

The value of external fixation for unstable pelvic ring injuries

Laurent GALOIS, Frédéric PFEFFER, Didier MAINARD, Jean-Pierre DELAGOUTTE

Unstable pelvic ring injuries are severe injuries, with high morbidity and mortality rates. Since 1994, the authors have been using external fixation to treat these injuries. They present the results achieved in a series of 22 cases of unstable pelvic ring injuries admitted to their institution between 1994 and 2001. External fixation was performed in all cases with pins inserted between the anterior superior and the anterior inferior iliac spine. Posterior injuries were treated operatively in four cases and non-operatively in others. The average age of the patients was 32 years (range : 22 to 56 years). According to Tile's classification, there were 10 type B and 12 type C injuries. Functional evaluation using Majeed's score at the time of review showed a mean score of 75.6 (range : 12-100). The pain score was 22.7/30. Radiological results were good in horizontal injuries, with satisfactory reduction of the symphyseal disruption. In vertical shear injuries however, skeletal traction alone did not achieve accurate posterior reduction in four cases, in which internal fixation was required.

Anteroinferior placement of external fixation pins appears as a safe technique with a potential for increased stability of fixation. Associated posterior injuries must be treated with direct internal fixation in cases with vertical instability in which heavy skeletal traction has failed to achieve reduction.

INTRODUCTION

Road traffic accidents and falls from a height, i.e. high-energy trauma, can result in severe damage to the pelvic ring. These injuries are often part of a polytrauma which is frequently life-threatening. Disruption of the pelvic ring results in loss of

its stability and requires urgent and appropriate treatment. There may be associated injuries requiring emergent treatment (haemorrhage, urinary tract injuries, etc.), but the long-term functional result of the bony injury must be given due consideration from the very moment of admission. Several treatment options may be used (10) : open reduction and internal fixation (40), percutaneous osteosynthesis (29, 38, 39), external fixation (6, 14, 20, 41) and conservative treatment. All these techniques have their advantages and disadvantages, and it is up to the surgeon, together with his intensive care team, to choose the most suitable strategy depending not only on the type of injury, but also on his experience.

Since 1994, we have been using external fixation in unstable injuries of the pelvic ring not only as an emergency treatment, but also as a method for fixation which is left in place until consolidation of the injuries. The aim of this technique is to stabilise anterior injuries of the pelvic ring, with posterior lesions being treated secondarily as required. Several types of external fixators are available for unstable injuries of the pelvic ring. Some of them

From the Department of Orthopaedic and Trauma Surgery, Hôpital Central, Nancy, France.

Laurent Galois, Orthopaedic Surgeon.

Frédéric Pfeffer : Orthopaedic Surgeon.

Didier Mainard, Orthopaedic Surgeon, Professor.

Jean-Pierre Delagoutte, Orthopaedic Surgeon, Professor.

Correspondence and reprints : Laurent Galois, Service de Chirurgie Orthopédique et Traumatologique (C.O.T) , Hôpital Central, 29 avenue Maréchal de Lattre de Tassigny, C.O n°34, 54035 Nancy Cedex, France. E-Mail : lgalois@free.fr.

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have been designed to be applied in cases with haemorrhagic shock (7, 11, 43, 44), while others are aimed more specifically at long-term stabilisation of the lesions (6, 17, 41). We selected the Orthofix® pelvic fixator in order to meet both these requirements. We report our experience with 22 unstable injuries of the pelvic ring which were treated in our department between 1994 and 2001.

PATIENTS AND METHODS

Patients

From 1994 to 2001, we treated 22 patients who presented with an unstable injury of the pelvic ring, using external fixation (fig 1, 2). The Orthofix® fixator was used in all cases with pins anchored in the interspinal space for biomechanical reasons (17, 31). There were 18 men and 4 women. The average age was 32 years (range : 22 to 56 years). Eighteen patients had been involved in road traffic accidents (82%), and four had fallen from a height (18%). Eight patients (36%) showed severe haemodynamic instability on admission. Involvement of the sacral plexus was present in four cases (18%). Four patients had injuries to the urinary tract affecting the bladder or urethra (18%). Emergency abdominal surgery was necessary in four cases (18%), three of whom had a ruptured spleen and one had an injury to the liver. Standard radiological examination of the pelvis was carried out in all cases, and CT-scans were also made in 18 (82%). Tile's radiological classifi-

cation, which focuses on stability of the pelvic ring, was used to categorise the different injury stages. In type **A** fractures, the pelvic ring is stable. The partially stable type **B** lesions, such as "open-book" and "bucket-handle" fractures, are caused by external or internal rotation forces. In type **C** injuries, there is complete disruption of the posterior sacroiliac complex, with vertical instability. Several subtypes of injuries can be individualised in types B and C : a B1 injury corresponds to a unilateral open book lesion, a B2 injury corresponds to medial rotation of a hemi pelvis, a B3 injury represents a combined injury of both hemi pelvis, C1 corresponds to a unilateral triplanar displacement, C2 combines a type C1 lesion with a type B lesion of the opposite hemi pelvis, and C3 is a bilateral triplanar displacement.. Ten patients in our series had a stage B lesion (7 B1, 2 B2 and 1 B3) and 12 had a stage C lesion (6 C1, 2 C2 and 4 C3). One fracture of the anterior arch was compound (grade 2 of Cauchoix and Duparc). In two cases, there was an associated fracture of the proximal diaphysis of the ipsilateral femur responsible for a floating hip.

The interpubic gap measured radiologically was on average 20.2 millimetres (range : 10 to 50 millimetres). There was a posterior injury with a trans-sacral fracture in 6 cases and a dislocation of the sacro-iliac joint in others.

Surgical technique

Under general anaesthesia, the patient is placed in the supine position on a radio-transparent table. A vertical surgical approach is made over the anterior interspinal



Fig. 1. — Type B1 (open book) injury of the pelvis with haemodynamic instability following a road traffic accident (motorcycle). Note the subluxated hip joint on the left side, with fracture of the femoral head.



Fig. 2. — Osteosynthesis in emergency using external fixation to permit closure of the pelvis and stabilisation of the patient's haemodynamic condition. The fracture of the left femoral head has been treated by open reduction and screw fixation.

Table 1. — Majeed score

Case	Tile	Pain 30 pts	Sitting position 10 pts	Work 20 pts	Sexual relations 4 pts	Ambu- lation 12 pts	Help with ambulation 12 pts	Distance walked 12 pts	Score /100 pts	Quality of result
1	B1	30	10	20	4	12	12	12	100	Exc
2	B1	30	10	20	4	12	12	12	100	Exc
3	B1	25	4	16	4	12	12	12	85	Exc
4	B1	25	8	16	3	12	12	12	88	Exc
5	B1	10	4	0	0	0	0	0	12	Poor
6	C1	10	6	12	2	12	8	4	54	Poor
7	C1	15	6	4	0	8	6	4	43	Poor
8	C1	25	8	16	3	12	10	10	84	Exc
9	C3	25	8	12	2	12	10	10	79	Good
10	C3	25	10	16	3	12	12	8	86	Exc
11	C3	30	10	20	4	12	12	12	100	Exc
12	B2	25	10	16	3	12	12	12	90	Exc
13	B3	25	4	12	4	12	12	12	81	Exc
14	B1	30	10	20	4	12	12	12	100	Exc
15	B1	30	10	20	0	8	12	12	92	Exc
16	B2	30	10	20	4	12	12	12	100	Exc
17	C2	10	6	0	0	0	0	0	16	Poor
18	C1	25	8	16	2	12	6	8	77	Good
19	C1	10	4	12	3	12	8	10	59	Poor
20	C1	15	8	4	3	12	10	10	62	Good
21	C3	25	8	16	4	12	10	4	79	Good
22	C2	25	8	16	2	12	10	4	77	Good

fossa, with the cutaneous incision situated slightly medially. The lateral cutaneous nerve of the thigh must be identified and respected. Two tapered pins are placed on each side, taking into account the oblique orientation of the iliac wing. The initial grip of the pins must be checked. The external fixator is then installed on the pins. The injuries are then reduced by external manipulation under fluoroscopy, by adjusting the heads of the external fixator. Posterior fixation is carried out in a later session (before the 5th day) if satisfactory reduction has not been achieved with heavy traction (10 to 20 kg).

In cases with horizontal instability, the patients are mobilised and placed in the sitting position from the first week after the operation. In cases with vertical instability, transtibial or transcondylar traction is applied for six weeks, even in cases in which internal fixation of the posterior elements has been performed.

The external fixator is left in place for 6 to 10 weeks, according to the type and severity of injury. The patients are then transferred to a specialised rehabilitation department and are monitored during regular consultations.

In the course of the study, all the patients were followed up in consultation and were examined by two sur-

geons. The Majeed function score (21, 22) was used for clinical assessment. A systematic radiological examination of the pelvis was carried out.

RESULTS

The average follow-up was 3.4 years (0.3 to 6.8 years). The external fixator was kept in place for an average duration of 9.5 weeks (range : 6 to 12 weeks). The average Majeed function score was 75.6 (range : 12 to 100). In cases with horizontal instability (stage B), this score was 84.8 (12 to 100). In cases with vertical instability (stage C), the score was 68 (16 to 100). The partial pain score was 26 (stage B) and 20 (stage C) respectively. The duration of external fixation did not affect the quality of the final result provided the required minimum period of 6 weeks was respected. The result was good or excellent in 9 cases out of 10 for stage B (90%) and in 8 cases out of 12 for stage C (67%), i.e. 17 cases out of 22 (77%) overall. The existence of an associated femoral fracture, creat-

Table 2. — Group

Case	Tile	Age	Follow up (years)	Poly trauma	Urological injury	Neurological injury	Haemodynamic instability	Pre-op symphyseal gap (mm)	Symphyseal gap at last review(mm)	Treatment of post. injury Traction - T Screws - S
1	B1	32	5.3	Yes	Yes	No	No	40	10	-
2	B1	34	5.3	Yes	No	No	No	15	5	-
3	B1	32	2.8	No	No	No	No	15	5	-
4	B1	30	2.9	Yes	Yes	No	Yes	15	5	-
5	B1	23	1.7	Yes	Yes	Yes	No	20	5	-
6	C1	35	2.9	Yes	No	No	Yes	10	5	T
7	C1	38	0.3	No	No	No	No	20	15	T
8	C1	52	0.3	No	No	No	No	20	10	T
9	C3	25	1.6	Yes	Yes	No	Yes	35	10	S+T
10	C3	22	4.1	Yes	No	Yes	No	15	5	T
11	C3	26	1.5	Yes	No	No	Yes	15	10	S+T
12	B2	30	4.5	No	No	No	No	15	15	-
13	B3	36	3.5	Yes	No	No	Yes	50	10	-
14	B1	31	7.2	Yes	Yes	No	No	20	5	-
15	B1	31	2.5	Yes	Yes	No	No	15	5	-
16	B2	29	5.5	No	No	No	No	15	8	-
17	C2	29	0.5	Yes	No	Yes	Yes	40	8	S+T
18	C1	38	3.5	Yes	Yes	No	No	20	10	T
19	C1	56	2.8	Yes	No	Yes	Yes	10	5	T
20	C1	21	6.8	Yes	No	No	No	15	5	T
21	C3	24	5.5	Yes	Yes	No	Yes	15	10	T
22	C2	24	3.5	No	No	No	No	20	10	S+T
Mean		31.7	3.4					20.2	8	

ing a floating hip (2 cases), severely deteriorated the functional results, with an average score of 33 (range : 12 to 54). The pre-operative radiographs showed an average pubic gap of 20.2 millimetres (range : 10 to 50 millimetres). On revision, the pubic gap was on average 8 millimetres (range : 5 to 15).

In 4 cases with a stage C injury, the posterior vertical instability of the sacro-iliac joint could not be fully controlled despite the combination of traction with external fixation. Percutaneous posterior screw fixation was performed in these 4 cases. Three patients presented para-symphyseal ossification without any effect on function. One patient developed osteoarthritis of the hip secondary to a complex fracture of the acetabulum. Local complications were noted in seven patients. These were mainly skin problems (5 cases) at the entry points of the external fixator pins, and also discharge (2 cases) of which one was septic, requiring

removal of the fixator at 5 weeks. Paraesthesia associated with injury to the lateral cutaneous nerve of the thigh, which regressed spontaneously, was reported in both cases. One patient developed a compressive haematoma in Retzius' cavity, requiring drainage on the 8th day after the operation.

DISCUSSION

Over the recent decades, advances in intensive care and in surgical treatment of unstable injuries of the pelvic ring have made it possible to reduce the mortality from these injuries, and also to improve their long-term functional outcome (2, 4). Conservative treatment by traction and hammock used to be the reference for stabilising these injuries, but complications associated with prolonged decubitus and imperfect reduction of the injuries made this technique appear inadequate in

certain cases. Moreover, increasing trauma severity resulted in increasingly severe injuries, for which a more suitable treatment option became necessary.

Not all pelvic injuries disrupt the continuity of the pelvic ring or pelvic stability. Thus fractures of the obturator frame do not destabilise the pelvic ring, and their consolidation with simple functional treatment usually poses no problems. Trans-sacral fractures, sacro-iliac dislocations and symphyseal separation, however, may be a source of instability and require surgery for stabilisation.

External fixation was the first technique proposed and used after the seventies. It has made considerable advances thanks to the development of new materials and also to better knowledge of the biomechanics of pelvic injuries. The initial prognosis has also evolved because of improvements in both intensive care and imaging techniques, permitting more rapid and accurate injury diagnosis.

The AO Group (Arbeitsgemeinschaft für Osteosynthesefragen) drew up a classification based on the severity of the injuries and the type of instability encountered. This classification was modified in 1995 by Pennal, and then taken up and completed by Tile (35-37). In type C injuries, there is complete disruption of the posterior sacroiliac complex due to vertical shear injuries. These unstable fractures are almost always caused by high-energy trauma such as a motor vehicle accident, a fall from a height, or a crush injury. Type B injury corresponds to an unstable injury on the horizontal plane such as an "open book" fracture, for which anterior osteosynthesis permits successful stabilisation of the injury. Internal fixation is used by some surgical teams, but there are relative contraindications, such as retroperitoneal haematoma (12, 13), and there is a risk of fixation failure or infection. The mini-approach solution, for example using screws, was then developed to reduce this risk of complication. Our experience with external fixation in type B unstable injuries has been entirely satisfactory. The principle of transverse compression of anterior injuries provides adequate short-term stability and encourages the consolidation of fractures and healing of ligaments (3).

External fixation permits rapid reduction of the injuries without a direct surgical approach, with limited risks of haemorrhage. The Orthofix exter-

nal fixator is very convenient to use in emergency situations, where the rapidity of installation made it possible to stabilise haemodynamically unstable patients in the group. It enabled good reduction of the symphyseal separation to be achieved, whatever the type of injury (Tile type B or C), with an average gap of 8 millimetres in the immediate post-operative period. The results in terms of function were good or excellent in 73% of cases in the short and medium term, which makes this external fixation a method of choice.

The pelvic volume is decreased by around 10% by this osteosynthesis, which helps to overcome the most severe bleeding. Angiography is the second stage in monitoring haemorrhage situations (42). It may be carried out after a pelvic clamp (7, 11, 30) or an external fixator has been fitted. If reduction of symphyseal separation is impossible, this may be because of urethral or vesical incarceration; cystography should therefore be conducted during surgery (9).

In certain cases, reduction cannot be achieved because of the presence of intact posterior ligamentous structures. Owing to the increase in pelvic volume, they exercise a trestle effect and prevent the pubic surfaces from coming together in cases with symphyseal separation.

Control of the reduction of posterior injuries in Tile type C stages (sacro-iliac or trans-sacral) remains problematic with only anterior external fixation, whatever the type of fixator used (5). The use of more complex external fixators (frame, trapezoidal) does not have any effect on the quality of reduction of posterior injuries and does not improve anterior stability (8). The combination with transtibial or transcondylar traction enabled us to obtain anatomical reduction in 70% of type C cases. Imperfect reduction is associated with pain in the medium term. The ascent of the hemipelvis caused by vertical shearing forces must be reduced gradually by traction, and additional posterior osteosynthesis may be considered in some cases (16). Reduction of these fractures or sacro-iliac separations remains possible under good conditions within ten days following trauma.

Posterior osteosynthesis using a plate or rods is possible but we prefer sacro-iliac screws (33, 38, 39).

The percutaneous posterior approach limits haemorrhage problems and does not lead to the healing defects encountered with posterior surgical approaches used in other techniques (26, 29), but it does have its own complications (28, 34): screw misplacement or secondary fixation failure.

Although the majority of sacral injuries are treated conservatively, certain injuries may be treated surgically with good results (32).

Freedom from pain is obtained in less than 50% of type C injuries compared with 80% of type B injuries. This is related to the severity of the initial trauma, the type of fracture encountered, ligament damage and, above all, insufficient reduction. Posterior injuries may affect the sacrum, the sacroiliac joint or the iliac bone. Transarticular fractures are likely to heal with increased instability of the sacro-iliac joint. This increase in mobility, however small it may be, leads to mechanical damage to neighbouring structures and to pain, with the pain being more severe in the sitting position or after prolonged ambulation. An analysis of the literature (21, 22, 25) confirms these findings in larger groups. Moreover, anatomical reduction of the fracture is not the only condition for obtaining a good functional outcome. Association with vascular (19), urological (1, 24) and neurological (18, 23, 24, 27) injury gives poorer results, as do compound fractures (15). Poor outcome may also result from association with injuries at various levels in the lower limbs.

Pin care is of primary importance and must be given much attention by the nursing staff. Serous discharge is common, particularly in obese patients. Pin tract infection may occur but it rarely results in osteolysis. The pins should be introduced through the teguments in the position where they will be located after reduction of the displacement of the bony fragments; this will reduce the risk of skin complications.

CONCLUSION

External fixation appears as an excellent method for the treatment of Tile type B and C unstable injuries of the pelvic ring. In posterior injuries with vertical instability, failure to achieve reduction

despite heavy traction, is an indication for additional fixation of the posterior lesions.

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