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PŮVODNÍ PRÁCE

Iliosacral Screw Fixation of the Unstable Pelvic Ring Injuries

Fixace nestabilních poranění pánevního kruhu iliosakrálními šrouby

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ABSTRACT

PURPOSE OF THE STUDY

To report on the early results and possible complications of iliosacral screw fixation in the management of unstable pelvic ring injuries.

MATERIAL AND METHODS

One hundred and two unstable pelvic ring injuries were treated using iliosacral screw fixation for posterior pelvic ring disruptions. Closed manipulative reductions of the posterior lesion were attempted for all patients. Open reductions were used in the minority of patients with unsatisfactory closed reductions as assessed fluoroscopically at the time of surgery. Anterior fixations were by means of open reduction in 62 patients and by external fixation in 14 patients, and by screws in 7 patients. Twenty patients had no anterior fixation.

Plain anteroposterior, inlet and outlet radiographs of the pelvis were obtained postoperatively at six weeks, three months, six months and one year. A pelvic computed tomography scan was performed postoperatively in those patients where residual displacement or screw misplacement was suspected. Complications were recorded.

RESULTS

One patient died 31 days after the trauma due to pneumonia and one died 9 months after the surgery after a fall from a height in a second suicidal attempt. There were two posterior pelvic infections and one anterior pelvic infection. Screw misplacement occurred in seven cases. In six cases a misplaced screw produced transient L5 neuroapraxia. There was no fixation failure requiring revision surgery. There was one case of injury to the superior gluteal artery.

DISCUSION

Unstable pelvic ring disruptions are severe injuries, associated with a high rate of morbidity and mortality. Pelvic fractures can be treated by variety of methods. Treatment with traction and pelvic slings does not offer accurate reduction and confines the patient to prolong bed rest with all potential complications. Several authors documented lower morbidity and mortality rates and shorter hospital stay in patients treated by early operative stabilization of pelvic injuries.

The timing of the surgery is still controversial. Some authors in large trauma centres believe that ideally the initial treatment should be the final treatment. The advantage of urgent fixation is the use of this usually minimally invasive technique in the initial stabilisation of a hemodynamically unstable patient. The disadvantage is performance of the surgery under increased stress and time limit, which may lead to the acceptance of sub-optimal reduction. Very good team work of the orthopaedic surgeon, anaesthetist and other involved specialists (general surgeon, urologist) is necessary.

CONCLUSIONS

Iliosacral screw fixation is a useful method of stabilizing unstable pelvic ring injuries. It is a difficult technique, with a steep learning curve. The surgeon must understand the complex and variable sacral anatomy. High quality fluoroscopic imaging is a must. Especially in vertically unstable injuries the sacroiliac screws need to be augmented by sound anterior fixation. Low rates of infection, wound healing problems and minimal blood loss are advantages of this method.

Key words: pelvic fracture, iliosacral screw fixation, complications.

INTRODUCTION

Fractures of the pelvis are associated with a high rate of mortality and morbidity. In recent years the outcomes have been improved by a more interventional approach (14, 15, 18). Accurate posterior pelvic reductions and stable fixations have been shown to correlate with improved functional results. There are several methods available. External fixation has been used by some authors, but the ability of the frames to stabilize the posterior lesion is limited and the reduction is often inaccurate (8, 20). Open reduction using posterior exposures have been complicated by wound healing problems (21, 23). Stable fixation can be achieved by using sacral bars, anterior and posterior plating systems with its own advantages and disadvantages (1, 4, 7, 19, 20, 28).

Iliosacral screw fixation has been described by Matta and Soucedo (11) and by Routt et al. (19). The screws, inserted from the upper ilium across the sacroiliac joint and into the first or second sacral vertebral body may be used for both sacroiliac joint dislocations and sacral fractures. These screws can be inserted with the patient in the supine (19) or prone (11) position and can be frequently placed percutaneously if an acceptable closed reduction of the posterior pelvis can be obtained using fluoroscopy or computed tomography guidance (5, 7, 19, 24). There are recognised complications of iliosacral screw use: screw misplacement with possibility of nerve root injuries, poor posterior pelvic reduction, fixation failure with secondary malunion, superior gluteal artery injury, and infections (2, 3, 6, 16, 21, 25).

The aim of the study was to evaluate the use of this method in the management of unstable pelvic injuries as well as the risk of early complications.

MATERIALS AND METHODS

Group of patients

One hundred and two patients with unstable pelvic ring disruptions were treated over a six-year period from May 1999 to September 2005 at the author's departments (level-one trauma centre) using the same treatment protocol.

METHODS

The patients were evaluated radiographically based on anteroposterior, inlet and outlet plain pelvic radiographs and a computed tomography scan of the pelvis. The pelvic disruptions were classified according to Tile (26).

Iliosacral screw fixation was used in all cases for fixation of the posterior element of the injury (obr. 1). In forty-four patients, the procedure was done in the supine position, in fifty-eight patients the procedure was done in the prone position. Closed manipulative reductions of the posterior pelvic ring were attempted for all patients. In eight patients, closed manipulative reductions as assessed fluoroscopically at the time of surgery were unacceptable and open reductions were necessary. Iliosacral screws were inserted under fluoroscopic control in inlet, outlet and lateral views as described by Routt (19, 20).

In cases where internal fixation of the anterior lesion was carried out, the anterior lesion was usually addressed first, especially in patients with symphysis pubis disruption, because this facilitates closed reduction of the posterior complex. In 62 patients open reduction and fixation of the anterior injury was performed through a Pfannenstiel approach with split of the rectus abdominis muscle, avoiding its detachment. External fixation was used in 13 patients, screw fixation in 7 patients and 20 patients had no fixation of the anterior lesion.

After the surgery, patients with unilateral lesions were allowed to mobilize weight-bearing on the uninvolved side, touch weight-bearing on the affected side for six weeks. Gradual progression to full-weight-bearing ensued over the next six weeks. Patients with bilateral lesions were allowed mobilizing from bed to chair as tolerated and were kept non-weight-bearing for at least six weeks. Patients with multiple trauma were mobilized according to their individual condition. Three patients had paraparesis due to their spinal fracture with spinal cord injury.

Plain anteroposterior, inlet and outlet pelvic radiographs were obtained postoperatively and at six-week, three-month, six-month and twelve-month follow-up controls. Pelvic CT scan was performed postoperatively in those patients where persisting malreduction of the fracture or screw malposition were suspected.

Clinical union was defined as the ability of the patient to fully weight bear on the injured side without any symptoms (20). Radiographic union was defined as remodelling at the fracture or dislocation without any sign of implant failure (20). On postoperative radiographs, an acceptable reduction was considered less than one centimeter of displacement in any plane in sacral fractures and a congruent joint in sacroiliac dislocations.

RESULTS

There were 72 males and 30 females, with a mean age of thirty-one years (range 11 to 71 years). Motor vehicle accidents accounted for 71 cases; 49 of these were car occupants, 14 were pedestrians, four were cyclists, four were motorcyclists, five patients were crushed by heavy objects and 26 fell down from a height. In 26 patients the pelvis was the only injury. All remaining patients had multiple injuries.

There were twenty type B1, nine type B2, ten type B3, twenty-seven type C1, nineteen type C2 and seventeen type C3 injuries. Of the 67 patients with unilateral posterior complex injury, the lesion was on the right side in 32 patients and on the left side in 35 patients. Thirty-five patients had bilateral injury. From 137 lesions of the posterior complex in 102 patients, there were 56 sacral fractures, 49 sacroiliac joint dislocations and 32 sacroiliac joint fracture dislocations. Two of the pelvic injuries were open.

Of the 102 patients, twenty-five sustained head injury, thirty nine had multiple rib fractures usually accom-

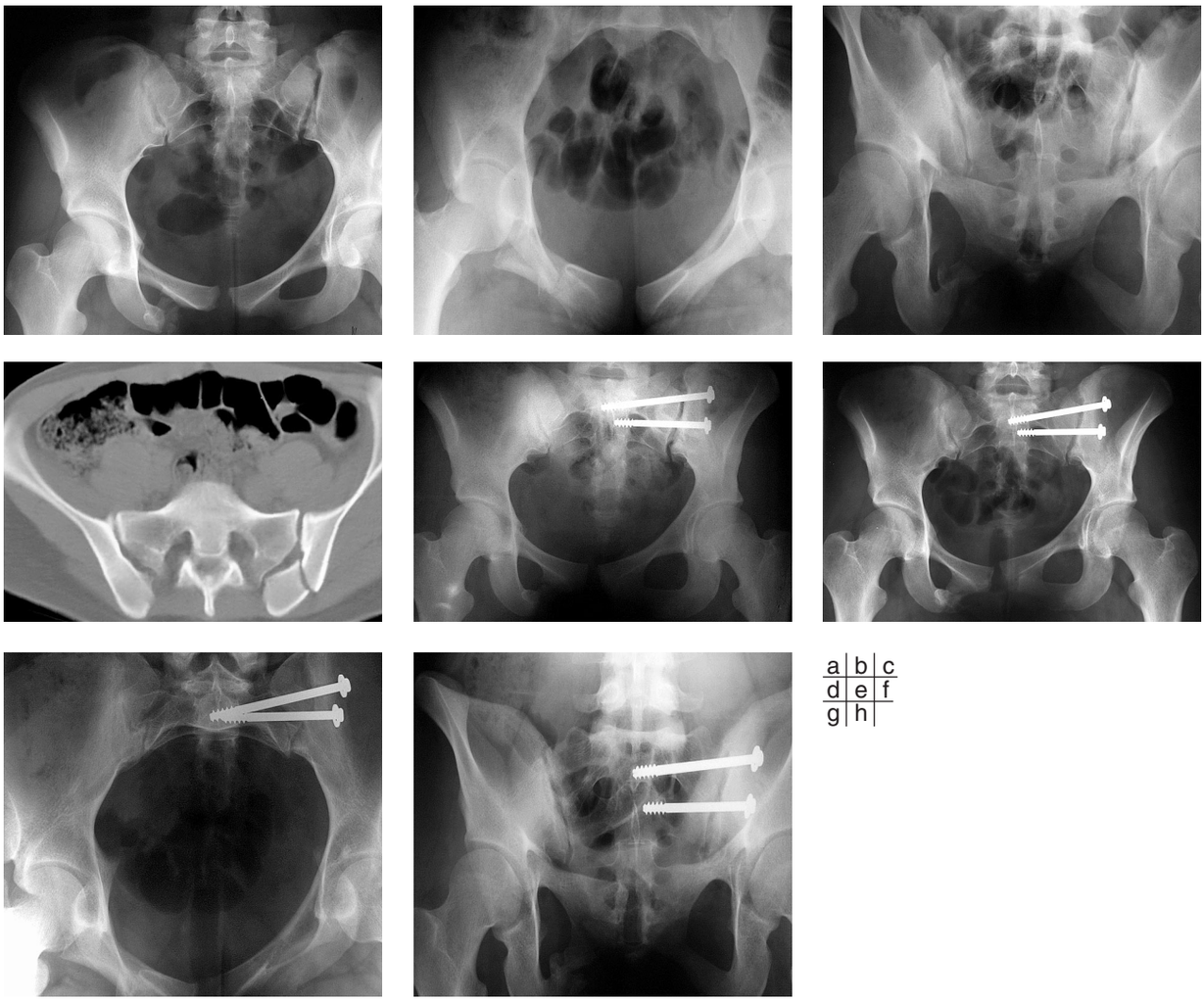

Fig. 1. Radiographic documentation of 21 year old female with pelvic fracture type B3.2 after car accident (posterior segment with iliac wing fracture and disrupted sacroiliac joint; anterior segment with minimal symphysis pubis disruption and right pubic rami fracture): a – X-ray after trauma (anteroposterior projection), b – X-ray after trauma (inlet projection), c – X-ray after trauma (outlet projection), d – CT-scan at the level of the first sacral vertebral body, e – X-ray after surgery showing good reduction of posterior segment (anteroposterior projection), f – follow-up X-ray 3 months after the surgery showing remodelation of right pubic rami fracture (anteroposterior projection), g – follow-up X-ray 3 months after the surgery showing persistent iliac wing dislocation in sacroiliac joint 2 mm posteriorly (inlet projection), h – follow-up X-ray 3 months after the surgery showing correct placement of iliosacral screws to the first and second sacral vertebral bodies (outlet projection)

panied by pulmonary contusion, twelve had abdominal injury and twenty one had urogenital injury. Fifty six patients had other musculoskeletal injury, including twenty two patients who sustained spinal fractures, three of them with spinal cord injury and paraplegia. Preoperative and postoperative neurological examinations were documented for all patients. Peripheral neurological examinations were difficult in some multiple trauma patients, specifically patients with cerebral trauma.

Definitive fixation was performed according to the patient's clinical condition. Fourteen were treated within twenty-four hours, five within forty-eight hours, twenty within seventy-two hours and the remaining sixty three more then 72 hours after the trauma, with 79 patients being operated within a week from the injury.

One 66 year old male, with type C1 pelvic injury, T12 burst fracture treated by posterior instrumentation and multiple fractures of ribs with lung contusion died 30 days after the surgery due to bronchopneumonia. One 48 year old female who sustained her pelvic trauma after a suicidal attempt (jump from height) committed suicide 9 months after the initial trauma. There were no patients lost to follow-up. One hundred and one patients were available for postoperative evaluations with follow up period in range from 6 to 78 months, with a mean period of 34 months.

In 89 patients (88 %), an anatomic or near to anatomic reduction was obtained. In 13 patients (12 %), there was residual displacement of one centimeter or more. A secondary loss of reduction was noted in 8 patients. In patients with sacral fractures the residual deformity was cephalad displacement in the outlet view and posterior translation in the inlet view. In patients with sacroiliac dislocations the residual deformity was a tendency to posterior translation in the inlet view and rotation in the outlet view.

In 102 patients, 157 screws were targeted into the first sacral vertebral body, and 6 screws were inserted into the S2 vertebral body.

Screw misplacement occurred in seven patients, five patients had screw protruding through the anterior aspect of the sacrum, and two patients had screws protruding into the S1 foramen. Six patients sustained transient fifth lumbar nerve root injury. In all patients the misplaced screws were repositioned. All patients with transient neurological injuries fully recovered. All screw related problems occurred early in the series when the lateral sacral view was not routinely used intraoperatively.

There were two cases of infection. One case of a deep infection occurred in a 31 year old female after an open reduction of her left sacral fracture. She sustained the injury after a fall from a significant height in a suicidal attempt. She had a concomitant head, chest injury and significant soft tissue injury of the posterior pelvis as well as an unstable fracture of L1 vertebra which was fixed. Her sacral fracture was operated from a posterior approach, 16 days after the trauma and fixed with 2 sacroiliac screws targeted to the S1 vertebra. She developed deep wound infection, which required debridement with implantation of antibiotic beads. The infection was controlled.

There was one deep infection of plate fixation of the symhysis pubis disruption in a grossly obese female, reaching only the subcutaneous tissues which fully resolved after debridement and antibiotic treatment.

There was one case of injury to the superior gluteal artery in 57 years old male operated 6 hours after a fall from a significant height in a suicidal attempt. The anterior lesion was fixed first. During the insertion of the sacroiliac screw the superior gluteal artery was injured and significant bleeding occurred. The approach was extended and the artery ligated. The patient healed uneventfully. Risk of an injury to the superior neurovascular bundle during sacroiliac screw insertion has been well documented using a cadaver model (4).

DISCUSSION

Unstable pelvic ring disruptions are severe injuries, associated with a high rate of morbidity and mortality. Pelvic fractures can be treated by variety of methods. Treatment with traction and pelvic slings does not offer accurate reduction and confines the patient to prolong bed rest with all potential complications. Several authors documented lower morbidity and mortality rates and shorter hospital stay in patients treated by early operative stabilization of pelvic injuries (8, 14, 15, 17, 18).

Several methods have been used to stabilize pelvic ring injuries. External fixation has proven to be useful in the acute management of hemodynamically unstable patients but fails to reliably stabilize vertically unstable injuries (13, 15, 20). There has been increased interest in the use of internal, more stable fixation of the posterior pelvic ring disruption. There are a variety of implants available, including anterior and posterior plates, sacral bars, and sacroiliac screws (1, 10, 14, 18). Because posterior pelvic ring disruptions are often associated with severe soft-tissue injuries, methods using a posterior surgical approach were complicated by wound healing problems and infection rates reported as high as 25% (9).

In 1989 Matta and Saucedo described a technique of fixation of the posterior pelvic ring using iliosacral lag screws with the patient positioned prone (11). After open reduction, biplanar fluoroscopy guides the implant placement. More recently Routt et al. described percutaneous placement of sacroiliac screws with the patient in supine position under fluoroscopic control, using inlet, outlet and exact lateral view (19). The method is particularly useful in multiple trauma patients because of associated minimal blood loss and low rate of wound complications. However, the technique is demanding, with a steep learning curve and there are recognised complications. To secure stability of the fixation it is important to insert the screws far enough into the sacral body (22, 28). Closed reduction may be difficult in cases of complete sacroiliac dislocation (27, 28). Reduction becomes increasingly difficult with delay of the surgery from the time of the trauma. If the closed reduction is not satisfactory, the surgeon needs to proceed to open reduction. In the series of Routt et al. attempted closed reduction failed in 17 out of from 68 patients (22). In our series we were able to achieve satisfactory closed reduction in 94 patients and had to proceed to open reduction in 8 patients.

Screw misplacement occurred in 7 patients (4.5 % of the 163 inserted screws), with transient neurological impairment in six patients. The screws were misplaced due to poor understanding of the upper sacral anatomy and use of biplanar fluoroscopy imaging during the early stage of our series. This is consistent with the findings of Routt et al. that use of the exact lateral view of the upper sacrum improved visualisation of the „safe zone“ and the accuracy of the insertion of the screw (20). He reported malposition of 5 from 103 screws with two transient neurological injuries in his early series. Keating et al. reported five screw errors in eighty five screws inserted, without neurological injury (8). Van den Bosch et al. reported seven screw errors in 88 patients (285 screws), all patients had neuralgia, two of them combined with sensory or motor deficit, all resolved completely after reoperation (27). Reilly et al. have documented that malreduction of 5 mm may decrease the „safe zone“ for screw passage by one third and with 1,5 cm fracture displacement it is impossible to pass safely two

screws (16). Because of complex sacral anatomy some authors advocated iliosacral screw insertion by using CT guidance (5, 7, 19, 24). However, operating in the CT suite has its limitations. The patient is positioned prone, which limits closed manipulative reduction. If closed reduction fails, it is difficult to proceed to open reduction. Some conditions, as morbid obesity and previous use of bowel contrast make surgery under fluoroscopy guidance more difficult. It is important that the reduction of the sacral fracture or sacroiliac joint dislocation is as accurate as possible.

The timing of the surgery is still controversial. Some authors in large trauma centres believe that ideally the initial treatment should be the final treatment (19, 20). Most of the patients in the series of Keating et al. were treated within 24 hours from the trauma (8). In 22 from 38 patients an open reduction from the posterior approach in prone position was performed and he reported seven (17 %) unsatisfactory reductions and malunion in 44 % of his patients. Also the patients of Routt were treated urgently, according to the patient's general condition (20). In 17 cases he had to proceed to open reduction. They reported 19 (11 %) malreductions of the posterior pelvic ring.

It is true, that many hemodynamically unstable patients stabilise after the fixation of the posterior pelvic lesion and if the procedure is done percutaneously, it does not present substantial stress for the already unstable patient. However, if the surgeon has to proceed to formal open reduction, it may be difficult in multiple injured patients. The advantage of urgent fixation is the use of this usually minimally invasive technique in the initial stabilisation of a hemodynamically unstable patient. The disadvantage is performance of the surgery under increased stress and time limit, which may lead to the acceptance of sub-optimal reduction. Very good team work of the orthopaedic surgeon, anaesthetist and other involved specialists (general surgeon, urologist) is necessary (14, 29). In our series, most of the patients were treated more than three days after the trauma, while they were in a stable general condition but most of them (79 %) within the first week after the injury. Only one patient died in the early postoperative period. The rate of malreduction was comparable with other series (12 %). There were no cases of secondary failure of the fixation.

The infection rate of our series with 1 deep infection in 8 patients who had an open reduction (1 %) is comparable with other series. Keating et al. reported three deep infections (14 %) in 22 patients (8), Routt et al. reported one case of anterior deep infection with subsequent failure of the anterior plate as well as the posterior screw fixation (21). Our case of anterior plate infection was limited to very thick subcutaneous tissue and was controlled after debridement and the patient healed uneventfully.

We have not seen an increased rate of malunion or fixation failures in patients without rigid anterior fixation. Generally patients with symphysis pubis disruption more than 2,5 cm, pubic rami fractures near to symphysis pubis, displaced pubic rami fractures and patients with vertically unstable injuries had the anterior lesion fixed. Mildly displaced pubic rami fractures were not fixed, as good healing could be anticipated as described by Matta and Tornetta(12).

Illiosacral screw fixation can be performed with the patient in the prone or supine position. Each of these options has its advantages and disadvantages. Matta, prefers to perform the surgery in the prone position of the patient (15, personal communication). In addition to fluoroscopic guidance he stresses the need of the surgeon to develop a feel when the drill bit is passing through the cortices of the illium and lateral cortex of the sacrum. He prefers an oscillating drill bit, as it gives better proprioceptive feedback than a guide wire. He prefers a posterior approach, which gives better visualisation of the back of the joint and allows superior placement of the reduction clamps. The posterior lesion is fixed first, with the exception of cases with symphysis disruption and both innominate bones intact, when the anterior lesion is fixed first. He obtained 95 % of reductions within 10 mm in his series, with 2.8 % of infection. However, it may be difficult to perform the surgery in prone position in an unstable, multiple trauma patient. The patient has to be turned and prepared for fixation of the anterior lesion.

Routt et al. described insertion of sacroiliac screws in supine position (19). In this technique, the anterior lesion is usually fixed first, as this simplifies closed manipulative reduction of the posterior complex disruption. In the supine position the thorax, abdomen and pelvis are all readily accessible if any surgical or urologic interventions are needed in the same setting. Closed manipulative reduction of posterior pelvic ring trauma is easier in the supine position, with the use of temporary Steinman pins or an external fixator. In multiple trauma patients the anaesthetic procedure is easier and shorter. If closed reduction fails, it is possible to proceed to open reduction from an anterior approach, with less wound healing problems. In the series of Routt et al. of 68 patients, 17 patients with complete SI joint dislocation required open reduction.

In our series, it was the preference of one surgeon (T.P.) to perform surgeries in the prone position of the patient. The rest of the surgeons preferred surgery in the supine position. The prone position was used in cases where due to the interval from the trauma to surgery or due to extensive displacement of the posterior complex the possibility of open reduction was anticipated. However, the overall number when open reduction was needed to obtain satisfactory reduction was small. We believe, that pelvic surgeon dealing with this type of injury should be familiar with both the supine and prone approach to the posterior complex as the choice in individual patient may be influenced by several factors (type of injury, accompanying trauma and general condition, time from trauma to surgery). This is in accordance with other series, where both supine and prone position were used in the same series (8, 27).

Risk of an injury to the superior neurovascular bundle during sacroiliac screw insertion has been well docu-

mented using a cadaver model (3). There was one case of injury to the superior gluteal artery in 57 years old male. During the insertion of the sacroiliac screw the superior gluteal artery was injured and significant bleeding occurred. The approach was extended and the artery ligated. The patient healed uneventfully.

CONCLUSIONS

We believe that early stabilization of the unstable pelvic ring injuries can decrease morbidity and improve long term results in this difficult population of patients. Percutaneous screw fixation of the posterior pelvic ring is a useful technique. The timing of the surgery should be tailored to the general condition of each patient, and availability of an appropriate surgical team. In vertically unstable injuries or cases with substantial displacement of the anterior lesion, rigid internal fixation of the anterior lesion is important for improved stability of the pelvic ring reconstruction.

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The study came up during many months when all the authors perfomed laborious processing of patients data achived at three different facilities. The work was interrupted by severe illness of Martin Ryšavý. After his death in january 2010, the others completed the study to declare their regards, respect and friendship.