

Intrapelvic internal fixation of pelvic fractures

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Outcome results of the consecutive 120 patients with fractures of the pelvic ring treated operatively between 1989 and 1999 were analysed. Through an anterior low-midline incision an anterior extraperitoneal approach was used for fixation of the anterior and lateral parts of the ring. The anterior approach was combined with the lateral incision on the lateral crest for fractures of the wing and with posterior approach for sacroiliac injuries.

The complication rate of the new techniques was low. The functional recovery result was good in 66 of the 81 patients with an unstable C-type pelvic injury, in 18 out of the 20 patients with a lateral compression, B 2-type injury and 13 out of 19 patients with an open book, B 1-injury. Neurological recovery was observed after adequate reduction in those patients suffering from lesions of the sacral plexus. The radiographical result was good in 73, 20 and 17 of the patients groups, respectively.

Internal fixation of the posterior ring in unstable pelvic fractures was introduced in the late 1980's (1–3). On the other hand, indications of internal fixation of the anterior ring have been variable and more conservative recommendations have been given (4–6). However, biomechanical studies have shown that best stability can be achieved by internal fixation of both the posterior and the anterior part of the pelvic ring injuries (7). The first report of internal fixation of the entire ring was published in 1993 (8).

Later on, open reduction and stabilization of the most unstable C type fractures have been more widely accepted first in the recent years. On the other hand, the treatment of partially stable open book fractures as well as lateral compression type fractures seem to be controversial in most centres. Conservative bed rest and / or external fixation are still accepted as primary choices in many units.

Our policy has been to restore the anatomy operatively in both B and C type displaced pelvic fractures injuries at our department.

Patients and methods

We evaluated 135 consecutive patients with an unstable pelvic ring injury between 1989 and 1999, all treated with open reduction and internal fixation.

The follow-up could be accomplished in 120 of the pelvic group (three excluded because of major spine injury, six had died, six were lost to follow-up). The mean follow-up time was 1,75 (1–8) years.

According to the AO classification there were 19 open book (12 type B1 and 7 type B3-1), 20 lateral compression (12 type B2-1, 8 type B2-2) and 81 vertically unstable (21 type C1-1, 13 type C1-2, 29 type C1-3, 10 type C2 and 8 type C3) injuries. There were eight open fractures and five had a Morel-Lavalle soft tissue injury. A concomitant acetabular fracture was seen in 15 cases. Lumbosacral injury was seen in 43 patients, of these four (in 21 %) in the open book injury group, six (30 %) in the lateral compression injury group and 33 in the totally unstable, type C group (41 %). The mean age of the patients was 33 (13–84)

years, male predominance by 86 versus 34 women. All the patients were operated on within 21 days the timing depending on the general condition, estimated bleeding risk and associated injuries of each individual patient. The mean ISS score was 29 (10–59).

Indications for operative treatment were in C type injuries: unstable injury of the posterior part of pelvis (fracture of the sacrum or posterior part of the wing, dislocation of the SI joint) with or without symphyseal disruption, displaced anterior part of the ring or a concomitant acetabular fracture. In B2 type fractures indication for operative treatment was displacement of the anterior fragments more than ten millimetres, in B1 type fractures disruption of the symphysis 25 millimetres or more.

Radiological result in the pelvic group was graded by the maximal residual displacement in the posterior or anterior injury to the pelvic ring as: excellent 0–5 mm, good 6–10 mm, fair 11–15 mm and poor more than 15 millimetres.

The posterior fixation was accomplished with the patient in prone position as described by Matta and Saucedo (3). Sacroiliac dislocation and sacroiliac fracture displacement were fixed with iliosacral screws. In severely unstable bilateral injuries (C3) a iliolumbar transpedicular frame was used. Anterior plating of the SI joint was selected in some open book (B1) injuries when the stabilization of the anterior ring alone did not guarantee sufficient reduction of the widened anterior SI joint space.

A vertical suprapubic midline incision gave an extraperitoneal, prevesical access to the anterior ring as well as to the lateral brim and to the quadrilateral bottom area. The fractures involving the iliac wing were exposed through a separate lateral incision. This dual incision technique was named as an ilioanterior approach (8).

Fixation of the reduced fragments was accomplished mainly with 3.5 millimetre reconstruction plates and screws placed on the intrapelvic side of the brim. The lateral part of the plate was fixed on the lateral pelvic brim under the psoas muscle mass through the lower midline approach. In bilateral fractures both sides could be reduced and fixed through the same approach. In cases, where the iliac wing was involved and exposed usually two plates were inserted, one at the bottom of the iliac fossa (i.e. near the anterior margin of the brim) and the other on the inner margin of the iliac crest. All unstable fragments were stabilized so that a stable ring structure could be restored. The

fractures on the inferior pubis or ischial tuber were left without fixation. In this series some open fractures, and severely comminuted and osteoporotic fractures were treated with an anterior frame (four cases).

All patients were mobilised immediately after the operation whenever the general condition of the patient did not prevent it. The patients were encouraged to walk with crutches and the weight-bearing was allowed after 4–2 weeks depending of the type of the injury in both patient groups. The joint was always mobilised immediately, whenever the pain was sufficiently reduced with analgesics. Walking exercises were controlled and guided by physiotherapists.

The functional outcome was measured using a scoring system described by Majeed (9) and modified by Lindahl and Hirvensalo (10). The scoring is based on clinical findings and focused on the possible handicap caused by the pelvic trauma and neglecting the effect of other injuries (e.g. fractures of the limbs).

Results

In all the 39 B type injuries an anterior plate fixation was used. The mean operative time was 112 (50–280) minutes and the mean blood loss 760 (100–2900) millilitres.

In 67 out of the 81 (83 %) with the type C injuries both posterior and anterior fixation was performed. In 11 type C patients the posterior fixation was considered sufficient without any anterior stabilization, two of these showed no anterior injury site and nine of them showed a minimal anterior displacement of the ring. Anterior fixation only was selected in three type C patients because of a minimal displacement of the posterior elements. The mean operative time in the C type group was 94 (20–325) minutes for the posterior fixation and 103 (20–270) minutes for the anterior fixation. The longest operative time included the fixation of the concomitant acetabular fracture. The mean blood loss in the C type group was 1540 (100–5000) millilitres.

The overall radiological results were excellent or good in 110 patients (92 %) and fair or poor in 10 (8 %). There loss of reduction was seen in symphyseal fixation in two patients in the B1 group, the other after repeated laparotomies and the other suffering from deep wound infection.

In the C type fractures there were four patients with poor reduction result (two in the posterior and two in the anterior part of the ring). In addition, in

Table 1 . Radiological and functional end-results in 120 patients with pelvic injuries

Fracture type	Number of patients	Radiological end result				Functional result (0 to 80 points)			
		Excellent	Good	Fair	Poor	Excellent (78 to 80)	Good (70 to 77)	Fair (60 to 69)	Poor (<60)
Open book	19	9	8	1	1	10	3	4	2
Lateral compression	20	16	4	0	0	13	5	2	0
Type C	81	53	20	8	0	51	15	14	1

Table 2. Complications after internal fixation of pelvic injuries (120 patients).

Complication	Number of patients
Loss of reduction*	8
Reoperation because of malposition	1
Nonunion	1
Deep wound infection**	5
Superficial wound infection***	4
Lesion of L5 nerve root	1
Injury to the lateral femoral cutaneous nerve	2
Heterotopic ossification	7
Lesion of external iliac vein	1
Hardware inside the acetabulum	1

* 5 in the anterior ring and 3 in the posterior part

** 2 patients with open fracture

*** 1 patient with open fracture

two cases a secondary displacement occurred in the symphyseal area which was initially left without any fixation. Similarly, two out of three patients with a primarily unfixed non-displaced sacral fracture had a displacement of more than ten millimetres at the final check-up (Table1).

The functional result was excellent or good in 13, fair in four and poor in two in patients with an open book type B1 injury. There were four patients having primarily a lumbosacral plexus injury. All the patients showed at least some recovery of the neurological symptoms.

There was one deep infection and the final result remained poor. The other poor result was seen in the patients with initial massive bleeding, reoperations, loss of fixation and removal of the plate.

In the type B2 group the final functional result was excellent or good in 18 out of 20 patients. Two had some pain in the anterior part of the ring at the final check-up.

There were six patients with an initial lumbosacral lesion recorded preoperatively, especially sensory deficiencies corresponding the L5 and S1 roots. All the patients had a complete neurologic recovery at the final follow-up.

Patients suffering from type C fractures showed excellent or good recovery in 66 cases (81 %). Five patients had an unsatisfactory functional result despite of a good radiologic result and without any signs of neural injuries. Four of them had moderate pain in the posterior part of the ring and one had a traumatic thigh amputation. All the others with poor result had either a poor reduction result or signs of lumbosacral plexus injury with neural deficiencies. Four of those eight patients with an unsatisfactory reduction result had a fair or poor functional end-result.

All the 33 patients with a lumbosacral plexus injury showed at least some evidence of neural recovery. Nine patients had complete recovery, six had some sensory deficits, two of them with a fair functional result. In 18 patients a partial functional muscular defect was present at the final check-up.

Complications after operatively treated pelvic fractures were loss or insufficiency of the reduction in ten cases, deep wound infection in five cases, all in complicated cases. There were four superficial infections, two in the anterior and two in the posterior sites. An iatrogenic lesion of the L 5 root was observed in one patient after incorrect positioning of the sacroiliac screw. One vascular lesion of the external iliac vein arose from a tapping instrument and was treated immediately with sutures without further consequences. Lateral cutaneous nerve lesions were seen in two cases, and signs of heterotopic ossification in seven patients (Table 2).

Discussion

Fixation of the anterior part of the ring is still considered unnecessary in many centres although all biomechanical tests show inferior stability compared to a more extensive fixation of the whole ring. External fixation devices cannot restore enough stability in the unstable type C injuries to allow mobilization of the patient without risk of redisplacement of the injury sites leading to suboptimal functional results (7,10–12). Neither have minimal invasive, percutaneous techniques been able to guarantee good reduction or stability of the entire ring.

At the Department of Orthopaedics and Traumatology in Helsinki University Hospital policy of internal fixation of both the acetabular and pelvic fractures was adopted simultaneously in 1989. The anterior approach was further developed during the following years as a route to achieve access to both on the entire pelvic brim and in the acetabular quadrilateral area. The first experiences were encouraging (8). Similar technique based on the anterior approach was reported later on by Cole and Bolhofner in 1994 (13) and Cole et al. in 1996 (14). Simultaneously, external fixation was largely abandoned at our department in pelvic fractures and used only as combination with internal fixation in selected cases. In the present study external fixator was used only in four cases who had complicated open fractures, extensive comminution or severe osteoporosis. In the recent years external fixation frames have been used solely as temporary fixation devices to reduce the pelvic volume in severe bleeding and when preparing the patient to angiography or internal fixation procedures.

The anterior extraperitoneal approach used in the present study gives a wide view on the true pelvis and can be used both on the pelvic and acetabular fracture treatment. As an anatomical, quite short midline incision between the rectus muscles it can be considered less invasive when compared to many other approaches on the pelvic area. The approach was combined with lateral and / or posterior approaches in pelvic fractures.

As seen in the limited number of complications this approach can be considered relatively safe, although the operation is demanding and needs good surgical skills and a good knowledge of intrapelvic anatomy. The low incidence of major surgical complications, as well as deep venous thrombosis and heterotopic ossification was an important finding. Although

the risk of major vascular injuries is always present, there was only one lesion of the iliac vein. Interestingly, there were no clinical or radiologically verified deep venous thromboses in the pelvic group and the incidence was low in the acetabular group. Moreover, there were neither femoral nerve injuries nor any lesions of the obturator nerve, although the nerve has always to be pushed down with a blunt retractor, when the lateral bony structures have to be revealed.

The neurological recovery in patients with plexus injuries needs to be noted. Good recovery in both muscular and sensory deficiencies was observed especially in those patients where the reduction and fixation were successful and were in accordance with earlier studies (10,15). Moreover, by anatomical reduction the leg discrepancy could be prevented in most cases leading to normal gait.

The good reduction together with proper stabilization allow early mobilization, prevent complications and thereby lead to a short hospital stay and to an early start of rehabilitation. The encouraging results with good functional recovery, the possibility of anatomical reduction with the less invasive techniques described above and the relatively low complication rate give a strong indication to continue the policy and efforts to reduce and fix the pelvic fractures in as anatomical positions as possible, whenever the general condition of the patient allows major operative procedures.

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