on examination have tenderness only over the area of the marks rather than throughout the abdomen can be observed," which appeared in Grapevine 1998;1;12:5
While Sir Benjamin Disreali stated, "when a man resorted to anecdotage it was time to retire," I must confess that my stance is not based on Class 1 or 2 evidence, rather on personal experience and a lot of prejudice. There are no prospective studies to evaluate abdominal wall bruising as a marker for hollow viscus injury and retrospective studies looking at hollow viscus injury in patients with abdominal wall bruising have not looked at all patients (only those with injury) and thus the denominator remains unknown. Allen and colleagues from Houston have recently reported a 9 year retrospective review of hollow viscus injury and found abdominal wall bruising occurred in 11% of patients(1). This is much less than previously reported (2). In their study there was a correlation between abdominal wall bruising and injury in back seat passengers. Unfortunately no study has looked at both abdominal wall signs and bruising.
I hope this clarifies what can be a difficult clinical challenge.

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Editor

Update on last month's case

Recap on case so far:

The patient was a 51 y.o. male involved in a high speed MVA, who required large volume resuscitation in the first few hours after admission. The patient had all the clinical and laboratory signs of shock/poor perfusion.
Within 24 hours the patient had had 23L (twenty three) of fluid and required inotrophes. A clinical diagnosis of possible cardiac tamponade was made (despite it's rarity in blunt trauma). The echo was reported as normal.

Update
During handover in ICU, the midnight echo was not mentioned and the second ICU specialist felt that the only diagnosis left was a cardiac tamponade (remember the patient already had a non-therapeutic laparotomy). Another echo was ordered revealing an obvious cardiac tamponade. The patient underwent urgent thoracotomy and made a remarkable heamodynamic and physiological recovery within 4 hours of surgery. He was discharged some weeks later after his tibial fracture had been fixed.

Message
This case illustrates a victory for clinical medicine. The issue here is not about the underlying diagnosis rather the hazards of certain investigation we undertake in trauma. Before we order the following tests:

- Echo
- Transoesophageal echo
- Abdominal Ultrasound
- CT scans of the Chest
- Spiral CT scans of the chest

please give some consideration to the their positive predictive and negative predictive value and the accuracy and experience of the person undertaking the test. There should be some minimum criteria in relation to investigation in trauma patients.

The test must be able to diagnose the condition
(CT scans of the chest will NOT rule out traumatic rupture of the aorta- Then don't do it). This issue was debated at the recent Trauma 98 meeting where many in the audience felt uncomfortable with some of the radiological viewpoints being expressed.
The person performing and reporting the test should be accredited to do so and know their accuracy.
(Emergency Echocardiograms need to be reported by an experienced cardiologist).
The test should have a good negative predictive value.
(There is no point in sending a patient for a spiral CT to rule out a pulmonary embolus- because a negative test does not exclude the disease- If you are worried get a pulmonary angiogram - while the patient is alive.)

Tests should be used carefully and the results obtained immediately after they are done and documented in the notes. This patient is alive due to good clinical acumen and some luck.

Backchat

Congratulations to Alfred Hing who recently received the Ken Boffard award for best paper at the Annual Scientific Congress of the College of Surgeons for his work on the pre-hospital care of penetrating trauma.

We would like to welcome four new faces to the Trauma Department.
Dr Karl Kolkmann is our new trauma fellow. He has completed his surgical training in Holland and has special interests in ultrasound. Jorge Sesperez has joined our Case Management Team. He has extensive experience in trauma care in ICU and ED. Trevor Gosbeil is our new research assistant in the Case Management and Clinical Pathways project. Charmaine Mirando joined the Department as secretary with a special responsibility in QA reporting.

Meetings

SWAN 7
The provisional program for SWAN 7 will be sent with this issue. You will be treated to 6 keynote international trauma experts. Some need no introduction. Dr Bill Schwab and Dr Margaret Knudson are two of the US most dynamic traumatologists and it is a huge honour for us to have them as visitors.

Controversies in Civilian and Military Trauma
This promises to be a very exciting meeting on May 15-16th 1999 Brisbane.
Contact 07 33955743.

Australasian Trauma Society Meeting
20th November 1999 Auckland 64 7 8383123

An early correct decision regarding amputation is therefore very important. This can be a very difficult decision. Various scoring systems can help but dependence on them is unwise(11,12). It is again therefore important that both orthopaedic and plastic surgery Consultants experienced in dealing with such injuries are involved early. It is also unkind to make too hasty a decision. Unless retention of the limb is seen as being life threatening, salvage surgery should be performed at initial wound surgery. Discussion of the issue with the patient can then start and relevant support mechanisms mobilised. Definitive amputation can then take place at the second look procedure when tissue viability will be more clear and the patient already has started on the path to acceptance.

INITIAL WOUND SURGERY

A concept familiar to experienced military surgeons, initial wound surgery is much more than simple debridement. It encompasses evaluation, limb and function preserving measures, excision, extension and decision making. As well as the need to understand the pathophysiology of such wounds, it is an area of surgery where there is no substitute for experience. It is also a procedure that is unfortunately all too often left for junior trainees to perform out of hours.

With regard to severe tibial fractures, vascular and nerve injuries need to be addressed at initial wound surgery. The appropriate management of these specific injuries is beyond the scope of this paper.

The size of the traumatic skin wound will give an underestimation of the degree of damage to soft tissues. The wound must therefore always be extended so a proper evaluation can take place. About two millimetres of skin from the wound edge should be excised and then longitudinal extensions made to expose the whole zone of injury. Transverse extensions must be avoided. The surgeon must be aware of the position of the medial and lateral perforating skin vessels as these need to be preserved. Undamaged skin overlying the subcutaneous border of the tibia should not be violated, except for external fixator pin placement. Undermining in a plane superficial to the deep fascia should be kept to a minimum. If indicated, four compartment fasciotomies should be performed at this stage. Ideally, wound extensions and fasciotomy incisions are made along a medial and an antero-lateral incision. The medial incision is longitudinal, one to two centimetres posterior to the medial edge of the subcutaneous border of the tibia. The antero-lateral incision is longitudinal, two centimetres lateral to the anterior edge of the subcutaneous border of the tibia. These are shown in the figure. External fixator pins can be placed safely between these incisions. These incisions will preserve potential fascio-cutaneous flaps which may be required for reconstruction.

With the true extent of the wound damage now revealed, evaluation of injured tissues can be made and debridement of non-viable tissue performed. Skin is relatively resistant to direct trauma and it may be found that only the contused wound edges are non-viable. The presence of dermal bleeding is a good indicator of viability. Even large areas of undermined skin can survive if properly managed. The subcutaneous fat, however, is less resilient and the area of non-viability may exceed that of the overlying skin. It is a difficult decision to excise viable skin in order to effectively debride the subcutaneous tissues but leaving non-viable tissue will result in a worse outcome. The need for an experienced surgeon is again highlighted. Muscle is very sensitive to direct trauma. Cellular death can occur early whilst the macroscopic architecture remains normal looking. Assessment of viability at initial wound surgery is notoriously difficult. All clearly devitalised muscle must be excised but dubious areas should be left until a second look procedure. As with all other tissues, bone needs a blood supply to survive. All separated bone fragments and those attached by non-viable soft tissues must be removed. The concept of leaving bone fragments behind to act as a graft is erroneous in the tibial situation. Any tissue which is heavily contaminated is likely to have been significantly injured and it is normally best to excise it rather than attempt simple cleaning.

It needs to be remembered that with modern methods of both bony and soft tissue reconstruction, very large wounds can be covered and bone length restored. Fear of creating a non-reconstructable defect must not deter the surgeon from removing all non-viable tissue. Inadequate debridement will lead to unnecessary complications.

With debridement completed, the resultant defect needs to be thoroughly irrigated. Topical antiseptics have not been shown to confer any advantage over isotonic crystalloid solutions. Large volumes are required, about six litres appears to be accepted practice. This can be by free flow with digital agitation or via a pulsed lavage system.

The traumatic wound caused by the initial injury has now been converted to a clean, viable surgical wound. There must be no attempt made to close this wound as significant tension cannot be avoided. There can be a case made for primarily closing skin extensions but this should only be performed with utmost caution.

RECONSTRUCTION

Precise techniques of reconstruction are again beyond the scope of this paper. Bone reconstruction is normally achieved with skeletal stabilisation and subsequent primary bone healing. In most cases this is performed at the same time as initial wound surgery. With significant bone loss, bone grafting, free vascularised bone transfer or bone transport techniques can be employed. These are normally carried out as secondary procedures, although there are proponents for their primary use. Soft tissue reconstruction is normally delayed until after a second look has shown the adequacy of debridement. Although simple procedures such as split skin grafting can provide cover for many wounds, the end result is often poor. Flap coverage provides a durable cover which brings its own blood supply and can import a variety of tissues as required. These flaps can be either local or free and both require considerable expertise in their design and execution. The bone and soft tissue defects need to be considered together and the plastic and orthopaedic surgeons need to be aware of each other's requirements and plans.

Summary

Open tibial fractures are frequently complex injuries and the early involvement of both orthopaedic and plastic surgery Consultants experienced in lower limb trauma is essential to avoid mismanagement. A joint plan needs to be established. Initial wound surgery should take place within six hours and ideally include skeletal stabilisation. Soft tissue reconstruction should follow a second or third look procedure but within five days.

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TRAUMA DURIN

Michael Sugrue Director Tr

Injury to the pregnant lady evokes a certain amount of anxiety because of its infrequent occurrence and the complex implications. By definition, it constitutes a multi-trauma and throughout the resuscitation and assessment of the lady it is important to remember that there are two patients. Of particular importance is that one of these patients must be resuscitated aggressively to save the other and very occasionally the baby has to be delivered to save the mother. The aim of this paper is to provide an overview of the current management and issues in relation to trauma in pregnancy.

Trauma in pregnancy is a relatively uncommon event, reported as occurring in 6-7% of traumas in the United States (1). Data from around Australia currently provided by Nepean, Auckland, Royal North Shore, Westmead, John Hunter Hospital and Royal Perth Hospital, suggest that trauma is relatively infrequent. Trauma in pregnancy can be divided into two categories - major and minor trauma. At Liverpool we have had 5 serious injuries to pregnant ladies between January 1996 and December 1997. This gives an instance of significant trauma in pregnancy of approximately 0.1%.

Anatomical and physiological changes occur during pregnancy that can mask or mimic injury and physical signs can be misinterpreted. Occasionally we had fear of harming the baby or upsetting the patient and therefore can have a complacent, potentially devastating, effect on outcome. It is important that there is no delay in the correct diagnosis and prompt initiation of treatment. There are a number of physiological changes that occur in pregnancy and it is important to be aware of these to avoid errors in assessment and management. These changes are shown in Table 1. In addition, there are some significant anatomical and functional changes which occur during pregnancy. There is delayed gastric emptying, increased gastroesophageal reflux, upward displacement of the peritoneal contents, displacement of the urinary bladder, and widening of the symphysis pubis.

MATERNAL FOETAL UNIT

The foetus is usually well compensated for life through higher affinity of foetal haemoglobin for oxygen. At any given partial pressure of oxygen foetal haemoglobin has a higher affinity for oxygen than maternal haemoglobin. Oxygen transport in the foetal placental unit is intimately tied to the maternal uterine blood flow. Because of the passive uptake of oxygen, foetal oxygenation is not higher than that in the uterine vein.

MATERNAL ASSESSMENT

When confronted with an injured pregnant patient the mother should be attended to first, as rapid resuscitation of the mother optimises foetal outcome. Maternal assessment should follow guidelines laid out by the EMST approach to trauma, with a detailed primary and secondary assessment. In relation to primary assessment, there are some slight differences from the assessment of the non-pregnant patient. In particular, positioning of the pregnant patient is very important especially in the third trimester. A supine patient often has vena cava compression reducing venous return. It is important to tilt the pregnant patient to the left by approximately 35°. The patient should be tilted as an entire unit, maintaining stabilisation of the cervical spine.

THE RISKS OF TRAUMA IN PREGNANCY

The risk to the pregnancy in "minor" or non-catastrophic trauma is still significant, with pre-term labour occurring in 8%, abruption in 1% and foetal death in 1%. For those with major trauma, mortality to the mother is approximately 9% depending obviously on injury severity score (2). The foetal death rate is 20% or greater and foetal injuries occur in isolation in 5%. The pattern of serious injuries in pregnant ladies is slightly different from that of non-pregnant ladies with injuries to the abdomen more common than injuries to the head and chest.

INVESTIGATIONS

How does one approach abdominal evaluation in a pregnant lady?
The best indication of maternal or placental injury comes from clinical observation. Clinical findings of placental abruption may include vaginal bleeding, abdominal cramps, uterine tenderness, amniotic fluid leakage, and maternal hypovolemia out of proportion to visible bleeding. Remember that up to 2 litres of blood can accumulate in the uterus and this can be a cause of maternal shock. The uterus may be larger than normal for gestational age. Change in foetal heart rate may also indicate placental injury. Abdominal signs can be more difficult to interpret in a pregnant lady and for this reason, ultrasound of the abdomen to detect free fluid is useful. Diagnostic peritoneal lavage can be used and has an accuracy of 92%. CT scanning and MRI have been used, however these should be avoided if at all possible especially in the first and early second trimester because of radiation. Ultrasound has the potential advantage of being able to detect significant foetal injuries, however it is not good in determining abruption or uterine rupture. It has an accuracy
of only 50% in detecting abruption.

FOETAL MONITORING

Is it needed and how long should we use it for?
Any viable foetus of 24 weeks or more requires monitoring after a trauma. This includes patients with no obvious signs of abdominal injury. Pearlman has recommended a minimum of 4 hours of CTG observation to detect intra-uterine pathology (3). This should be extended to 24 hours if at any time during the first 4 hours there is more than one uterine contraction every 15 minutes; there is uterine tenderness and non-reassuring foetal monitor strip, vaginal bleeding, rupture of the membranes or any serious maternal injury.

Over the last 10 years at Liverpool we have had 6 foetal deaths, of which 5 arrived in our resuscitation room with foetal heart sounds, or CTG evidence of viability. It is important that there is a joint multi-disciplinary monitoring approach to the pregnant trauma patient. Rapid caesarean section facilities should be available. In the presence of placental abruption, when the foetus is alive on presentation, foetal

G PREGNANCY

rauma Liverpool Hospital

distress is present in over 60% of these cases and an immediate caesarean section is required. Resuscitation of the mother is absolutely vital and if maternal shock occurs, the foetal mortality approaches 80%.

In summary, foetal monitoring should occur in all major and minor trauma patients, for a minimum of 4 hours in minor cases, and in major cases a minimum of 24 hours.

WHAT ABOUT PERIMORTEM SECTION?

Restoration of the mother's and foetal circulation is the optimum goal. However, exclusive attention to the mother may prevent recovery of a potential viable baby. Maternal revival after delivery of the foetus has been reported in peri-mortem circumstances, presumably due to relief of vena cava compression, however, this is rare. It has therefore been suggested that there is no such thing as a post mortem section only a peri-mortem section. If there is no response to advanced resuscitation within a few minutes, maternal CPR should be continued, and if necessary this can be performed through a thoracotomy without cross clamping the aorta and an emergency room caesarean section performed.

In a review of 250 years of literature, Ritter has documented 120 successful perimortem caesarean sections. Of these, 61 babies have survived perimortem caesarean section to discharge from 1900 to 1985. 70% were delivered in less than 5 minutes, 13% in 6-10 minutes, 12% in 11-15 minutes and 5% after 16 minutes. The incidence of neurological sequelae increased with longer delivery time. It is important to realise that there is a difference between survival rate from perimortem sectioning and discharge home, as less than half those who actually survive a perimortem section are discharged. Caesarean section should only be performed in the emergency department where the uterine size exceeds the umbilicus, where there is evidence of foetal life by clinical examination, either on doppler or ultrasound and when the patient has not been receiving CPR for more than 10 minutes. It is important to remember other conditions that can occur in trauma in pregnancy: amniotic fluid embolism, which is rare but an important cause of disseminated intravascular coagulation and shock, and more commonly foetal maternal haemorrhage. Foetal maternal haemorrhage (FMH) is the transplacental haemorrhage of foetal cells and is a unique complication of pregnancy. The reported instance of FMH is 8-30% compared to 2-8% for non-traumatic victims. Anterior placental location and uterine tenderness have been associated with an increased risk of foetal maternal haemorrhage. Complications of FMH include rhesus sensitisation in the mother, foetal anaemia, foetal paroxysmal tachycardia and foetal death. As little as 1ml of rhesus positive blood can sensitise 70% of rhesus negative women. Therefore all rhesus negative mothers who present with a history of abdominal trauma should receive a prophylactic dose of Rh immune globulin. The Kleihauer-Betke test has been utilised to determine the presence of foetal maternal haemorrhage. It is not entirely accurate and is not necessary in Rh positive women.

CONCLUSION

After injury during pregnancy, the key to a successful outcome for both the mother and child is prompt and adequate initial assessment and resuscitation of the mother.

All patients with minor trauma should be admitted to hospital for at least 24 hours.

Those with major trauma always require a multi-team approach.

Careful foetal monitoring is essential once foetal viability has been established.

If maternal resuscitation fails, urgent perimortem caesarean section may be useful with short CPR times.

References

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PHYSIOLOGICAL CHANGES ASSOCIATED WITH PREGNANCY

Parameter	Non-pregnant	Pregnant
Cardiovascular		
Heart rate	70-80 bpm	↑ 10-15 bpm
Cardiac output	4.5 L/min	↑ to 6 L/min
Systolic blood pressure	110 mm Hg	↓ by 5-15 mm Hg
Haematology		
Blood volume	4000 mL	↑ by 30%-50%
Plasma	2400 mL	↑ to 3700 mL
RBC	1600 mL	↑ to 1900 mL
Haemoglobin	12-16 gm/dL	↓ to 10-14 gm/dL
Haematocrit	37%-48%	↓ to 32-42%
WBC	4500-10,000 mm	5000-14,000 mm
Respiratory		
Tidal volume	500 mL	↑ by 40% (700mL)
Residual volume	1200 mL	↑ by 40% (720mL)
Respiratory rate	12-20 breaths/min	Increased
PH	7.38-7.44	↑ 7.41 - 7.46

Table 1