2.1 The patient and the injury: decision making in trauma surgery

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2.1 The patient and the injury: decision making in trauma surgery

1 Introduction

Decision making and communication are vital factors for successful surgery; good surgeons make wise decisions. Before recommending surgical treatment, a thorough assessment of the patient must be undertaken to understand the full extent of the injury, anticipate and prevent postoperative complications, and determine the potential for recovery.

The first priority is to save life and therefore the management of major chest, abdominal, and head injuries will always take precedence. Fractures are rarely life-threatening but pelvic fractures may require splintage, stabilization, packing, or embolization to stop severe hemorrhage. The next priority is to save limb by early treatment of vascular injuries and open fractures. Joint dislocations, and severely displaced fractures should be reduced, but most fractures can be splinted. This allows time to optimize the patient’s condition, perform investigations, and formulate a definitive treatment plan.

- The surgeon must evaluate the “personality” of the injury. This is determined by
  - patient factors;
  - the soft-tissue injury;
  - the fracture.

Decisions must be made in the context of the local health care facilities. This chapter will discuss these key elements in the decision making process (Fig 2.1-1).
2 Decision making and planning

2 Polytrauma (chapter 4.1)

The initial assessment and management of all patients with polytrauma should follow advanced trauma life support (ATLS) guidelines. This divides treatment into four phases:

- primary survey;
- resuscitation;
- secondary survey;
- definitive care.

2.1 Primary survey and resuscitation

- The primary survey and resuscitation are undertaken simultaneously, ideally by a multidisciplinary trauma team. The aim of the primary survey is to identify all immediately life-threatening conditions and commence treatment in the following sequence:

<table>
<thead>
<tr>
<th>A</th>
<th>Airway with cervical spine control</th>
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</thead>
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<tr>
<td>B</td>
<td>Breathing</td>
</tr>
<tr>
<td>C</td>
<td>Circulation with hemorrhage control</td>
</tr>
<tr>
<td>D</td>
<td>Disability (assessment of neurological status)</td>
</tr>
<tr>
<td>E</td>
<td>Exposure of patient and environmental control</td>
</tr>
</tbody>
</table>

If a trauma team is available, these phases can be performed simultaneously by different members of the team (Fig 2.1-2). The neck and spine must be protected until the spine is cleared according to local guidelines. The most common life-threatening injuries occur to the chest, abdomen, and head. They must be dealt with rapidly. Early radiological assessment of the chest and pelvis is essential. Excess movement of the pelvis must also be avoided as this can dislodge blood clots from pelvic fractures and increase bleeding. Pelvic binders are now commonly used to splint the pelvis, but a simple belt or tied bed sheet may be just as effective.

Bone injuries are rarely life-threatening unless there is severe hemorrhage from pelvic, open, or multiple long-bone fractures. Packing the wound and applying direct pressure should control external hemorrhaging. Hemorrhaging from fractures can be reduced by early splintage which restricts movement and allows clots to form. It is essential that hypothermia is prevented as this inhibits the coagulation cascade. Early infusion of blood products, such as fresh frozen plasma, platelets, and cryoprecipitate should be considered in all patients with persistent hypovolemic shock. In the near future factor VIIa may become available for this indication.

2.2 Secondary survey

The secondary survey takes place once the primary survey has been completed. A full history of the accident should be taken from the patient (if possible), paramedics, and relatives. A past medical and drug history must be obtained.
2.1 The patient and the injury: decision making in trauma surgery

- A thorough examination from head to toe, front and back, should identify remaining injuries.

In the limbs, each bone and joint should be tested for tenderness and stability and a neurovascular assessment of each limb is mandatory. All wounds should be carefully inspected and any gross contaminants removed. If possible, photographs should be taken before the wounds are covered with saline-soaked, sterile dressings. These must be left undisturbed until definitive wound management in the operating room. Appropriate tetanus coverage and antibiotics should be administered. X-rays of all suspected fractures must be obtained. Computed tomography (CT) scans can be helpful in the evaluation of spine, pelvis, and complex articular fractures.

2.3 Definitive care

Decision making is difficult in polytrauma patients and experienced, senior surgeons should be involved early. A key strategic decision in polytrauma is to undertake damage-control surgery or early total care.

2.3.1 Damage-control surgery

- Damage-control surgery should be considered in patients who remain hemodynamically unstable or those with hypothermia, abnormal base deficit, or blood-clotting abnormalities.

No single investigation gives a clear guide to decision making but the immunological status of the patient appears to be an important factor [1]. A test may be developed, in the near future, that identifies patients most at risk of a major systemic inflammatory response following trauma. In this group of patients only life- and limb-saving surgery should be performed during the early phase. Long-bone fractures can be rapidly stabilized with simple, temporary external fixation. The fixation pins should be outside the zone of injury and, if possible, outside the zone of any future surgery for definitive care (Fig 2.1-3). The patient should be transferred to the intensive care unit as soon as possible and definitive surgery delayed until the patient’s condition is optimal, often at 5–10 days posttrauma [2].

2.3.2 Early total care

Early total care is beneficial for some patients with polytrauma. This involves definitive surgical stabilization of all long-bone fractures during the early phase of treatment. This may reduce pulmonary complications and allow earlier rehabilitation of the patient [3].

- Early total care is suitable for patients with multiple fractures but without major chest or visceral injury. Patients must be hemodynamically stable with normal blood gases, clotting, and temperature.

Careful planning of the sequence and timing of surgery is essential while a deterioration in the patient’s condition may mandate a change to damage-control surgery.

2.4 Isolated injuries

The first questions to ask when presented with an apparently isolated injury are:

- What else is injured?
- Does the mechanism of injury suggest the patient could have polytrauma?
- Is there an injury to the joint above or below?
Decision making and planning

In polytrauma each individual injury should have the same thorough evaluation that is undertaken for single injuries. In each case patient factors, such as multiple comorbidities, may have a profound effect on decision making. The local evaluation of each injury has two key facets: the soft tissues and the fracture pattern. These factors, together with patient factors, will determine the “personality” of the injury and subsequent decision making and treatment.

The “personality” of the injury

3.1 The patient

A holistic approach to the patient is essential. A full case history and examination must be performed together with appropriate investigations.

Fig 2.1-3a–c The application of external fixation for damage-control surgery must be outside the zone of injury. The zone of future definitive fracture surgery should also be bridged, if possible.
Important factors that will influence decision making include age, general health status, mental health, occupation, and social factors.

**Age**
Age is obviously important, especially in childhood when the growing skeleton has potential to remodel and injuries may result in growth disturbance. The development of osteoporosis in the ageing skeleton has a major influence on surgical techniques, but age alone is not sufficient when assessing elderly patients. Preinjury mobility, residential status, cognitive function, long-term medication, and preexisting medical conditions are all important and influence decision making [4, 5].

**3.2 General health status**

**Cardiorespiratory problems** will influence the anesthetic used and are important factors when determining a patient’s fitness for surgery.

**Diabetes** alters a patient’s metabolic response to trauma and requires careful management during the perioperative period. In diabetics neutrophil granulocytes do not function normally, which predisposes these patients to infection. They also suffer from small vessel disease which may cause delayed healing and a further increase in the risk of infection. These patients can develop neuropathic nonunion and joint destruction (Charcot’s joint). A careful evaluation of the neurovascular status of the limb is essential and patients must be aware of the increased risks [6].

**Peripheral arterial disease** will have an important influence on soft-tissue and fracture healing. The ankle-brachial index should be measured in all these cases.

**Venous disease** in the legs can cause chronic swelling, venous congestion, and ulceration which will affect treatment and prognosis. Surgery must be avoided, if at all possible, in patients with acute vasculitis, and the presence of this problem should always be considered in patients with systemic inflammatory diseases such as rheumatoid arthritis and systemic lupus erythematosus.

**Renal disease** and chronic renal failure can result in abnormal bone metabolism and it is not unusual to treat fractures in patients on dialysis. These patients may have electrolyte and coagulation disorders and are at increased risk of infection and nonunion. It is essential that renal physicians are involved in the perioperative management.

**Liver disease** also predisposes to osteoporosis and fracture. Patients with cirrhosis may have coagulation disorders. Liver function and coagulation must always be tested prior to surgery. Viral hepatitis may put the nursing and surgical team at risk of cross infection.

**Neurological conditions**, such as stroke and Parkinson’s disease, may alter a patient’s ability to bear weight and comply with rehabilitation. These patients are at risk of further falls and may require additional external splints for protection. Patients with head injury are more prone to heterotopic bone formation and may have muscle spasticity that results in joint contractures. These must be prevented by physical therapy and splints.

**Malignant disease** should always raise the possibility of pathological fracture and the presence of a primary bone tumor must be considered in young patients presenting with pathological fracture. Decision making in patients with pathological fracture and advanced malignancy is always difficult and should involve the patient, relatives, and the palliative care team.
**Joint disease**, such as osteoarthritis or rheumatoid arthritis, must be evaluated when assessing any fracture.

- Some articular and periarticular fractures may be managed by primary joint replacement if there is advanced arthritis.

The presence of a joint replacement and periprosthetic fracture will require careful assessment to determine preexisting loosening or infection, the etiology of the fracture, and the relationship between the fracture lines and the prosthesis.

**Obesity** is a major health care problem in the western world. Morbid obesity presents the trauma surgeon and anesthetist with some unique problems. Patients may be too large for standard operating tables and poor respiratory function may preclude the normal supine position. Compliance with rehabilitation programs can be a problem and splints or plaster casts may be difficult to apply [7].

**Medications**, such as corticosteroids can result in osteoporosis, poor healing, and increased risk of infection. Patients may also be at risk of Addisonian crisis if they have been on high doses of steroids. Patients on immunosuppressives require careful management and have a similar increased risk of infection together with potential coagulation disorders. Patients on beta-blockers and other cardiac drugs may be unable to mount a normal response to hypovolemia. Anticoagulants such as coumadin (Warfarin) are now prescribed commonly and require close hematological monitoring. Nonsteroidal antiinflammatory drugs have been implicated in the pathogenesis of some nonunions and their use should be avoided following nonunion surgery [8].

### 3.3 Mental health

Mental health can have a major influence on the outcome following trauma. Any preexisting psychological disorder must be considered and posttraumatic psychological reactions are common. Pain management can be complex and difficult and sometimes require specialists in this field. Compliance with treatment, physical therapy, and rehabilitation may be a problem and the involvement of mental health teams is often necessary to optimize treatment of the patient. It is well recognized that worker’s claims for compensation can radically alter a patient’s response to injury and treatment [9].

### 3.4 Occupation

Occupation can have an important influence on a patient’s functional goals. Following severe hand trauma the functional requirements of a fine-skilled worker, such as a jeweller, will be different from a heavy manual worker. This may warrant a completely different surgical and rehabilitation program. Professional sports men and women are another group where functional demands may influence decision making.

### 3.5 Social factors

Social factors that influence fracture management include cigarette smoking, which may delay soft-tissue and fracture healing, and alcohol abuse which predisposes to falls, and osteoporosis. Patient compliance and rehabilitation can be a problem in this group. Intravenous drug abusers present similar challenges and are at risk of blood-borne viral diseases such as hepatitis B, hepatitis C, and HIV. Universal precautions must be applied to prevent cross infection of health care workers.
2.1 The patient and the injury: decision making in trauma surgery

4 The soft tissues

- It is not possible to overemphasize the importance of soft tissues in fracture management.

The major principles of soft-tissue management have been covered in chapter 1.6. Each type of soft tissue must be assessed to determine the full extent of the zone of injury:

<table>
<thead>
<tr>
<th>Soft tissue</th>
<th>Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Wounds and scrapes, contusion, swelling, and edema</td>
</tr>
<tr>
<td>Subcutaneous fat</td>
<td>Hematoma, closed degloving, and devitalized skin</td>
</tr>
<tr>
<td>Muscles and tendons</td>
<td>Function, compartment syndrome</td>
</tr>
<tr>
<td>Nerves</td>
<td>Motor and sensory function of each major nerve in limb</td>
</tr>
<tr>
<td>Vessels</td>
<td>Skin color, warmth, capillary refill, and pulses</td>
</tr>
</tbody>
</table>

Following this examination, the soft-tissue injury can be classified and this part of the “personality” of the fracture defined (chapter 1.5; 1.6).

5 The fracture

Plain x-rays will define the fracture and should be done in two planes at 90° to each other: The joint above and below the injury must be imaged. Most information for fracture care is on the plain x-rays. X-rays taken with traction after the patient is anesthetized can provide valuable information for the planning of fracture fixation. Additional investigations are often required. A CT scan is very helpful for the imaging of intraarticular fractures, providing information on the size, location, and displacement of fracture fragments. Computer manipulation of the CT scan in the sagittal and coronal planes and 3-D projections may be helpful. MRI now provides good detail of bone injuries and may be very helpful in cases of a combined bone and soft-tissue injury (eg, tibial plateau fracture with meniscal and ligament injury).

Full evaluation of the fracture will allow classification and surgical planning, but the timing of surgery is not determined by the fracture but by the physiological condition of the patient and the soft-tissue injury.

6 Timing of surgery

To chose the correct time for the performance of fracture surgery is a key decision that will be determined by the “personality” of the fracture. Surgery at the wrong time can be disastrous for the patient: The hemodynamically unstable polytrauma patient should only have minimal surgery to save life and limb, not complex reconstruction surgery to restore joint function. Surgery through swollen and edematous tissue has a high risk of wound breakdown and secondary infection.

The vast majority of patients have an isolated, closed fracture. Surgery is not urgent and should be scheduled after appropriate investigations and planning. The timing of surgery will depend on the patient’s health and the state of the soft tissues. Ideally, it should take place within 1–3 days postinjury to reduce hospital stay and allow the patient to commence early rehabilitation (Tab 2.1-1). Isolated, closed femoral shaft fractures should have surgery within 24 hours as this reduces the risk of respiratory complications [3].
## Decision making and planning

<table>
<thead>
<tr>
<th>Kind of injury</th>
<th>Details of injury</th>
<th>Time of primary surgery</th>
<th>Procedure of primary surgery</th>
<th>Time of early reconstruction surgery</th>
<th>Definitive reconstruction surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polytrauma</td>
<td>Hemodynamically unstable</td>
<td>Immediate</td>
<td>Damage-control surgery External fixator</td>
<td>5–10 days “window of opportunity”</td>
<td>After 3 weeks</td>
</tr>
<tr>
<td></td>
<td>Hemodynamically stable</td>
<td>Immediate</td>
<td>Early total care</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ISS &lt; 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open fracture</td>
<td>Type I–IIIA</td>
<td>&lt; 6 hours</td>
<td>Definitive fracture fixation</td>
<td>24–72 hours Debridement and soft-tissue coverage</td>
<td>After 6–20 weeks Bone graft and soft-tissue management</td>
</tr>
<tr>
<td></td>
<td>Type IIIB and IIIC</td>
<td>&lt; 6 hours</td>
<td>Definitive fracture fixation or local damage control</td>
<td>24–72 hours Debridement and soft tissue cover and definitive fracture fixation</td>
<td>–</td>
</tr>
<tr>
<td>Closed fracture</td>
<td>Good soft tissues</td>
<td>1–3 days</td>
<td>Definitive fracture fixation</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Poor soft tissues</td>
<td>&lt; 24 hours</td>
<td>Local damage control, spanning external fixator</td>
<td></td>
<td>After 10–14 days Definitive fracture fixation</td>
</tr>
<tr>
<td>Unstable fracture dislocation</td>
<td>Good soft tissues</td>
<td>Early</td>
<td>Definitive fracture fixation</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Poor soft tissues</td>
<td>Immediate</td>
<td>Local damage control, spanning external fixator</td>
<td></td>
<td>After 10–14 days Definitive fracture fixation</td>
</tr>
</tbody>
</table>

Tab 2.1-1 The timing of fracture surgery.
Polytrauma patients who are hemodynamically stable and fit for early total care (ETC) should have urgent fracture fixation. The soft tissues will determine the local treatment and, if these allow, early definitive fracture fixation is probably ideal. Polytrauma patients who are hemodynamically unstable or otherwise not fit for prolonged surgery (eg, hypothermic) should have damage-control surgery (DCS) to save life and limb. This will usually involve the application of temporary external fixators to rapidly stabilize long-bone fractures and unstable fracture dislocations. The timing of additional fracture surgery can be difficult and will depend upon the physiological state of the patient. Current evidence suggests that definitive care is best delayed for 5–10 days (chapter 4.1). This allows the patient to recover from the systemic inflammatory reaction to trauma while minimizing the risk of infection secondary to external fixator pin-track sepsis.

Open fractures require urgent wound debridement, ideally within six hours of injury. However, a slightly longer delay is probably acceptable in clean wounds and children [10] to avoid surgery in the early hours of the morning. Antibiotics should be administered and the patient must be scheduled for surgery as the first case in the morning. The decision to perform local damage-control surgery (ie, wound debridement plus temporary external fixation) or local definitive care (ie, wound debridement plus definitive fracture fixation) will depend upon many factors which include the delay between injury and surgery, the state of the soft tissues, the available facilities, and the experience of the surgeon. The majority of wounds will require delayed primary closure or flap cover. This should be performed within five days. If a temporary external fixator has been applied it may sometimes be appropriate to perform definitive fixation at this time.

Closed fracture dislocations or complex articular fractures are an important group to consider. These often develop severe soft-tissue swelling with fracture blisters. If the patient is seen early, before the soft tissues have swollen, then early definitive fracture fixation will be the best option, provided appropriate investigations for planning (eg, CT scan) are available. However, if the soft tissues are already compromised, local damage-control surgery should be considered if

- soft tissues are compromised;
- patient comorbidities require treatment before surgery;
- specialist surgical or nursing team not available;
- specialist surgical implants/instruments not immediately available.

Many fractures can be simply splinted and elevated (eg, wrist, calcaneous) until the swelling resolves. However, in some cases (eg, pilon, knee) a temporary, joint-spanning external fixator may protect the soft tissues from further injury and also prevent shortening, joint subluxation, and additional damage to the articular surface. This treatment appears to facilitate soft-tissue healing and often allows the patient to remain at home while swelling resolves, usually at 7–21 days. Definitive surgery is scheduled at this stage.

7 Communication

The surgeon is the leader of the health care team that manages trauma patients.

- Clear communication with doctors, nurses, patients, and relatives is an essential skill.

Once the surgeon has evaluated the “personality” of the injury, he or she must formulate a treatment plan and communicate this effectively. There are three key facets to the treatment plan:

- surgical strategy;
- surgical tactic;
- surgical plan.
2 Decision making and planning

Surgical strategy is the overall treatment plan for the patient, including preoperative investigations, surgical and medical treatment, and rehabilitation. In the polytrauma patient, good communication with other specialists is important to set priorities and determine the sequence and timing of multiple procedures. It is essential that one senior surgeon takes overall responsibility for the patient’s management, this will usually be the trauma surgeon.

Surgical tactic is the overview and plan for each complete episode in the operating room. This allows the surgeon, anesthetist and operating room personnel (ORP) to prepare for each operation. Key information that must be communicated includes the planned procedure, patient position, type of operating table, instruments and implants required, the need for intraoperative radiology or blood transfusion, splints and special postoperative requirements such as an intensive care bed.

Surgical planning is the fine-detail drawing that the surgeon should prepare for each fracture fixation. This allows the surgeon to mentally rehearse the operation, determine the anatomical approach to the fracture (and thus patient position), and select the implants needed. Potential intraoperative complications and problems can be anticipated and avoided. This is an important discipline for orthopedic trauma surgeons and is described in chapter 2.4.

Good communication with patients and relatives is important. They should have a clear understanding of the nature of the injury, the intended surgical treatment, and the rehabilitation program. A realistic expectation of the outcome is essential and good communication with patients will usually prevent a breakdown in trust that might lead to litigation.

8 Health care environment

The facilities available to deliver trauma care vary greatly, not just from country to country but also within regions and even cities. The facilities available will be a key determinant of what care can be provided. Before commencing treatment, particularly in rare or complex cases, the surgeon must ask two questions:

- Does my hospital have the staff, facilities, and implants to undertake the planned procedure?
- Does the surgeon/Do I have sufficient skill, experience, and expertise to treat this condition?

The formulation of the surgical tactic and plan is very helpful and will allow the surgeon to anticipate the requirements for instruments and implants, specialist procedures such as microvascular free-flaps, and special facilities such as intensive care. This plan can then be matched against the available facilities and expertise within the hospital.

Surgeons must have a realistic appreciation of their own skills and limitations. Without sophisticated facilities and highly-trained personnel it may not be safe to carry out complex reconstruction surgery and patients should be transferred (as safely and rapidly as possible) to an institution where these are available.

When the patient’s needs exceed the resources available in the treating institution such a transfer is mandatory.

Good rehabilitation facilities must also be available as the most perfect osteosynthesis will be a waste of time and resources if the patient does not receive the appropriate advice, physical and occupational therapy to allow them to regain maximum possible function after injury.
2.1 The patient and the injury: decision making in trauma surgery

9 Conclusion

In summary, the trauma surgeon must take a holistic approach to fracture management. Fractures are rarely life-threatening and other injuries may take priority. The formulation of a definitive treatment plan will depend upon patient factors, soft-tissue injury, and the fracture itself. These three factors determine the “personality” of the injury and must be fully evaluated prior to treatment.

10 Bibliography


11 Acknowledgment

We wish to thank Peter Worlock for his contribution to this chapter in the first edition of the AO Principles of Fracture Management.