Acute Pelvic Fractures: II. Principles of Management

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Abstract

The past two decades have seen many advances in pelvic-trauma surgery. Provisional fixation of unstable pelvic-ring disruptions and open-book fractures with a pelvic clamp or an external frame with a supracondylar pin has proved markedly beneficial in the resuscitative phase of management. In the completely unstable pelvis, external clamps and frames can act only as provisional fixation and should be combined with skeletal traction. The traction pin is usually used only until a definitive form of stabilization can be applied to keep the pelvic ring in a reduced position. If the patient is too ill to allow operative intervention, the traction pin can remain in place with the external frame as definitive treatment. Symphyseal disruptions and medial ramus fractures should be plated at the time of laparotomy. Lateral ramus fractures can usually be controlled with external frames. A role has been suggested for percutaneous retrograde fixation of the superior pubic ramus; however, the benefits to be gained may not be enough to outweigh the serious risks of penetrating the hip, and this technique should therefore be used only by surgeons trained in its performance. The techniques for posterior fixation are becoming more standardized, but all still carry significant risks, especially to neurologic structures.

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Many advances have been made in the general management of polytrauma patients. The stabilization of major fractures of the lower extremities and the axial skeleton, including the pelvis and spine, has changed the outlook for these patients. The role of the orthopaedist on the trauma team is essential, and the orthopaedic surgeon must therefore be prepared to be present at the initial resuscitation of the patient in order to take part in the decision-making process. All orthopaedic surgeons taking emergency call must be proactive in this regard and make themselves available.

The management of a pelvic-ring disruption depends on the overall treatment plan for the patient with polytrauma, as well as the type of pelvic fracture present. Therefore, the first step in management is a careful assessment of the patient both generally and specifically. Other steps in the continuum of care include resuscitation and provisional stabilization and definitive stabilization of the pelvic ring, which, although considered separately, often overlap.

Assessment

Clinical Evaluation

In all areas of clinical medicine, an accurate history is essential, but this is particularly true in the case of pelvic trauma, because the history may alert the surgeon to the type of pelvic fracture the patient has suffered. Epidemiologic studies of pelvic fractures have shown two distinct groups: (1) fractures due to high-energy trauma, most often from motor-vehicle accidents, falls from a height, and crushing injuries; and (2) fractures due to low-energy trauma, as from simple falls at home (often seen in older osteoporotic persons).[1]

The general physical examination should follow the guidelines of the American College of Surgeons on polytrauma care.[2] Of particular importance in the diagnosis of pelvic trauma are the following factors:

Wounds

All wounds in the pelvic area must be carefully assessed to rule out the presence of an open fracture. This is especially true of wounds in the perineum and the posterior sacroiliac area.

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Contusions

The site of a massive contusion in the pelvic area may alert the surgeon to the type of force mechanism that produced the fracture, which will influence the surgical management.

Hematuria

In men, the presence of blood at the tip of the penis from the urethral meatus suggests a urethral rupture. In women, blood from the urethra or vagina suggests an occult open fracture of the pelvis.

Pelvis and Lower Extremities

The lower extremities should be examined for shortening and rotational deformity. In the absence of a long-bone fracture, shortening and external or internal rotation must be due to pelvic displacement.

Careful palpation in the pelvic area may reveal abnormal motion and crepitus in the hemipelvis. Compression of the iliac crest may reveal abnormal internal rotation, indicative of rotatory instability. The application of traction to a limb without a long-bone fracture can often be useful in the detection of posterior or vertical translation. The traction maneuver usually requires two individuals, one palpating the iliac crest and the other applying traction to the limb.

If the presence of gross instability of the pelvis is difficult to determine, the patient can be examined under an image intensifier. This may be done in either the radiology department or the operating room, depending on the other injuries present and the overall management plan.

Rectum and Vagina

Examination of both structures is essential for complete patient assessment to rule out an open fracture.

Neurologic Examination

Injury to the lumbosacral plexus is extremely common, especially in type C (unstable) injuries, with an incidence approaching 50%.[3,4] Therefore, a careful neurologic examination is mandatory to rule out lesions affecting the lumbosacral plexus and must be recorded on the chart.

Radiologic Assessment

Plain Radiography

In the polytrauma protocol of most trauma units, a single anteroposterior radiograph of the pelvis is mandatory (Fig. 1, A). Another extremely useful projection is the inlet view, normally used in obstetric practice, which is obtained by directing the x-ray beam from the head to the midpelvis at an angle of 60 degrees to the x-ray table (Fig. 1, B). This view shows posterior displacement of the sacroiliac complex better than any other and is especially useful when computed tomography (CT) is not available. Also useful is the outlet projection, which is taken with the beam directed from the foot to the symphysis pubis at an angle of 45 degrees to the horizontal (Fig. 1, C). This view is helpful in visualizing the entire sacrum, including both sacroiliac joints, and will also show superior migration of the iliac crest.[5] A knowledge of the landmarks on each of these views has assumed greater importance recently because of their use in percutaneous iliosacral-screw fixation.[6,7]

Computed Tomography

Computed tomography has added a new dimension to the determination of displacement in pelvic-ring injuries and is the best method

A B C

Fig. 1 **A,** Anteroposterior radiograph of the pelvis, which is mandatory in all polytrauma protocols. **B,** Inlet view, obtained by directing the x-ray beam from the head of the patient to the midpelvis at an angle of 60 degrees, shows posterior displacement of the sacroiliac complex. **C,** Outlet projection, obtained with the beam directed from the foot of the patient to the symphysis pubis at an angle of 45 degrees to the horizontal, shows the symphysis and the sacrum. (Reproduced with permission from Tile M [ed]: *Fractures of the Pelvis and Acetabulum*, 2nd ed. Baltimore: Williams & Wilkins, 1995.)

of visualizing lesions of the sacroiliac complex. It is especially useful in identifying fractures of the sacrum, clearly showing those that are compressed or impacted due to lateral compression, rather than gaping and unstable. Axial images are certainly sufficient, but newer methods of three-dimensional CT can be helpful in visualizing the overall pattern of injury to the pelvis (Fig. 2).

Diagnosis of Instability

The completely unstable type C pelvic fracture can usually be diagnosed clinically. The affected hemipelvis is not only unstable in rotation when compression is applied to the iliac crest laterally, but also translates abnormally both vertically and posteriorly with no firm end point when a push-pull force is applied to the limb. Radiographic findings that indicate gross instability include more than 1 cm of posterior or vertical displacement and the presence of avulsion fractures of the sacrum or the ischial spine, indicating disruption of the sacrospinous ligament, or of the transverse process of L5 associated with a shear mechanism. A large gap (rather than compression) in the sacroiliac complex may be seen on CT.

The partially stable type B pelvic fracture usually has an end point when the hemipelvis is examined as described above, beyond which posterior or vertical translation is not possible. The pelvis may rotate internally or externally or may be impacted in the displaced position.

Resuscitation

It is beyond the scope of this article to discuss the resuscitation of the polytraumatized patient in detail. Therefore, I will concentrate on the role of pelvic stabilization in the resuscitation process. Hemorrhage in pelvic trauma may be life threatening. The site of blood loss can be determined with the use of peritoneal lavage, portable ultrasound, or CT. In the resuscitative phase, control of hemorrhage is essential, and volume replacement must be immediate and adequate. Other modalities for the control of hemorrhage include the use of a pneumatic antishock garment (especially during patient transfer), arterial embolization techniques, urgent laparotomy, and pelvic packing if the patient is in extremis.

Provisional stabilization of the unstable pelvis is an integral part of the resuscitation of the patient. Therefore, the orthopaedist on the trauma team must be prepared to play a role in acute resuscitation and decision making.

Provisional Stabilization

Provisional fixation is indicated for patients with lesions that increase the pelvic volume, such as the partially stable open-book fractures (types B1 and B3-1) and all of the unstable (type C) fractures. Application of a pelvic clamp or an external frame plus supracondylar femoral traction reduces the pelvic volume, partially stabilizes the bones and soft tissues, reduces the amount of bleeding and pain from the pelvis, and allows much easier nursing care.

Clearly, in patients with such lesions and with significant blood loss, provisional fixation with frames or external fixators is indicated. However, if the patient's general condition is stable, with no evidence of continuing pelvic hemorrhage, the surgeon should apply skeletal traction in anticipation of early definitive surgical management. In this situation, decision making is difficult because placement of external pins in the iliac crests may compromise early internal fixation through anterior approaches. Therefore, if the patient is

A B C

Fig. 2 Three-dimensional CT images. Anteroposterior **(A)**, inlet **(B)**, and outlet **(C)** projections clearly depict internal rotation of the right hemipelvis (arrows), with posterior and superior displacement occurring through the symphysis pubis and right sacroiliac area.

not in shock, very careful planning of the orthopaedic management is vital, especially the timing of definitive fixation.

Provisional stabilization can be achieved with various forms of external fixation, with or without skeletal traction, and/or with internal fixation.

External Fixation

External fixation can be applied to the pelvic ring with either a pelvic clamp or more traditional methods.

Pelvic Clamp

Pelvic clamps have been designed to be quickly applied to patients in extremis. At this time, they seem to offer little biomechanical advantage over the more traditional forms of external fixation. Furthermore, studies performed to determine the optimal time of application have disclosed little difference between the clamp and other modalities. However, since the concept is valid, it is possible that, with further refinements, a pelvic clamp will be developed that can be safely and quickly applied to help stabilize the pelvis, even in trauma-room situations.

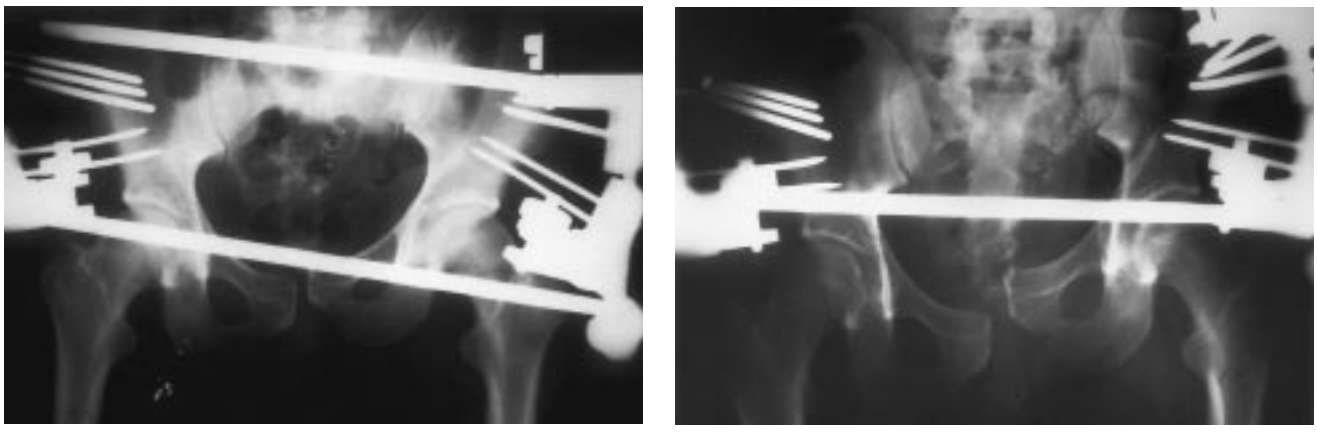
Traditional External Fixator

The traditional external fixator uses two or three pins in each iliac crest, the pins being joined by an anterior frame. There is very little difference biomechanically between the various types of anterior-frame constructs that are available. I favor a standard rectangular frame. There is a growing trend to use at least one pin in the strong supra-acetabular bone. This must be done under image intensification with the pins aimed away from the hip joint to avoid the dire consequences of penetrating the hip.

Biomechanical studies have shown that both the pelvic clamp and the external skeletal fixator can restore adequate stability to the partially stable (type B) fracture, allowing the patient to be nursed in the upright position.[8-10] However, neither can restore adequate stability to the unstable (type C) pelvis, so as to allow the patient to get out of bed or ambulate without risking displacement of the fracture (Fig. 3).

Skeletal Traction

Because external frames and pelvic clamps cannot restore adequate stability to an unstable pelvis, the use of a skeletal-traction pin in the distal femur is recommended as a temporary measure, until a definitive management decision can be made. With the external frame in place, the patient can then be nursed in the upright position. The use of 30 lb of traction will help to maintain the unstable hemipelvis in the reduced position. Rarely, if the patient is extremely ill and other forms of definitive stabilization are undesirable or unsafe, this may become the definitive form of fixation, which, with care, can lead to a good outcome (Fig. 4). Failure to apply traction, however, will allow the hemipelvis to shorten and become displaced and may make later attempts at reduction difficult, leading to a poor outcome. The use of a traction pin with external fixation allows the surgeon the option of proceeding



A B

Fig. 3 Images of a patient who sustained an unstable (type C) fracture of the hemipelvis with a fracture through the left sacrum and symphyseal disruption. **A,** Anteroposterior radiograph shows the posterior lesion to be adequately reduced, with some displacement at the symphysis. Fixation was with a double-cluster frame with two pins in the supra-acetabular area and three in the iliac crest, which is one of the most stable constructs. **B,** When the patient was allowed out of bed, there was marked displacement of the left hemipelvis through the sacrum and the symphysis, with complete loss of reduction.

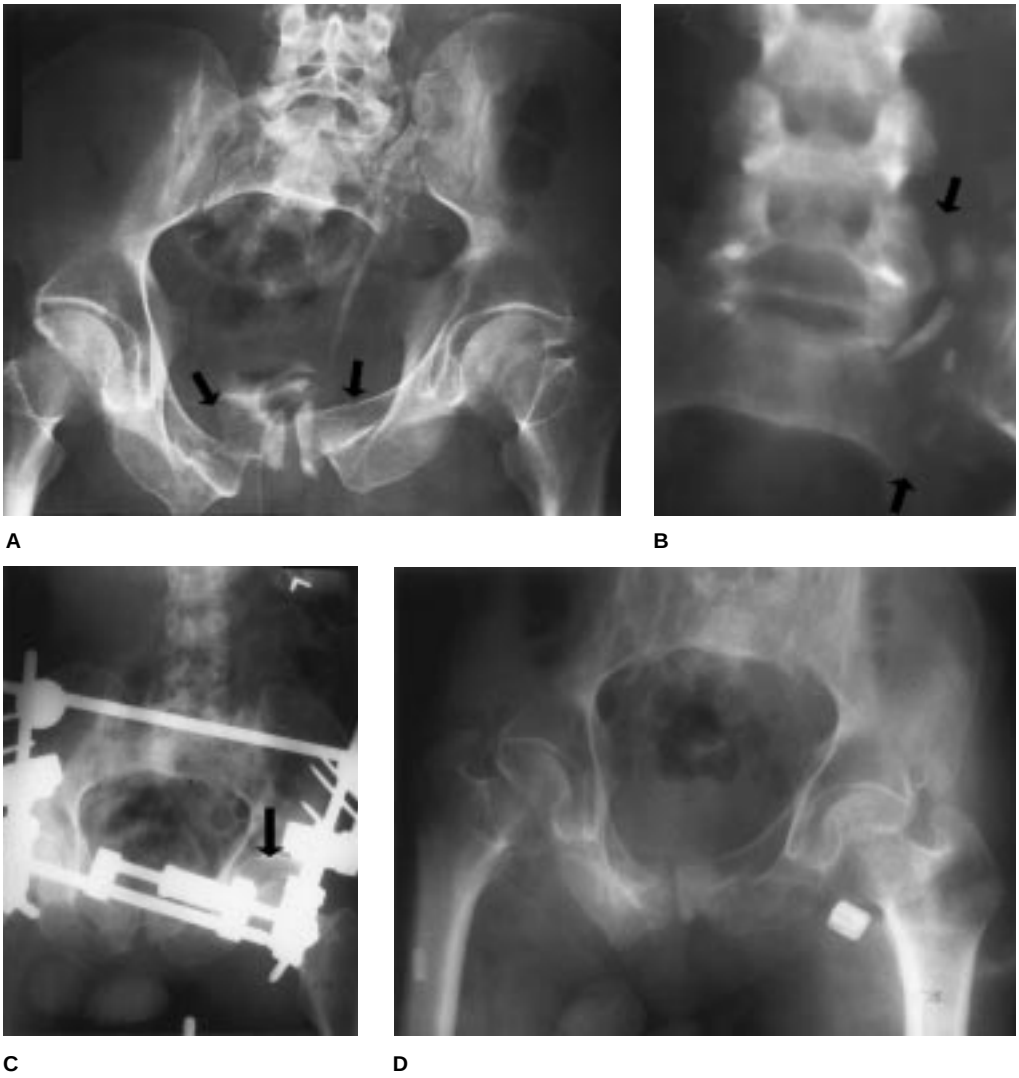


Fig. 4 Images of a 59-year-old man who sustained a complex unstable fracture of the left hemipelvis in a motor-vehicle accident. **A,** Inlet view shows posterior displacement of left hemipelvis through sacral fracture. Anterior portion of symphysis pubis was avulsed by the contracting rectus abdominis muscle (arrows); remainder is widely displaced. **B,** Tomogram through left sacroiliac joint shows marked sacral disruption. Upper arrow indicates avulsion of transverse process of L5 (always indicative of gross posterior pelvic instability). Because of isolated lesion of left lumbosacral nerve plexus, external fixator and left skeletal traction were applied. **C,** Inlet view demonstrates distraction of hip joint and good posterior reduction (arrow). **D,** At 10 weeks, anterior and posterior lesions had healed in satisfactory position and S1 root function had recovered. Patient has permanent L5 nerve-root deficit but no symptoms referable to pelvic-ring disruption. (Reproduced with permission from Tile M [ed]: *Fractures of the Pelvis and Acetabulum,* 2nd ed. Baltimore: Williams & Wilkins, 1995.)

to more definitive stabilization with the pelvis in a reduced position, rather than in a shortened, displaced position.

Timing of External Fixation

In the management of patients with multiple injuries, controversy often arises with respect to the timing of application of external frames—that is, whether they should be applied before or after laparotomy. At most major trauma centers, it is considered that quickly applying an external frame or clamp to an unstable pelvis, with a frame construct that is out of the way of the abdomen, helps the general surgeon performing the laparotomy by reducing the amount of retroperitoneal bleeding. In cases in which intraperitoneal bleeding from mesenteric veins or other sources is minimal, laparotomy may be avoided. Therefore, frames or clamps should be applied as soon as possible, usually before laparotomy.

In central Europe, trauma care is provided by trauma surgeons, who look after both soft-tissue and bone components. The conventional wisdom there is to apply the frame first and then proceed to laparotomy and pelvic packing when possible.[11-13]

In the presence of massive intraperitoneal bleeding (usually from solid viscera), many general surgeons will wish to operate first and have the frame applied later. In all cases, there should be active discus-

sion by all members of the management team.

Internal Fixation

The question whether there is a role for internal fixation in the resuscitative phase of pelvic trauma is unanswered at the present time. The literature on early internal fixation of the pelvis has shown a marked increase in complication rates.[14,15] However, with minimally invasive techniques, the indications for early internal fixation may change in the next decade. In my opinion, early internal fixation of the pelvis is indicated in the following situations:

Anterior Stabilization of the Symphysis Pubis

In the case of a patient with a symphyseal disruption who is undergoing a laparotomy, internal fixation of the symphysis will greatly simplify management (Fig. 5). In this relatively common situation, an orthopaedic surgeon should be present at the time of urologic repair or laparotomy, prepared to stabilize the anterior structures.

The initial preparation and draping of the patient should also include the area of the symphysis, and the midline abdominal incision should be carried directly to the symphysis. If a bladder or urethral injury is present, the urologist should be encouraged not to use a suprapubic drain tube, but rather to use suction drains well away from the area of the internal fixation, as well as a urethral catheter. If there is fecal contamination or an open fracture, sound judgment is required. In most instances, external fixation is the preferred option. The colostomy should be placed in the upper portion of the abdomen.

In this situation, the use of two plates at right angles on the symphysis pubis gives excellent biomechanical stability.[16] In the postoperative period, the posterior lesion can be controlled with a simple external fixator until a final decision is made on definitive posterior stabilization.

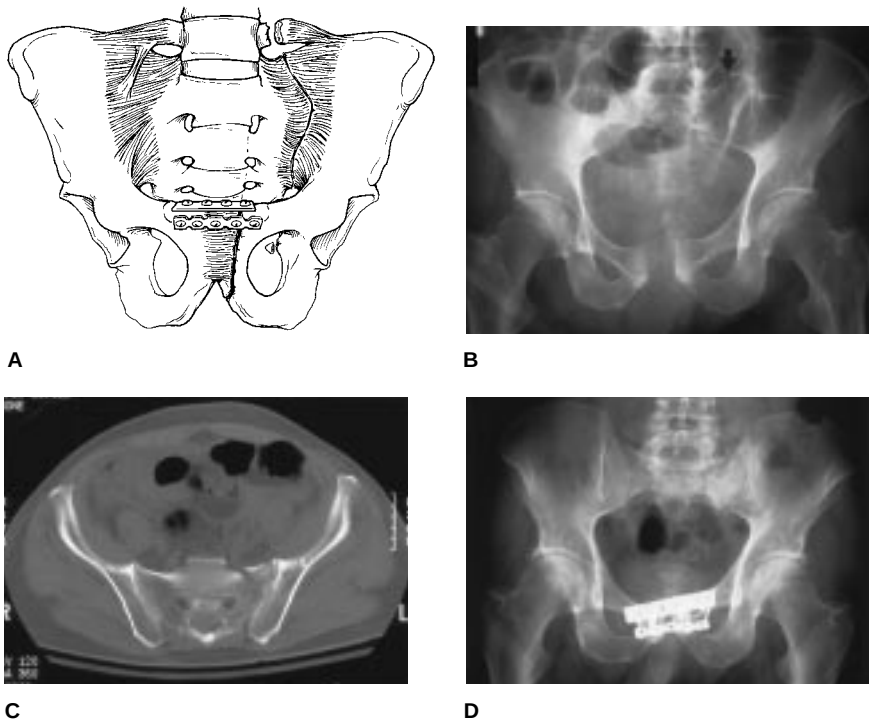


Fig. 5 Internal fixation of the symphysis pubis. **A,** Drawing depicts two-plate fixation. A single plate is adequate fixation for a stable type B fracture, but two plates afford much greater stability for an unstable type C fracture. **B,** Anteroposterior radiograph of a patient who fell from a roof and sustained disruption of the symphysis and a left sacral fracture. **C,** Sacral fracture is best seen on CT. **D,** Anteroposterior radiograph obtained 5 months after injury shows healing of the sacral fracture in excellent position.

Posterior Stabilization

At this time, posterior stabilization in the first 24 hours must still be considered experimental and risky. I believe, however, that percutaneous techniques, performed with the use of either CT guidance or directional wands, will become more commonplace in early posterior stabilization in the future. Because of the danger to neurologic structures and other complications, these techniques should be used only in centers with surgeons highly specialized in the treatment of pelvic fractures.

Definitive Stabilization

The need for definitive stabilization will obviously depend on the specific fracture type and the general state of the patient. Decision making is difficult and must be individualized. The following are guidelines for definitive management, other factors being equal.

Type A Fractures

Definitive fixation is rarely required for a stable pelvic fracture (type A1 or A2), the exception being the displaced fracture of the iliac wing, which may be treated by internal fixation. The vast majority of stable fractures can be treated nonoperatively and symptomatically with the expectation of a good outcome. Transverse sacral and coccygeal injuries are really spinal

injuries and will not be discussed further here.

Type B Fractures

Partially stable type B injuries cannot, by definition, be translated posteriorly or vertically and can, therefore, be managed relatively simply. Internal fixation is rarely indicated.

Type B1

The open-book fracture with less than 2.5 cm of anterior symphyseal disruption can be managed nonoperatively. The tendency is for the symphysis to heal in a slightly widened position with minimal long-term adverse effects.

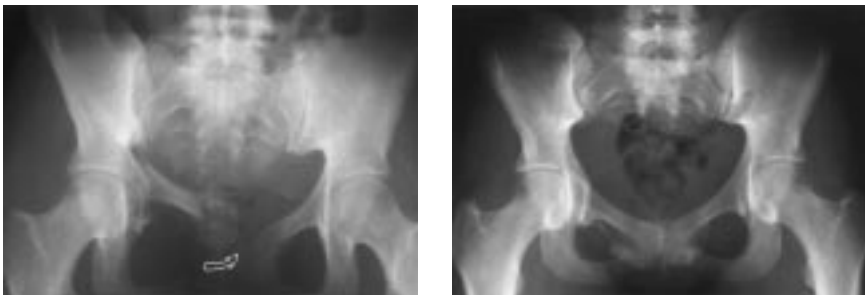
With symphyseal disruption greater than 2.5 cm, stabilization can be achieved by anterior fixation with a plate or an external frame. With either technique, the patient may be ambulated with support. Symphyseal healing is often delayed 8 to 12 weeks; therefore, any frame treatment must be extended for at least that period.

Type B2

The patient with an isolated, partially stable injury caused by lateral compression can be treated with bed rest and symptomatic care. A simple external frame is recommended for the polytraumatized patient, because it will stop rotatory motion and alleviate pain. The injured hemipelvis is reduced by external rotation.

Anterior internal fixation may be indicated for patients with a tilt fracture, which may lead to dyspareunia in women. If the patient has a locked symphysis, an attempt to reduce this injury by closed means should be undertaken first (Fig. 6).

Open reduction and posterior internal fixation should be reserved for the patient in whom there is so much internal-rotation deformity that the normal external rotation of the hip cannot overcome it. This is a rare indication, as most patients can tolerate some internal rotation of the hemipelvis.



A B

Fig. 6 Closed reduction of an overlapped symphysis in a 19-year-old woman who sustained a lateral-compression type B2-1 pelvic injury in a motor-vehicle accident. **A,** Anteroposterior radiograph shows internal rotation of the right hemipelvis, fracture through the right superior ramus, and fracture of the superior portion of the symphysis, which overrides the left hemipelvis (arrow). **B,** The patient was taken to the operating room for open reduction; however, under image intensification, closed reduction was achieved by applying direct pressure over the right iliac crest, which externally rotated the hemipelvis, and then direct pressure on the superior fragment. The fracture was reduced to a virtually anatomic position, without the need for open reduction. Note the anatomic healing of the superior ramus and the calcification at the symphysis. The final outcome was excellent. In spite of the calcified symphysis, the patient subsequently had two uncomplicated vaginal deliveries. (Reproduced with permission from Tile M [ed]: *Fractures of the Pelvis and Acetabulum*, 2nd ed. Baltimore: Williams & Wilkins, 1995.)

Type C Fractures

When the general condition of the patient allows, definitive stabilization of an unstable fracture can be desirable. Indications include anterior fixation of the disrupted symphysis and medial ramus fractures. A nonreduced unstable posterior complex is best treated by internal fixation. The choice of method will depend on the preference of the surgeon and the type of lesion.

Definitive Internal Fixation

Definitive internal fixation should be done only by surgeons experienced with these techniques. The timing of surgery is dependent on the general state of the patient, but as a rule should be done as early as safety allows, usually within the first 5 to 7 days. Neurologic monitoring is desirable and may prevent iatrogenic nerve injury.[17] Use of a cell-saver device is also desirable, because hemorrhage in open pelvic surgery can be massive. Prophylactic antibiotics are essential. The choice of the approach (anterior or posterior) and the specific incision site should be based on the soft-tissue injury and the pelvic-fracture pattern. It is important to avoid operating through crushed or contused skin or soft tissues. In that setting, percutaneous techniques may be safer. Image-intensifier control is essential in such cases.

Anterior Fixation

Recent biomechanical work in our laboratory has confirmed the importance of anterior fixation to restore pelvic stiffness and stability after an unstable pelvic-ring disruption.[16,18] The use of two anterior plates at right angles, as previously described (Fig. 5), is desirable in this situation. It was found that if two plates were used anteriorly, iliosacral screws, anterior sacroiliac plates, and transiliac bars

did not differ appreciably in the degree of posterior stability provided.[9]

Posterior Fixation

Posterior fixation can be achieved by either open or closed means. Closed treatment should be undertaken only in highly specialized centers and under strict radiographic control with image intensification, CT, or other guidance systems.[6,7]

For iliac fractures not involving the sacroiliac joint, direct open reduction and internal fixation with the use of plates and lag screws is indicated. An anterior approach is usually most appropriate.

For sacroiliac dislocation, the surgeon has the choice of either an anterior or a posterior approach. In pure dislocation, the anterior approach to the sacroiliac joint entails fewer postoperative soft-tissue problems and offers the advantage of supine positioning of the patient, which allows anterior symphyseal fixation at the same time. Two plates are placed across the sacroiliac joint anteriorly. Only one screw can be placed in the sacrum because of the proximity to the L5 nerve root (Fig. 7). Sacroiliac dislocation may also be fixed with iliosacral screws by means of a posterior approach.

In the case of a fracture-dislocation in which a large fragment of the ilium remains, use of a posterior approach for direct reduction and fixation of the iliac fracture offers the benefit of reducing the sacroiliac joint as well (Fig. 8). Fixation by a posterior approach is also recommended for a sacroiliac fracture-dislocation in which the sacrum is fractured.

For sacral fractures, Matta and Saucedo[6] report that placement of iliosacral screws into the body of the sacrum under radiographic control affords good stabilization (Fig. 9, A and B). However, the technique is difficult and entails the danger of injuring the major vascular and neurologic structures of the pelvis. Therefore, it

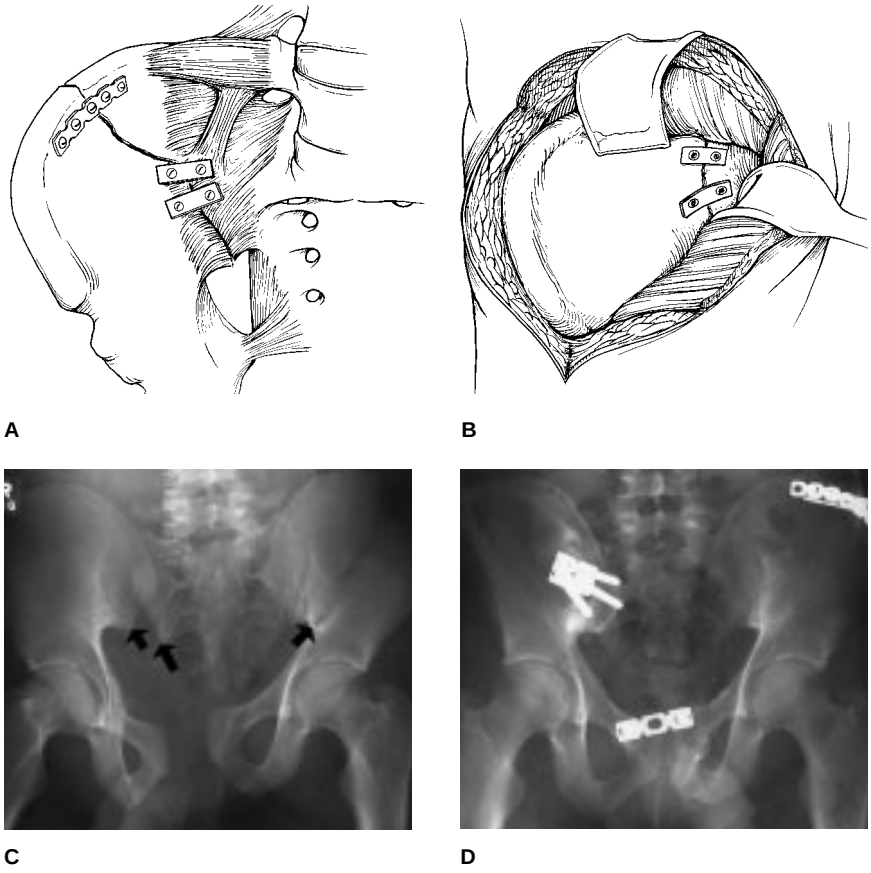


Fig. 7 Posterior fixation methods. **A,** Fixation of a fracture-dislocation of the right sacroiliac joint through an anterior approach. **B,** The sacroiliac dislocation was fixed with two anterior plates, but only one screw could be inserted into the sacrum because of the proximity of the L5 nerve root. **C,** Anteroposterior radiograph of another patient shows dislocation of the right sacroiliac joint, fracture of the left ilium, and a wide diastasis. **D,** With the patient in the supine position, the symphysis was plated with a single reconstruction plate. Two anterior plates were used to fix the right sacroiliac joint, and a reconstruction plate and lag screw were used to fix the left iliac fracture with a good outcome. (**C** and **D** reproduced with permission from Tile M [ed]: *Fractures of the Pelvis and Acetabulum*, 2nd ed. Baltimore: Williams & Wilkins, 1995.)

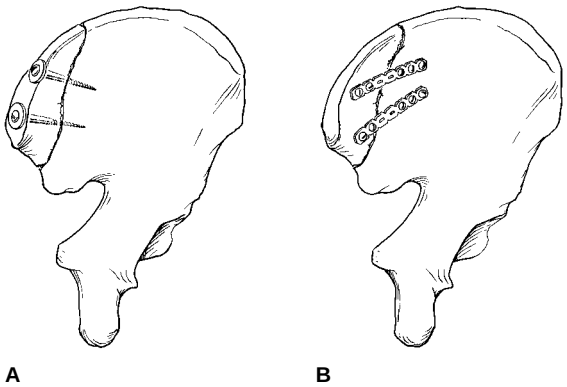


Fig. 8 Fixation of a posterior iliac fracture through a posterior approach can be performed with either lag screws **(A)** or a plate **(B)**. The sacroiliac joint should be stabilized with iliosacral screws or screws through the plate.

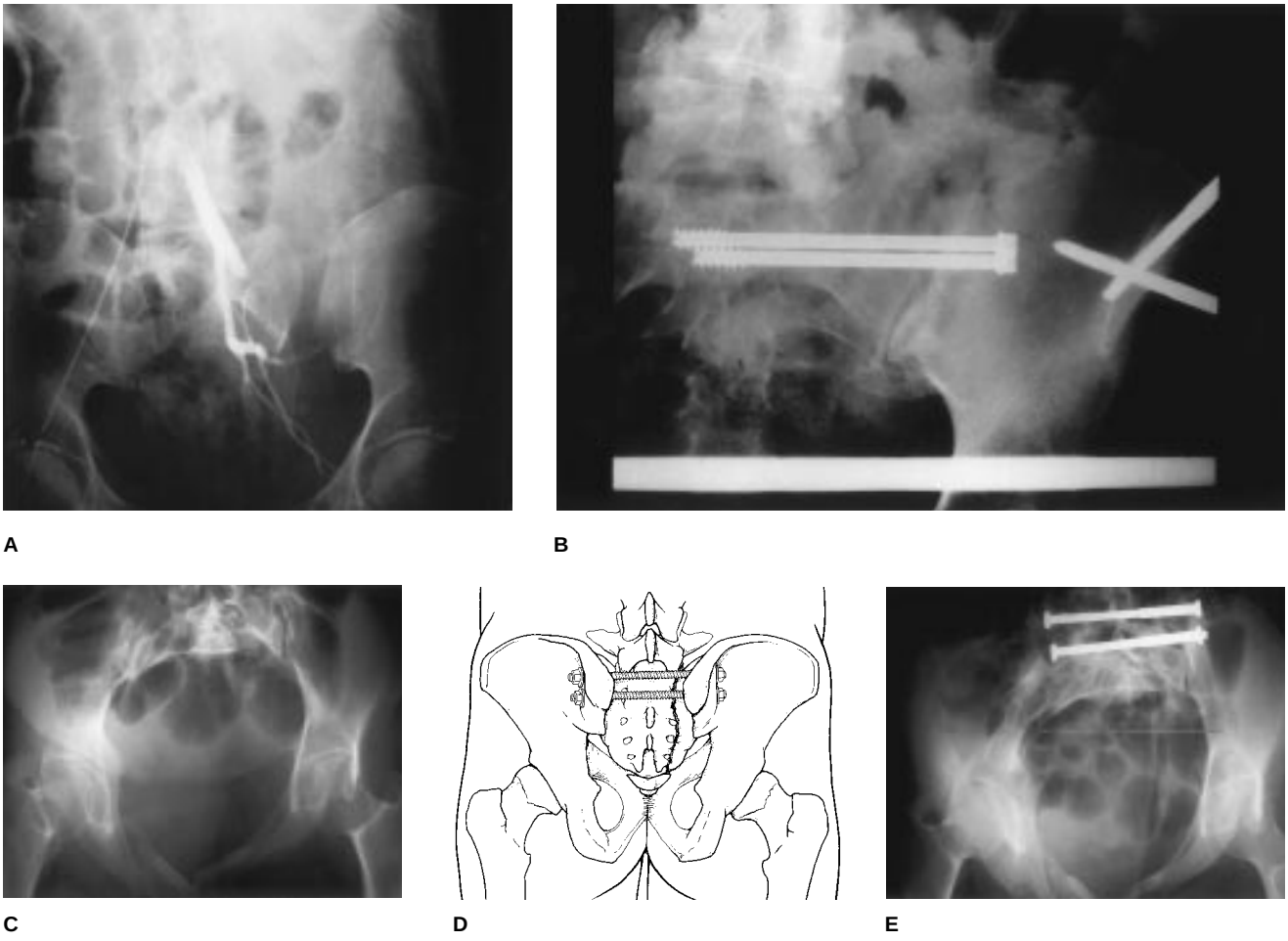


Fig. 9 Treatment of sacral fractures. **A,** Arteriogram depicts unstable sacroiliac joint. **B,** Two iliosacral screws were inserted after reduction of the dislocation. Callus formation may be noted along the anterior border of the sacroiliac joint. **C,** Anteroposterior radiograph of another patient shows unstable pelvic fracture. **D,** Transiliac bars were inserted posterior to the sacrum. **E,** Inlet view shows the position of the two sacral bars and sound healing of the sacral fracture. (**A, B, C,** and **E** reproduced with permission from Tile M [ed]: *Fractures of the Pelvis and Acetabulum,* 2nd ed. Baltimore: Williams & Wilkins, 1995.)

should be attempted only by a surgeon expert in its performance. This technique may be performed by open[6] or closed[7] means.

Transiliac bars may also be used for posterior fixation of sacral fractures (Fig. 9, C–E). The bars are inserted posterior to the sacrum, thereby avoiding direct injury to the sacral nerves. Although excellent biomechanical stability and safety are possible in the treatment of sacral fractures with this technique, a compression injury may be caused by tightening of the bars; therefore, monitoring is desirable to avoid nerve injury.

Complications

Complications of pelvic trauma can occur as a result of the injury pattern and the operative intervention. The surgeon must ensure that the treatment modality chosen is safe. Prophylactic antibiotics are a necessity to reduce the incidence of sepsis. Wounds must be kept away from areas of skin and soft-tissue crush to limit the incidence of wound necrosis. Fixation devices must be carefully placed to avoid penetration of the great vessels and the neurologic structures. Intraoperative neurologic monitoring is desirable but may be impractical.

Pelvic-vein thrombosis is common after pelvic trauma, and antithrombotic prophylaxis is generally indicated.[19] This is problematic in the immediate posttrauma period, however, because of the danger of further bleeding. Therefore, anticoagulants should be used only after the patient's condition has stabilized.

Summary

The past two decades have seen many advances in pelvic-trauma surgery. There is no question that provisional fixation of unstable pelvic-ring disruptions and open-book injuries is markedly beneficial in the resuscitative phase of treatment of patients whose general state is compromised by major, ongoing blood loss from the pelvic area. Use of the pelvic clamp is becoming more commonplace, as is the use of supra-acetabular pins in the more conventional types of frame construction.

In the completely unstable pelvis, external clamps and frames can act only as provisional fixation and should be combined with skeletal traction, which in the past was the mainstay of pelvic-trauma treatment. The traction pin should generally be used only as a temporary measure, until a definitive form of stabilization can be applied. If the patient is too ill to allow operative intervention, the traction pin can remain in place with the external frame as definitive treatment. If the patient's general condition is stable, an external frame can be avoided, and early definitive care can be planned. In these circumstances, a temporary traction pin is desirable until definitive internal fixation is performed.

Symphyseal disruption and medial ramus fractures at the symphysis should be plated at the time of laparotomy. Lateral ramus fractures can usually be controlled with external frames. Routt et al[20] have introduced percutaneous retrograde fixation. However, the danger of penetrating the hip joint is great, and the benefits gained may not be enough to outweigh the risks involved, since the morbidity from lateral ramus fractures is minimal. Pending further evaluation, this technique should be reserved for surgeons experienced in its use.

The techniques for posterior fixation are becoming more standardized, but all carry significant risks, especially to the neurologic structures. Monitoring of nerve function during surgical procedures is desirable, but the cost-benefit ratio is still controversial.[17,21] In patients with sacral fractures, the incidence of nerve injury approaches 50%. In these patients, pelvic stabilization has allowed good reduction of the pelvic ring and healing of the fracture or the sacroiliac joint. Unfortunately, overall outcomes have been disappointing because of continuing pain, which is probably due to nerve injury.[4] It seems likely that the future will be characterized by earlier interventions in the treatment of unstable pelvic fractures, involving percutaneous techniques performed with the use of strict radiographic control and guidance systems.

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