



Surgical treatment for unstable pelvic fractures in skeletally immature patients

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KEYWORDS

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Pelvic asymmetry
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ABSTRACT

Objective: To present the results and conclusions of our study on surgical treatment for unstable pelvic fractures in children subjected to surgical reduction and stabilisation.

Methods: We analysed the cases of fourteen skeletally immature patients with unstable pelvic fractures who underwent surgery for this condition between March 2004 and January 2011. The surgical technique used was based on the principle of surgical reduction and stabilisation of anterior and posterior lesions of the pelvic ring. This was a retrospective study, based on clinical assessment and X-ray analyses.

Results: The mean age of patients at the time of the condition was 9.4 years (range 2–13 years). Eight patients were female and six were male. The cause of the trauma was being hit by a car in ten cases, falls in three cases and an accident involving a motorcycle in one case. Five patients presented with other associated injuries, including fracture of the clavicle, femur shaft, proximal humerus, tibial shaft or olecranon, and bladder damage. All the patients assessed showed excellent clinical progress. Pelvic asymmetry prior to surgery varied from 1.1 to 2.9 cm (mean 1.5 cm) and dropped to a range of 0.2 to 0.9 cm (mean 0.4 cm) after reduction. In none of the cases was there a change between the pelvic asymmetry measured immediately after surgery and at the end of the follow-up period.

Conclusion: Pelvic fracture in skeletally immature patients is rare and surgery is not normally indicated. Various authors have questioned this conservative type of treatment due to complications encountered. Bone remodelling does not seem to be sufficient to ensure an improvement in pelvic asymmetry, which justifies opting for surgery to reduce and correct deformities in the pelvic ring.

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Introduction

Pelvic fractures in skeletally immature patients are relatively rare, accounting for less than 0.2% of all paediatric fractures and 1–5% of admissions to tertiary children's health clinics [1,2]. These fractures are usually caused by high-impact accidents and are often combined with injuries to other organs (the genitourinary system, abdominal viscera, central nervous system, neurovascular and musculoskeletal structures) [3].

Although they have a relatively low rate of occurrence, pelvic injuries in children are associated with high levels of morbidity and mortality. A post-mortem study that examined 66 deaths caused by trauma in children showed pelvic fracture and severe bleeding to be the cause of death in 42% of the cases. As with adults, retroperitoneal bleeding is the worst complication in cases of unstable pelvic fractures [4–6].

Children with pelvic fractures have a greater survival rate for the associated injuries compared with adults and thus represent a higher socioeconomic cost and higher morbidity over the long term. A prospective study conducted on 95 children with pelvic fractures evaluated the patients' locomotive capacity and level of dependency. The results showed that 80% of the patients with unstable fractures, and 52% of those with stable fractures, were dependent on help for getting around [6–8].

Conservative treatment involving rest, traction and a cast has been recommended for pelvic fractures in children, because of the potential of this approach for curing the injury via the bone remodelling that occurs in this age group. However, many cases progress negatively due to potential complications, which are characterised by pelvic asymmetry, non-structural scoliosis, lower back pain, discrepancy in length of the lower limbs and claudication when walking. The conservative type of treatment does not produce satisfactory functional outcomes for some injuries that involve major displacement, particularly the presence of dislocation of the sacroiliac joint due to a vertical instability, or even in cases of acute accentuated horizontal instability. The presence of open triradial cartilage in the child promotes remodelling, but there is no consensus in the literature

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on the best way to treat these serious injuries and there is still much controversy over which children are likely to benefit from this invasive type of treatment [1,3,4]. In an emergency situation where there is haemodynamic instability, immediate treatment must be conducted using an external fixation, even if only temporarily, to prioritise controlling the bleeding and saving the patient's life [9]. In cases with dislocation of the sacroiliac joint, using only an anterior external fixation will not be sufficient to reduce and stabilise the posterior ring [10].

The purpose of this article was to present the results of definitive surgical treatment for unstable pelvic fractures in children subjected to surgical reduction and stabilisation on an elective basis after primary care has been given in the emergency ward.

Methods

After receiving approval from the Research Ethics Review Board, we evaluated fourteen skeletally immature patients with unstable pelvic fractures who were treated surgically at the National Institute of Traumatology and Orthopaedics (Rio de Janeiro, Brazil) between March 2004 and January 2011. The selected patients underwent outpatient clinical assessment and pre- and post-operative X-rays were analysed. All the patients had been given primary care at the emergency ward of another institution and were referred to our department for final treatment because of the complexity of their injuries. The inclusion criterion for the study subjects was an unstable pelvic fracture in patients with radiological signs of an immature skeleton, which was defined by the presence in X-rays of triradial iliac cartilage. Any patients with a stable fracture or with a pattern of non-displaced fracture of the iliac or the sacrum were excluded from the study.

The surgical technique used in this study was based on the principle of surgical reduction and stabilisation of anterior and posterior fractures of the pelvic ring. The anterior component, a fracture of the rami or symphysis pubis dislocation, was reduced indirectly using a tubular external fixation frame comprising only two Schanz pins in the supra-acetabular region of each iliac, inserted with the help of radioscopy based on inlet and outlet views of the iliac. The diameter of the Schanz pins used was suited to the diameter of the patient's bone: in three cases, 5.0 mm were used and in all the other cases, 3.5 mm pins were used due to the dimensions of the pelvis in question, along with the corresponding connectors and bars, to assemble the external fixation.

An anterior access to the pubic symphysis for direct reduction of the dislocation was performed in only one case because of the time elapsed since the injury, and a 3.5 mm plate was used to set the bone. For the posterior pelvic fracture, the indirect reduction method, via anterior manipulation with the supra-acetabular Schanz pins, combined with longitudinal traction of the lower limb, enabled the use of a cannulated screw inserted through the small incision into the injured sacroiliac. In 11 cases, this screw was 4.0 mm in diameter because the safety corridor for insertion was smaller due to the dimensions of the immature bone. In three cases, the grooved screw was 7.0 mm in diameter because these three were older children whose pelvis was large enough to support this dimension. In only one case, where the posterior injury was a "crescent" fracture in the wing of the iliac, the anterior fixation with a supra-acetabular external fixator frame was used alone and bone consolidation took place successfully without loss due to reduction. In three cases where there were fractures in both sacroiliac joints as a result of lateral compression, the bilateral fixation was used with cannulated screws. The anterior external fixation was removed at between six and eight weeks, following radiological evidence



Fig. 1. Keshishyan et al. [5] method of measuring pelvic obliquity, where the pelvic asymmetry is the difference in length between the diagonals ($X - Y$ cm). The degree of deformity corresponds to the difference in the diagonals ($X - Y$ cm) divided by the sum of the diagonals ($X + Y$ cm).

of consolidation of the fractures. In all thirteen cases where cannulated screws were used for posterior stabilisation of the sacroiliac joint, it was not necessary to remove this implant after the injury had healed.

This was a retrospective study based on an evaluation of medical records, clinical assessments and X-rays, with a mean follow-up period of 808.83 days after the original injury. The study endpoint was based on a radiographic quantification of residual pelvic asymmetry after surgery, using the method of Keshishyan et al. [5] (Figure 1), comparing pre- and post-operative findings. In this method, pelvic asymmetry is determined by the difference, in centimetres, between the lengths of two diagonal lines drawn from the rim of the sacroiliac joint to the contralateral triradial cartilage. Normal anatomical variation in this measurement is considered to be 4 mm of asymmetry, which may occur due to rotation of the pelvis at the time of the X-ray; over 5 mm, this deformity must be considered to be pathological [5]. Pelvic asymmetry was also correlated with the deformity index, which is the difference in length of the two diagonal lines divided by their sum, to provide a minimal error due to this rotation of the pelvis in antero-posterior X-rays.

Patients were clinically assessed by means of an interview and a physical examination. Assessments included the arc of movement and the abductor force of the hip joint, deviations in the spinal column, neurological sequelae, gait characteristics and the presence of pain upon palpating the pelvis. These data were correlated with X-ray findings.

Results

Patient clinical data are shown in Table 1. There were eight females and six males in the study. The mean age at the time of injury was 9.4 years (range 2 to 13 years). Patients underwent surgery with a mean elapsed period of 11 days from the time of fracture (range 4 to 29 days). The cause of the initial trauma was being hit by a car in ten cases, falling from heights in three cases, and an accident involving a motorcycle in one case. The bone and joint injuries to the pelvis were divided into anterior and posterior, with symphysis pubis dysfunction present in seven patients, fracture of two rami in four patients and fracture of four rami in three patients. In eight cases, the posterior injuries corresponded to dislocation of the sacroiliac joint; in one case,

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