THE NORTHERN HOSPITAL

# PELVIC FRACTURES

*"Bookshelves" oil on canvas, Giuseppe Maria Crespi, 1725*

*These are not books, lumps of lifeless paper, but minds alive on the shelf. By taking down one of these volumes and opening it, one can call into range the far distant voice in time and space and hear it speaking to us, mind to mind, heart to heart...*

*Gilbert Highet, "The Immortal Profession", 1976*

*Coker sighed sadly. He turned his attention to the radio man.*

*"There won't always be those stores. The way I see it, we've been given a flying start in a new kind of world. We're endowed with a capital of enough of everything to begin with, but that isn't going to last forever. We couldn't eat up all the stuff that's there for the taking, not in generations - if it would keep. But it isn't going to keep. A lot of it is going to go bad pretty rapidly. And not only food. Everything is going, more slowly, but quite surely, to drop in pieces. If we want fresh stuff to eat next year we shall have to grow it ourselves, and it may seem a long way off now, but there's going to come a time when we shall have to grow everything ourselves. There'll come a time, too, when all the tractors are worn out or rusted, and there's no more petrol to run them - anyway - we'll come right down to nature and bless horses - if we've got 'em.*
*"This is a pause - just a heaven sent pause - while we get over the first shock and start to collect ourselves. But it's no more than a pause. Later, we'll have to plough, still later we'll have to learn how to make plough-shares, later than that we'll have to learn how to smelt iron to make the shares. What we are on now is a road that will take us back and back and back until we can - if we can - make good all that we wear out. Not until then shall we be able to stop ourselves, on the trail that's leading down to savagery. But once we can do that, then maybe we'll begin to crawl slowly up again".*
*He looked round the circle to see if we were following him.*
*"We* ***can*** *do that - if we will. The most valuable part of our flying start is knowledge. That's the shortcut to save us starting where our ancestors did. We've got it all there in the books if we take the trouble to find out about it".*
*The rest were looking at Croker curiously. It was the first time they had heard him in one of his oratorical moods.*
*"Now", he went on, "from my reading of history, the thing you have to have to use knowledge is leisure. Where* ***everybody*** *has to work hard just to get a living and there is no leisure to think, knowledge stagnates, and people with it. The thinking has to be done largely by people who are not directly "productive" - by people who appear to be living almost entirely on the work of others, but are, in fact, a long-term investment. Learning grew up in the cities and in great institutions - it was the labour of the countryside that supported them. Do you agree with that?"*
*Stephen knitted his brows.*
*"More or less - but I don't see what you're getting at"*
*"It's this - the economic size. A community of our present size cannot hope to do more than exist and decline. If we stay here as we are, just ten of us now, the end is, quite inevitably, a gradual and useless fade-out. If there are children we shall be able to spare only enough time from our labour to give them just a rudimentary education; one generation further, and we shall have savages or clods. To hold our own, to make any use at all of the knowledge in the libraries we must have the teacher, the doctor, and the leader, and we must be able to support them while they help us".*

*John Wyndham, "The Day of the Triffids", 1951*

*Humanity is now so utterly dependent on its advanced technology, science, agriculture and industry it is very difficult to imagine a time when these did not exist. And yet this veneer of civilization is thin. We live on planet with finite resources, and an almost exponentially expanding population. The natural environments in which the human species evolved are rapidly disappearing, and along with the disappearance of natural environments, both terrestrial and aquatic, humanity drives the great sixth extinction of life on Earth. Hysteria grips nations when they learn that their gross national product has not increased for the last financial quarter. All strive to improve the "standard of living" - and yet what is the end game in all of this ? - is it that every citizen on the planet lives in the manner of those in North America, Australia, or Europe? Does the Earth have the resources to support this kind of lifestyle for 8 billion people - even more into the future, and without any immediate prospect of leaving the Earth and colonizing other worlds - if indeed any even vaguely suitable exist elsewhere in the galaxy! Modern medicine is defeating infectious disease, and perhaps stands on the threshold of defeating cancerous disease, perhaps in the next century even ageing will be greatly retarded, and people will live to 150 years of age. But what is the end game in this regard - a planetary population of teeming billions, with every square inch of land surface utilized? Of course scientific advances may render all of these concerns moot - but then again they may not. It is difficult imagine that some kind of Malthusian catastrophe does not await humanity, if not by the end of this century - then perhaps in the next - and if not the next, then surely the one after. Some type of Armageddon will need to faced in the future. This may of course be in the form of natural disaster such as comet impact, but it seems somewhat more likely that the disaster will be human made, perhaps by social collapse and warfare over limited resources or by the radical alteration in the environment that sees in another ice age or a greenhouse inferno.*

*The leitmotif of human apocalypse is a popular subject for writers of fiction. Of the genre, perhaps the most terrifying of all is John Wyndham's "The Day of the Triffids". Either by cosmic disaster sent by God or by human made catastrophe at the hands of a weapon of mass destruction gone horribly wrong, virtually the entire planet is blinded. To compound this hellish existence of the blind survivors, a new, possibly genetically engineered plant, the carnivorous, lethally armed and mobile Triffids, explode into a new evolutionary niche to become the dominant species on planet earth. They are predators and their prey is Homo Sapiens, now in their sightless state utterly defenseless again them. Humanity once with supreme hegemony over the Earth, now faces its nemesis just as the dinosaurs did so 65 million years ago. But there are tiny bands of survivors. One such band led by a man named Coker fascinatingly argues with his fellow survivors on the best way in which the human species might recover. The great advantage we will have, he argues, is the accumulated knowledge of our ancestors in the form of books, and by dint of this he hopes that humanity will not have to relearn what it took millennia to discover. But it will take a "leisured class" to study and understand the books, a luxury that can only come with increased population, which conflicts with their immediate imperatives of survival, which could best be summed up as "burning the books to keep warm and to cook food!".*

*As we progress with our astonishing technology to ever increasing levels of dizzying sophistication we move ever more distant from our primal origins. While this is in some respects a "good" thing, in other ways it leaves us more vulnerable than ever should our technology and industry suddenly fail us. We will be left with a population, evolved in harmony with its technology, but now utterly defenseless and unable to survive without it in an environment from which it originally evolved! One can readily see by Coker's keen insights into the history of*

*humanity that information will be critical to the survivors if they are not to regress into a brutish past so graphically described in Hobbes' "Leviathan"....*

*"....In such condition there is no place for industry, because the fruit thereof is uncertain, and consequently, not culture of the earth, no navigation, nor the use of commodities that may be imported by sea, no commodious building, no instruments of moving and removing such things as require much force, no knowledge of the face of the earth, no account of time, no arts, no letters, no society, and which is worst of all, continual fear and danger of violent death, and the life of man, solitary, poor, nasty, brutish, and short"*

*It is perhaps alarming that all recorded knowledge is increasingly being electronically "digitalized" to the universal acclaim of all who "know best". This has its Guttenbergian advantages of course, but should this technology ever fail us on the grand scale, a stellar gamma ray burst perhaps from a nearby star that erases all electronic signatures from the face of the earth, or perhaps more plausibly a catastrophic collapse in human society in the form of conflict, war or radical environmental alteration, where will the old knowledge be found. Our one best hope will lie not in virtual electronic signals that can only be decoded by highly sophisticated machinery with the equally highly sophisticated "subscription only" infrastructure required to support it, but rather in the humble organic material that can be held in the hand - books. The papyrus of Egypt will still survive, while the ephemeral "Kindles" will be lost forever.*

*A very human sentiment on the value of books that can be taken down from a shelf, without "renewable subscription" and which in its own right can be a thing of real beauty and real Art, and which in a physical, earthy and tangible way can "call into range the far distant voice in time and space and hear it speaking to us, mind to mind, heart to heart..." was penned in 1995 by an admiring reader by the name of Gregory Szekely to the magisterial historian John Julius Norwich....*

*"....Tomorrow I will go back to work as a welder for the railroad, but tonight I am the acting Emperor of Byzantium...thankyou"*

*When we behold a pelvic radiograph of an unfortunate victim of severe trauma, we stand on the shoulders of giants that have preceded us. We give no conscious thought to the countless great physicists, scientists, engineers, philosophers of the past whose accumulated contributions to the pool of human knowledge enable us to see with ease the skeleton of a living person, a feat of magic unimaginable just over a century and half ago. One particular fracture of major importance appears to us as an "open book". The modern electronic image of this "open book" may act as a symbolic reminder of the older organic variety that was responsible for the conveyance to us of the accumulated knowledge of millennia past. It is to be wondered if we can trust the new technologies to pass on to our far distant descendents this knowledge as effectively as the papyrus and the quill.*

# PELVIC FRACTURES

## Introduction

Hemodynamically unstable **pelvic fracture** patients have high mortality rates.

They are associated with a high incidence of pelvic and intra-abdominal visceral injury and bleeding.

The mortality rates of pelvic fracture are the highest of any skeletal injury, with haemorrhage being the major reversible contribution to this. In patients who die from haemorrhage, 60 % die from pelvic bleeding itself and 40 % die from bleeding from associated injuries. [1]

In the seriously bleeding patient with pelvic fracture there are 4 key clinical issues that will need to be addressed:

1. How to determine the source of bleeding in haemodynamically unstable pelvic fracture patients?

2. What is the optimal way of stabilizing the pelvis?

3. How best to control pelvic bleeding:

   - Without associated intra-abdominal bleeding.

   - With associated intra-abdominal bleeding.

4. What is the optimal angiography and embolization technique?

## Classification

Pelvic fractures can be classified in a variety of ways. The Young-Burgess is commonly used, (as below)

Complications of pelvic fractures can be severe and life-threatening

*The Young –Burgess Classification of Pelvic Fractures* [2]

| TYPE | | FEATURES | STABILITY |
|---|---|---|---|
| **Mechanism** | **Sub Type** | | |

| | | | |
|---|---|---|---|
| **Lateral Compression** | I | These injuries involve a **transverse** fracture of the pubic rami (ipsilateral or contralateral to the side of injury), with a second injury. There are 3 types as follows:<br><br>A **transverse** fracture of the pubic rami (ipsilateral or contralateral to the side of injury),<br><br>*with:*<br><br>A sacral compression fracture on the side of impact. | Stable |
| | II | A **transverse** fracture of the pubic rami (ipsilateral or contralateral to the side of injury),<br><br>*with:*<br><br>A crescent (iliac wing) fracture on side of impact. | Unstable |
| | III | A LC-I or LC-II injury on the side of impact, with a contralateral S-I joint injury. | Unstable |
| **Antero-Posterior Compression** | I | These injuries involve **symphyseal diastasis** and/or **longitudinal** rami fractures with variable S-I joint disruption. There are 3 types as follows:<br><br>Slight widening of the symphysis pubis and/or anterior S-I joint, (but with intact anterior and posterior S-I ligaments) | Stable |
| | II | A widened anterior S-I joint with disrupted ligaments, but intact posterior S-I ligaments. | Unstable |
| | III | Complete S-I joint disruption with lateral displacement, with disrupted anterior and posterior S-I ligaments.<br>(Open book fracture) | Unstable |

| | | |
|---|---|---|
| **Vertical Shear** | Symphyseal diastasis or *vertical* displacement anteriorly with posterior diastasis and *vertical* displacement, (usually through the S-I joint, occasionally thru the iliac wing/sacrum). | Unstable |
| **Combination** | A combination of the other injury patterns, LC/VS being the most common. | Unstable |

**It is important to note that the terminology "stable" in this orthopaedic classification refers purely to bony mechanical stability and not to hemodynamic stability. Hemodynamic stability does not correlate exactly with fracture type. All significant pelvic fractures have the potential for catastrophic bleeding.**

## Complications

Important complications of pelvic fractures include:

1. Bleeding:
   - Bleeding can be severe and *life threatening* in cases of pelvic fracture.
   - It can be either arterial or venous (or both) and may arise from the bony pelvic fracture itself or from associated trauma to pelvic, intra-abdominal or retroperitoneal organs or blood vessels.
2. Pelvic and abdominal organ trauma:
   - There is a *high incidence* of associated trauma to abdominal, pelvic and retroperitoneal organs and blood vessels.
3. Urethral injury:
   - Pelvic fractures may be associated with urethral injuries

## Clinical assessment

*Important points of history:*

Establish, in particular the mechanism of injury.

Pelvic fractures are usually the result of a significant degree of force, which will also make other associated injuries likely.

The exact mechanism of injury, may give a clue as to the type of pelvic fracture that is present, (although with severe injuries fracture type will often be mixed).

An A-P force will predispose to the classical “open book” fracture patter. Lateral compression forces may result in iliac wing fractures. Falls from a height may result in vertical shear type fractures.

*Important points of examination:*

**Pelvic fractures are the result of major trauma and a full primary and secondary survey along standard ATLS guidelines must always be undertaken.**

Assessing for **hemodynamic stability** (or otherwise) will be the initial priority.

Important features of examination for pelvic injury include:

1. Local bony tenderness points.

    - In particular over the pubic rami.

2. Swelling / ecchymosis.

    - Swelling and ecchymosis of the medial thigh, genitalia or lumbro-sacral joint regions can be indirect signs of massive blood loss.

3. Assessing pelvic ring stability:

    - This can be problematic in the distressed multi-trauma victim, or indeed the unconscious victim, however “springing the pelvis”, may give some indication of pelvic trauma and/ or instability.

      Apply *gentle* anterior-posterior compression (as below) and lateral-medial compression over the ASIS.

      Axial mobility may be checked by pushing and pulling on the legs to determine stability in cranio-caudal direction.

      Differences in length or asymmetry in rotation of hips may also indicate a pelvic fracture.

3. Assessing for possible urethral injury:

- Perineal ecchymosis
- Perineal or scrotal haematoma
- Blood at urethral meatus

## Investigations

Following initial stabilization, investigations can be undertaken:

1. Blood tests:

- FBE
- U&Es / glucose
- Cross match blood as clinically indicted.

Others as clinically indicated.

2. Establish monitoring:

- ECG
- Pulse oximetry
- Non invasive blood pressure monitoring, (in the first instance), arterial lines may be placed later as the clinical situation allows.

3. Initial trauma series plain x-rays:

- **Minimum of cervical spine, CXR and pelvis.**

  Note that the bony pelvis is essentially a ring structure that rarely sustains an injury in only one location. *Displacement* of ringed structures usually implies two fracture sites.

Others as clinically indicated.

### *Determining the source of bleeding in haemodynamically unstable pelvic fracture patients*

Following initial stabilization, the source of bleeding must be determined. In a hemodynamically unstable trauma patient with a pelvic fracture there are 5 potential sites for major blood loss:

1. External

2. Long bones.

3. Chest.

4. Abdomen/ pelvis

5. Retroperitoneum.

*Initial Assessment*

Initial assessment involves ruling out external, chest and long bone injury as the source of bleeding.

Careful visual inspection will determine the source of any external blood loss, and the possibility of long bone fracture blood loss.

*Urgent CXR and pelvic x-rays are the next priority.*

*CXR and pelvic x-rays should determine:*

- A large hemothorax should be evident, (smaller hemothoraces may not be detected).

- Pelvic fractures. If an **unstable** fracture pattern is seen or suspected (see above), the probability of pelvic *arterial* bleeding into the pelvic retroperitoneum is approximately 50 % and the probability of intra-abdominal bleeding is approximately 30 %.

  Note that pelvic bleeding may be cancellous, venous or arterial.

  Cancellous and venous bleeding will be present in all pelvic fracture patients.

  Arterial bleeding is more serious. Anterior arterial pelvic bleeding most commonly comes from the internal pudendal or the obturator arteries. Posterior bleeding is most commonly from the superior gluteal and lateral sacral arteries.

*FAST scan*

The next preferred investigation is **FAST scanning** in the resus cube.

Note however, that there is a high rate of false negative results (up to 19 %) for free abdominal fluid in the presence of pelvic fractures.

DPL is another option if the expertise for this is available.

**If the FAST scan (or DPL) is positive in the face of continuing hemodynamic instability, immediate laparotomy is warranted.**

*CT scanning*

This may be considered if the patient is relatively stable and the FAST scans are inconclusive.

**If intra-abdominal bleeding has been ruled out angiography is the next step for locating a retroperitoneal source of bleeding, (even in preference to a CT, especially if the patient is unstable as the best initial guide to determine the probability of pelvic arterial bleeding)**

The best guide to significant blood loss is an unstable pelvic fracture (according to the Young-Burgess classification), seen on plain x-ray, however one draw back is that major posterior element disruption may not be appreciated when compared with a CT scan.

*Recommended ideal maximum time frames for these procedures have been suggested as follows:* [1]

- 5 minutes for initial assessment and stabilization.
- 10 minutes, CXR and pelvic x-ray.
- 30 minutes for FAST / CT
- 45 minutes for transfer of a hemodynamically unstable patient from the resus cube to theatre.

## Management

1. As for any multitrauma immediate management involves assessment and management of any immediate ABC issues.
2. Cervical spine immobilization as clinically indicated.
3. Opioid analgesia as clinically indicated.

*Stabilizing the pelvis*

*Recommendations:*

1. Rotationally unstable fractures benefit most from pelvic stabilization.

   Vertical instability will require supplementary ipsilateral skeletal traction.

   - Rotationally unstable fractures include, LC II, LCIII, APC II and APC III.
   - With additional vertical instability, VS or CM, satisfactory stabilization is much more difficult to achieve and hence the supplementary ipsilateral skeletal traction will be required.

2. Non-invasive fixation devices:

The optimal external pelvic stabilization device is:

- **Non-invasive**
- Allows good access to both femoral arteries (should angiography be necessary) as well as good laparotomy access.
- Radiolucent.

A number of non-invasive devices are available.

It the absence of availability of one of these devices the quickest and simplest method is simply a bed sheet wrapped and clamped tightly around the pelvis between the iliac crests and the greater trochanters, (**see Appendix 1 below**).

Non-invasive external pelvic stabilization should be applied in the resuscitation room.

Through a "tension band" effect on the iliac wings, the anterior abdominal wall contributes to limiting the degree of anterior pubic diastasis, which will increase if the pelvis is not stabilized prior to the midline incision.

*The control of pelvic bleeding*

*Recommendations:*

1. Pelvic arterial haemorrhage without intra-abdominal bleeding requires immediate angiography and embolization.
    - Previously considered a "last resort" procedure it is now recommended as first line treatment in patients who do not require immediate laparotomy
    - The angiography suite should be prepared as a "mini intensive" care setting with close monitoring, ongoing resuscitation and re-assessment of other bleeding sources by dedicated clinicians.
2. Intra-abdominal bleeding requires **immediate laparotomy** and concomitant external pelvic stabilization in the operating theatre.
    - A *contained* retroperitoneal pelvic hematoma seen at laparotomy should be packed with sponges and the abdomen closed. Immediate angiography should then follow.
    - Surgical arterial ligation (internal iliac vessels) followed by pelvic packing may be required if:
        - ♥ If there is a *ruptured* pelvic hematoma that is freely bleeding into the abdomen found at laparotomy.

- ♥ The exsanguinating patient unresponsive to initial resuscitation.
- ♥ No angiography facilities are available.

3. Non-invasive external stabilization in the resus cube aids to control small venous and cancellous bone bleeding.

   - Early external stabilization has a role in the management of hemodynamically unstable pelvic fracture. This will help control bleeding from cancellous bone and by maintaining non-moving apposition helps prevent repeated trauma to already clotted vessels.

*Angiography and embolization techniques*

*Recommendations:*

1. Any site of contrast extravasation, false aneurysm, occlusion of a main stem artery and vasospasm with complete vessel occlusion should be embolized.

2. Steel coils are used for the embolization of main arteries and larger branches.

3. In patients with multiple distal, small branch bleeding sites, scatter embolization with a gelfoam suspension of small particles mixed with contrast material provides temporary occlusion without significant ischemia until the gelfoam dissolves.

4. Repeat treatments may be necessary.

**See also appendix 2 below for flow chart summaries on management of pelvic fractures where the facilities for angiography exist and where they do not.**

## Appendix 1

*The Pelvic Sheet Clamp:*

*Technique of pelvic sheet clamping, (photographs permission and courtesy Dr Chantel Mary Thornton)*

Place a folded bed sheet underneath the patient between the iliac crests and **greater trochanters**, (as above left).

With two trauma team members cross the sheet across the symphysis and pull the sheet firmly so it tightly fits around and stabilizes the pelvis, (as above right).

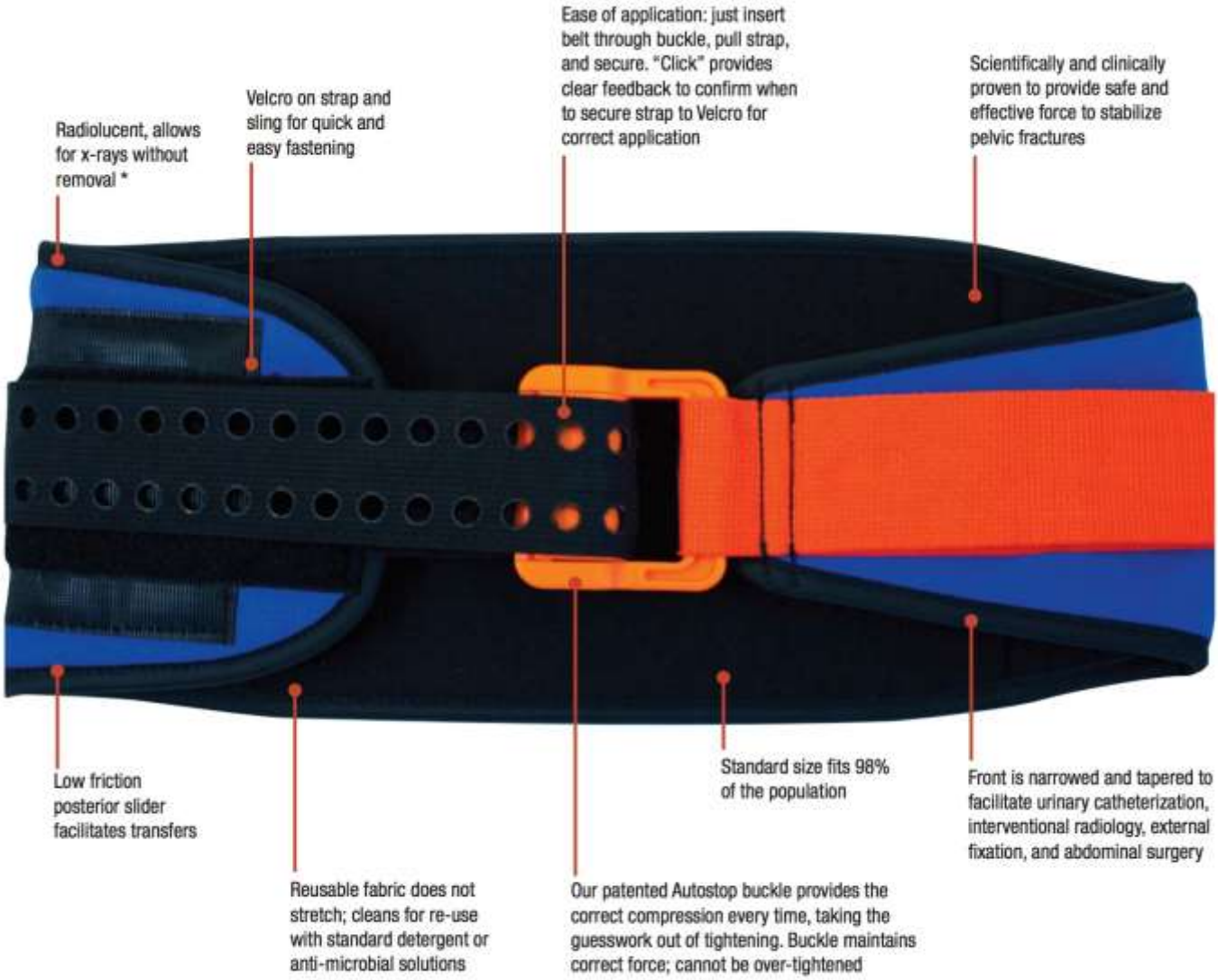
A third person should then clamp the sheet at the four points as shown (above), *(away from laparotomy and angiography access points).*

3. Invasive fixation devices:

   Invasive anterior external fixation devices should be applied when venous bleeding is ongoing or if more time is needed until definitive internal fixation.

   - These devices, however can be problematic when it comes to laparotomy access and femoral access for angiography. Additionally, certain fracture patterns will not allow for placement of pins into the iliac crests.

*Example of a non-invasive Pelvic Binder Device*

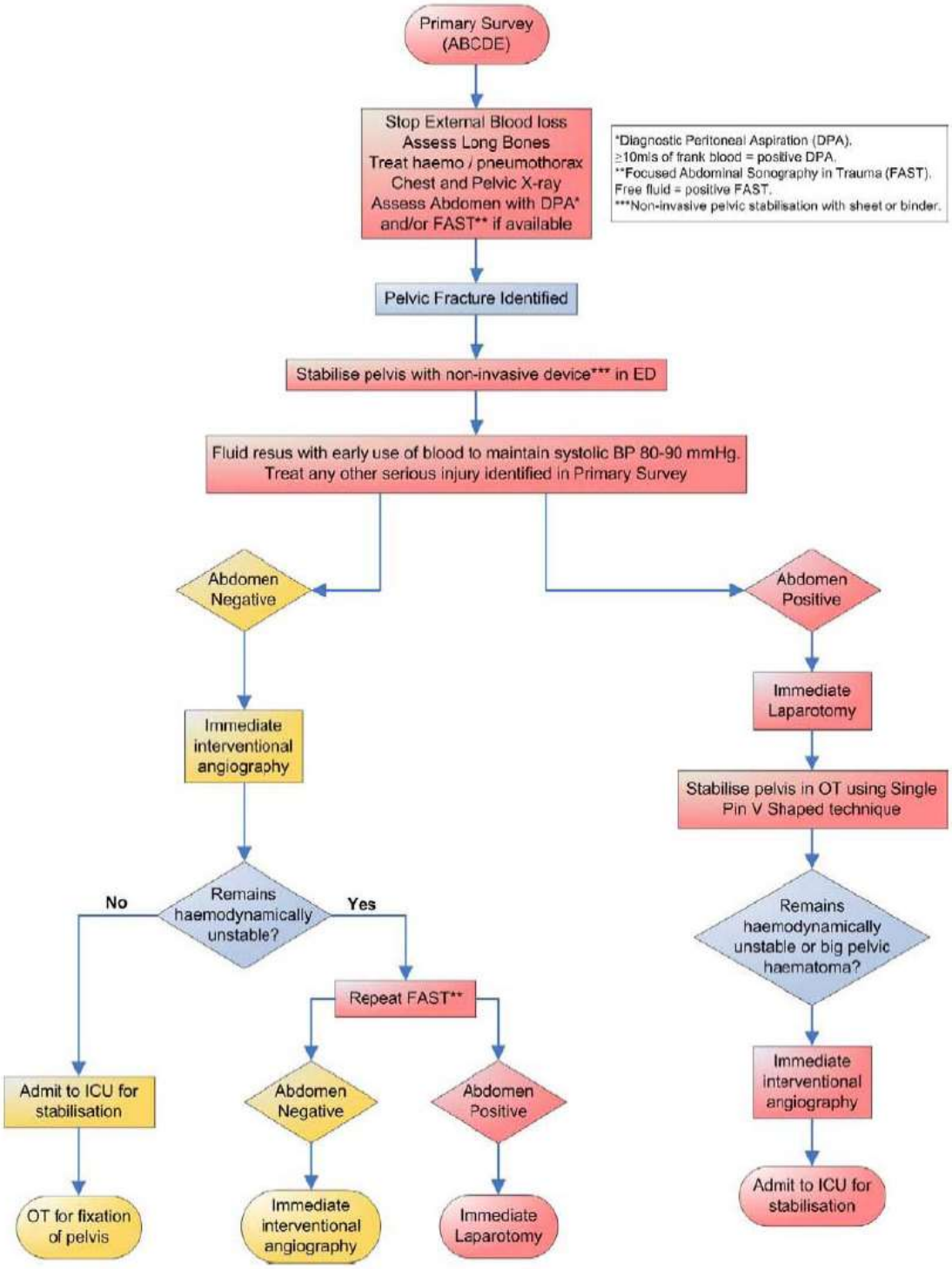



*The SAM pelvic sling device, (FERNO, Australia).*

## Appendix 2

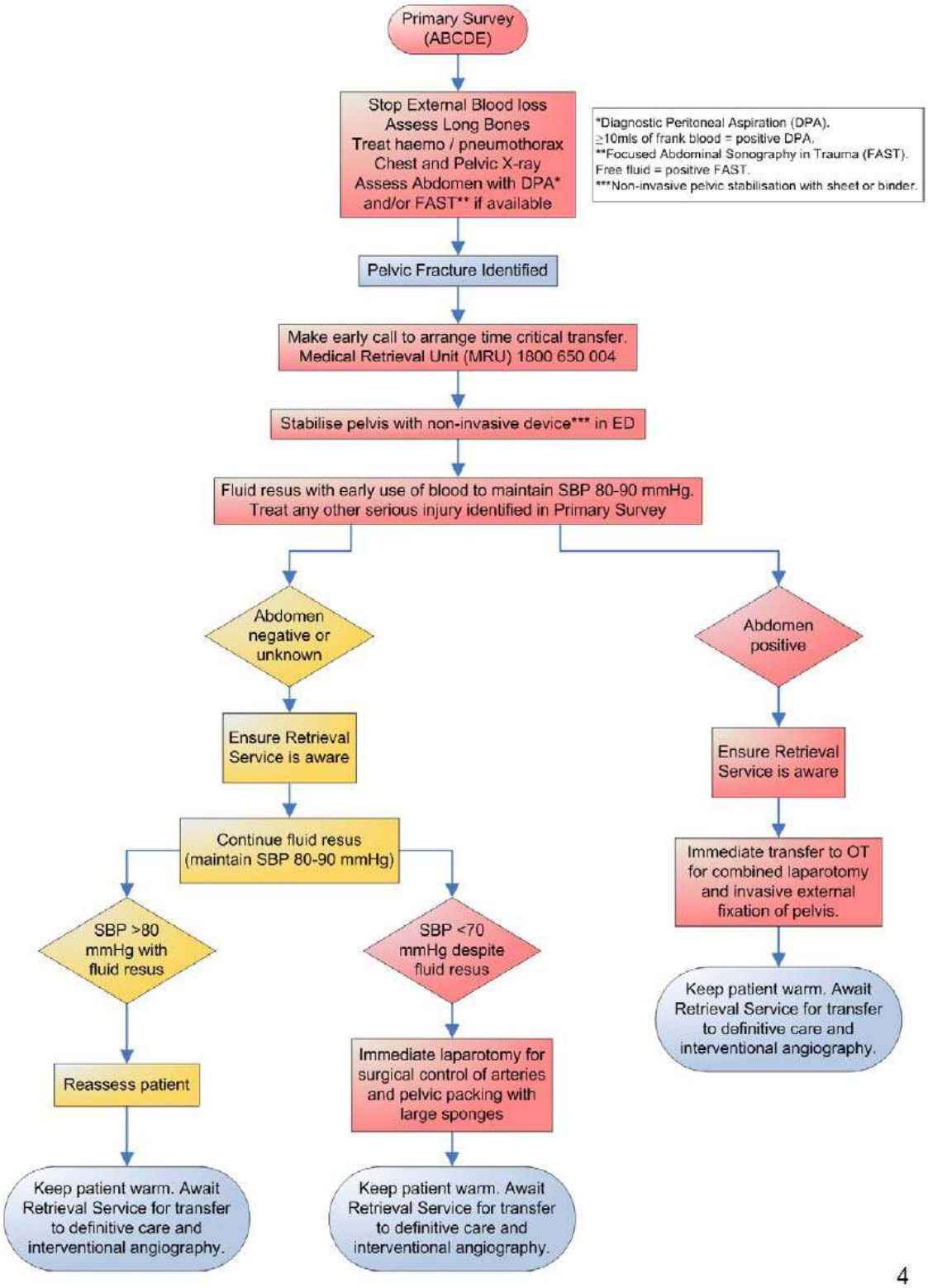
Algorithm 1:

Management of the Haemodynamically Unstable Patient with a Pelvic Fracture with Angiography Services Available



**Algorithm 2:**

## Management of the Haemodynamically Unstable Patient with a Pelvic Fracture without Angiography Services Available






*(Flow charts permission and courtesy Dr Chantel Mary Thornton).*

## Appendix 3


*Classic appearance of the "open book fracture" (or Antero-Posterior Compression Grade III fracture)in a 56 year old male.*

*There is a severe diastasis of the pubic symphysis associated with a diastasis of the right sacro-iliac joint, (Radiograph courtesy Dr Zachary Robinson).*

*References:*


1. Heetveld M.J et al, Guidelines for the Management of Haemodynamically Unstable Pelvic Fractures, ANZ J. Surg; July 2004, (74) p. 520-529.

2. From "Trauma to the Pelvis" in Emergency Medicine, Tintinalli J.E, 4th ed 1996, p.1247.

3. Thornton C.M. "Pelvic Fractures", Presentation to the College of Surgeons, (with permission).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