

Original article

Surgical treatment of type IV unstable pelvic fractures in pediatric patients using the Torode and Zieg classification

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ABSTRACT. Introduction: Pelvic fractures are infrequent in pediatric patients; they account for 1% of hospital admissions. Acetabular fractures are still more infrequent, but when they are associated, they are life threatening. To distinguish pelvic fractures in children from those in adults, one first needs to know their anatomical differences. The magnitude of the trauma can usually cause injuries in other organs and systems, including the abdominal organs, the genitourinary system, vascular and nerve injuries, etc., as well as long bone, spinal and chest fractures. These injuries may be life threatening and must be treated before the pelvic fracture is addressed. **Objective:** To show the results obtained from the surgical treatment of Torode and Zieg type IV pelvic fractures. **Methods:** This is a retrospective, observational, longitudinal, descriptive study of 26 patients with Torode and Zieg type IV unstable pelvic fractures during a two-year period. **Results:** The age group 14-16 years was the most affected one, with 83.3% of the fractures, followed by the 12-14 years group with 8.33% and the group under this age with 8.33%. The most frequent mechanism of injury was trauma resulting from being run over, with 41.66%, car crash with 37.5%, and falls from a height with 20.83%; 37.5% of patients were polytraumatized and required intensive care; the mortality rate in the study was 7.69%. **Conclusions:** According to

RESUMEN. Introducción: Las fracturas de pelvis en pacientes pediátricos son poco frecuentes corresponden al 1% de los ingresos hospitalarios. Las fracturas de acetábulo aún son más infrecuentes pero cuando éstas se asocian ponen en riesgo la vida; para diferenciar las fracturas de pelvis de los niños con las de los adultos, primero hay que saber sus diferencias anatómicas. La magnitud de los traumatismos habitualmente puede provocar lesiones a otros órganos y sistemas incluyendo órganos abdominales, aparato genitourinario, lesiones vasculonerviosas, etc. fractura de los huesos largos, raquis, tórax. Estas lesiones pueden ser amenazantes para la vida y primero deben ser tratadas antes que la fractura de pelvis. **Objetivo:** Mostrar los resultados obtenidos en el tratamiento quirúrgico de las fracturas de pelvis tipo IV de Torode y Zieg. **Métodos:** Se trata de un estudio retrospectivo, observacional, longitudinal descriptivo donde se estudiaron 26 pacientes con fractura de pelvis inestable tipo IV de la clasificación de Torode y Zieg en un período de 2 años. **Resultados:** El grupo de edad más afectado es de 14 a 16 años en 83.3%, el grupo de 12 a 14 años en 8.33% y menores de esta edad en 8.33%, el mecanismo de lesión encontrado con mayor frecuencia correspondía a traumatismo por atropellamiento de 41.66%, tipo choque en 37.5% y caídas de altura en 20.83%, de estos

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the results and the patient assessment, we propose that unstable pelvic fractures be managed surgically. The mechanism of injury observed in these patients was not lateral compression, as the literature states, but rather a combined mechanism.

Key words: fracture, pelvis, classification, child, wounds and injuries, surgery, evaluation.

pacientes en 37.5% corresponde a pacientes politraumatizados que requirieron terapia intensiva; encontrando una mortalidad en nuestro estudio de 7.69%. **Conclusiones:** De acuerdo a los resultados y la evaluación de los pacientes nosotros proponemos que las fracturas de pelvis inestable deben de ser manejadas de manera quirúrgica. El mecanismo de lesión observado en estos pacientes no fue la compresión lateral como lo menciona la bibliografía, fue un mecanismo combinado.

Palabras clave: fractura, pelvis, clasificación, niños, heridas y traumatismos, cirugía, evaluación.

Introduction

Pelvic fractures in pediatric patients are rare, they only represent 1% of hospital admissions, acetabular fractures are also rare but when present these are generally associated to other injuries that put the patient's life at risk.¹

The development of technology in vehicles as well as better trained pre-hospital care paramedic teams help in transporting more live patients with multiple trauma to hospitals. In the past they died on the way; so this is a challenge for the pelvic surgeon when treating the pediatric population since the experience worldwide is not great and of course treatment of a pediatric fracture differs greatly from adult treatment.

Pelvic fractures in children are different than adult fractures given their continuous growth, the presence of a large volume of cartilage and of well mineralized and less fragile bone, as well as more elasticity of joints and soft tissue.²

The greater volume of cartilage, less fragile bones and joints allow for more energy absorption of the child's pelvis. Therefore, less severe trauma to fracture the pelvis is necessary in children, compared to adults. Except for tearing fractures of the physis.²

Pelvic fractures in children must be properly treated since the developing pelvis is more flexible and elastic than the adult one which provides less stiff protection in its contents which may suffer easier damage than the equivalent organs in adults.³

McDonald describes that the immature pelvis is capable of enduring considerable elastic deformations without suffering fracture, in such a way that injuries may be caused to abdominal and pelvic organs with none or little evidence of bone trauma, the presence of pelvic fractures in children indicates there is great bone trauma, great pelvic bone displacement indicates it is from great energy. The severity of the trauma may frequently cause injuries to other organs and systems including abdominal organs, the genitourinary tract, neurovascular injuries, etc., long bones, the spine and chest.

These injuries can be life threatening and often have priority over pelvic fractures when it comes to treatment.⁴

When there are fractures in the cartilage, growth plates can also be damaged and may result in disturbed growth and progressive bone deformity, for example the «Y» cartilage may stop its growth, thus producing a shallow socket, just like a vertical shear fracture in a medial direction can give way to lack of coverage to the femoral head.²

The distortion of the pelvic rim in girls may cause obstetric problems, but this is not yet well supported and there isn't enough bibliography to help us.

Material and methods

This is a retrospective, observational, longitudinal descriptive trial that studied patients with type IV unstable pelvic fractures using the Torode and Zieg classification (*Figure 1 and Table 1*) in a 2 year period classified by sex, obtained in the hip, pelvis and acetabulum surgery Service and the Pediatrics Service of the *Hospital de Traumatología, UMAE Victorio de la Fuente Narváez IMSS*, Mexico City, with the following inclusion criteria: 1. Patients with IMSS benefits; 2. Type IV unstable pelvic fracture of the Torode and Zieg classification; 3. Multiple trauma patients with unstable type IV pelvic fracture ages 0 to 16 years; Exclusion criteria: multi trauma patients with unstable type I, II and III pelvic fractures.

Results

26 patients with type IV unstable pelvic fractures using the Torode and Zieg classification were studied in a 2 year period, 62.5% were males and 37.5% were females, the age group affected most is the 14 to 16 years with an average of 83.3%, the 12 to 14 years 8.33% and less than 12 years 8.33%, the injury mechanism found more often was trauma from car run over accident with 41.66%, car crash 37.5% and falls from high floors 20.83%, 37.5% of these patients had multiple trauma, 29.16% needed in-

tensive care therapy, the mortality rate in our study was 7.69%.

Associated injuries were found in 98% of cases that were local or distant, abdomen injuries in 37.5% needing an exploration laparotomy finding injury in the spleen in 16.66%, in the liver 4.16%, in mesenteric vessels 12.5% and injuries in the digestive tract 4.16%.

The association with chest injuries was found in 20.83%, hemothorax was found in 8.33%, pneumothorax 4.16% and pulmonary contusion in 8.33%. Association with skull injuries was found in 37.5%, head injury in 20.83%, hemorrhage in 8.33% and traumatic air entry into the brain in 8.33%.

Association with long bone fractures of the pelvic limb was present in 62.5%, the bone afflicted most was the femur 20.83%, followed by hip fractures 12.5%, spinal fractures 8.33% and ankle fractures 4.66%. Association with

the upper limbs was found in 33.33%, clavicle fractures in 16.6%, radius and humerus 8.33%. Association with the urinary tract and bladder injuries was 8.33%, urethral injuries 8.33% and rectal tears 4.16%.

The most frequent type of fractures in type IV injuries were: fractures with pelvic rim disturbances, pubic injuries and dislocation of sacroiliac joints 50%, vertical shear injuries 12.5%, pelvic injuries associated with socket fractures found in 25% and pelvic injuries associated with three lesions were found in 12.5% (*Figure 2*).

The following are treatments performed in type IV fractures: conservative treatment 8.33%, treatment with sacroiliac joint plates and dislocation of the pubis 37.5%, percutaneous screws 20.83%, straight reconstruction plates in a posterior fashion 25.09% and external fixation 8.32% (*Figures 3 and 4*).

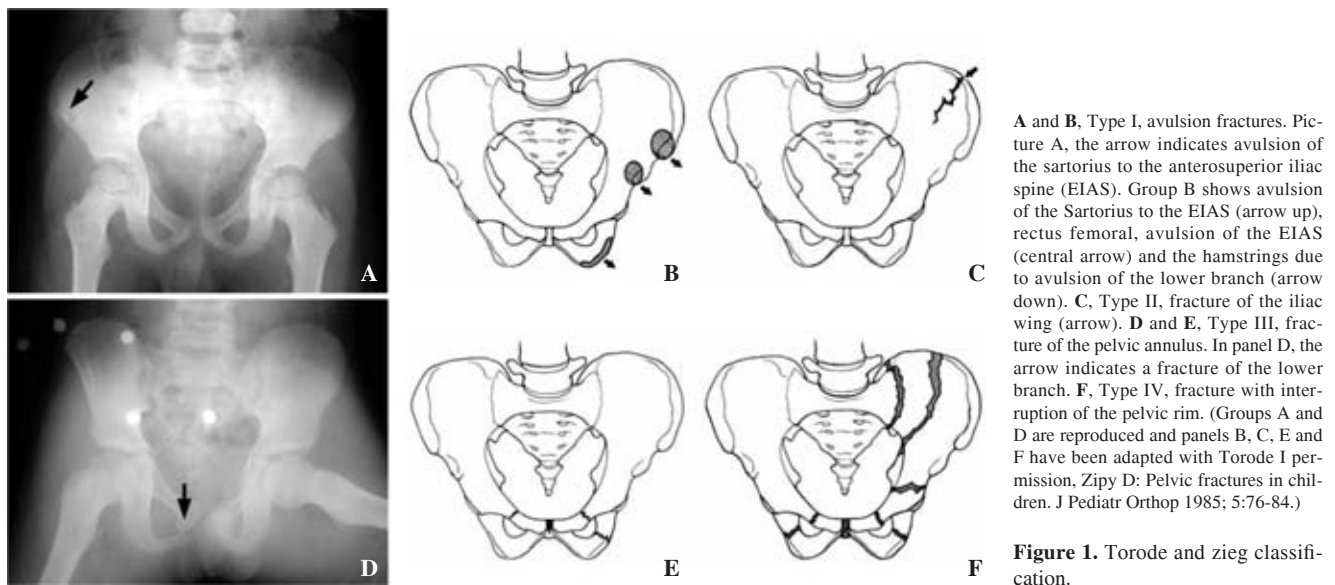


Figure 1. Torode and Zieg classification.

Table 1. Torode and Zieg Classification.

Type I Avulsion fractures	Type II Fractures of the wing of the iliac	Type III Simple fractures of the pelvic annulus	Type IV Fractures that cause an unstable fragment (rim disruption fracture)
	II a. Separation of the iliac process	III a. Fracture of the pubic bone and disruption of the pubic symphysis posterior structures remain stable	IV a. Fractures of the 4 branches with disruption of the sacro-iliac joint
	II b. Fracture of the body of the wing of the iliac	III b. Fractures with socket avulsion associated or not to a concomitant fracture of the pelvic rim	IV b. Vertical shear fractures
			IV c. Pelvic fractures associate to socket injuries
			IV d. More than 3 associated fractures

The following was evaluated in the results obtained: pain, gait, the degree of mobility, range of motion, postsurgical X-ray results and reduction criteria, with excellent results in 50%, good in 22.2%, bad in 16.66% and poor results in 11.11% (Figures 5 and 6).

The complications observed were: vascular injuries 8.33%, burns 4.16%, nerve lesions 33.3%.

The affected nerves we observed were: sciatic nerve 20.83%, cauda equina syndrome 4.16%; these injuries were pre-surgical, the post-surgical injuries observed were injuries of the root of L5 4.16%, femoro-cutaneous nerve injuries 4.16%, discrepancy in limb length 12.5% (Figures 7 to 9).

Discussion

The purpose of this work is to show the results obtained in the surgical treatment of type IV pelvic fractures by To-

rode and Zieg since we did not find any bibliography on this type of injuries, most of the bibliography we found does not refer specifically to a single type of fracture, therefore, we believe it is important to make the difference between pelvic I, II or III fractures which in most cases are treated conservatively. But when it comes to type IV fractures, where there really is an unstable pelvis, it is a challenge to determine which is the best treatment method since there are different schools of thought, some support conservative treatment and others surgical treatment.

Ferbach and Wilkinson, Metzmecker and Pappas, Sundar, Minne, R. Date, propose good results with conservative treatment, while Torode and Horst already mention a classification and results obtained with conservative treatment and the need to perform surgery in some cases. Tile, Mears and Slatiss prefer open reduction and internal fixation. Alosa



Figure 2. Patient with injury caused by automobile accident.



Figure 3. X-ray photograph of a patient with a combined mechanical pelvic injury.

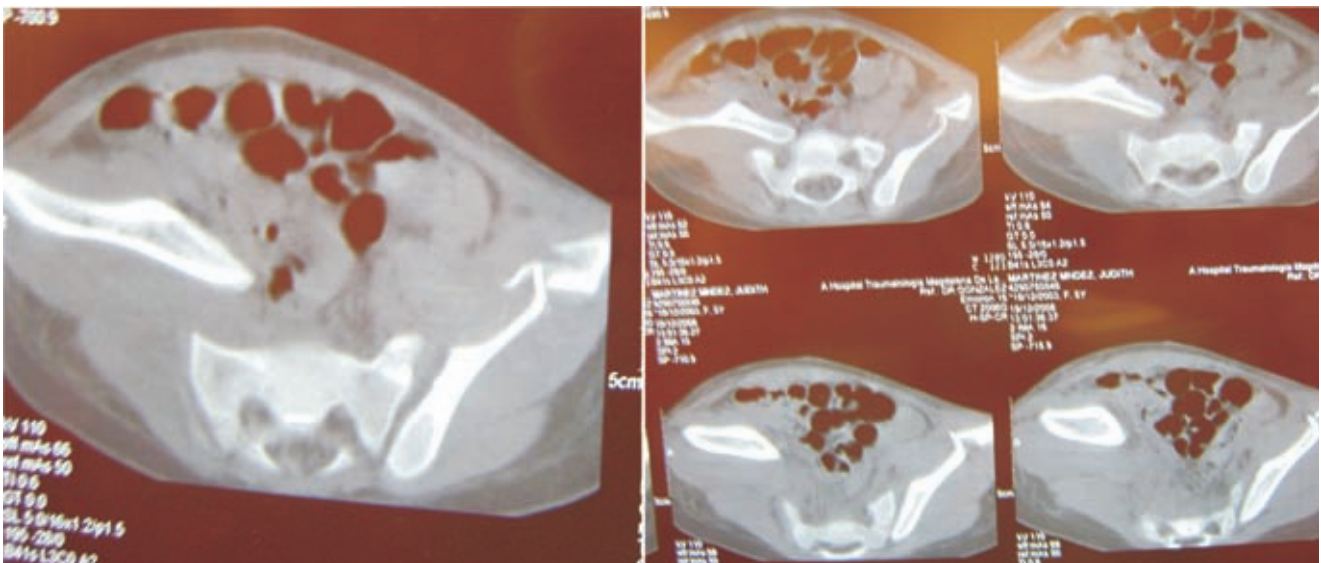


Figure 4. Clinical photograph of the post-operative control after placement of skin graft in bloody area.

and Hurowit report the use of internal fixation with good results; they recommend this method because it allows for better mobilization in children with fractures.

In Rockwood's study of adolescents, he suggests surgical treatment.

We propose studying the patient individually, the type of pelvic fracture, the patient's age, and the Tanner criteria in order to determine the type of surgical treatment necessary, fixation material we can use depending on the age of the patient because when there is a type IV pelvic fracture we are dealing with high energy trauma and a high rate of morbidity and mortality. We believe this type of fracture is a real challenge for the pediatric surgeon as Rockwood said: this type of injury should be treated by expert surgeons; if it's not possible then it should be treated conservatively.

In our study we found a mortality rate of 7.69%, reports in the literature go from 2.89 to 11.1% according to Bond

or Qunvy who found 25%. The injury mechanism with the highest percentage found in our study was patients who were run over by a car 41.66%, Edwards, P. Junkies found 87% automobile accidents. We found that 37.55% were multi trauma patients, Edwards found 35%.

We found that pelvic fractures were associated to abdominal injuries, Horst and Rieger found 20.4%.

The association with chest injuries found was 20.83%, Horst and Rieger found 18.5%, the association with head injury was 37.5%, Horst reported 48.1%, the association with long bones was 62.5%, the most frequent were femur fractures with 20.83%, tibial fractures 16.66%, hip fractures 12.5%, spine fractures 8.33%, Horts and Rieger reported an association of 46.6% with femur injuries in 33% and spinal injuries in 5.6%, he does not report the statistic of other bones.

The association with upper limb injuries was found in 33.33%, the most afflicted bones were the clavicle 16.66%, radius and humerus 8.33%, Horst and Rieger only reported 14.8% without specifying which are the segments affected most.

Associated to the urinary tract we found injuries to the bladder, the urethra and rectal tears. Torode reports bladder injury in 5.4%, urethra injury in 5%, vaginal tears in 5.7%, Sthuler reports 10.7% of urethral injuries and 5.4% of bladder injuries.

The complications observed in pelvic fractures were vascular injuries in 8.33% and nerve injuries in 33.3%, post surgically we observed injuries to the nerve root of L5 due to the approach used, we did not find reports in the literature of post surgical injuries to the femoro-cutaneous nerve nor of discrepancy in the length of lower limbs.

What we can show in this work is that type IV pelvic injuries according to Torode's classification is that 50% correspond to fractures with pubic and sacroiliac joint disturbances, 25% of this type of fractures is associated to acetabular fractures, injuries from vertical shear fractures were found in 12.5%, likewise, fractures of more than three bones (iliac, sacrum, acetabulum) were found in 12.5%. This indicates that the most frequent mechanism of injury is not lateral compression but rather combined mechanisms. They were treated as follows: conservative treatment 8.33%, which corresponded to pubic



Figure 5. CAT Photograph of patient with injury caused by a lateral compression mechanism.

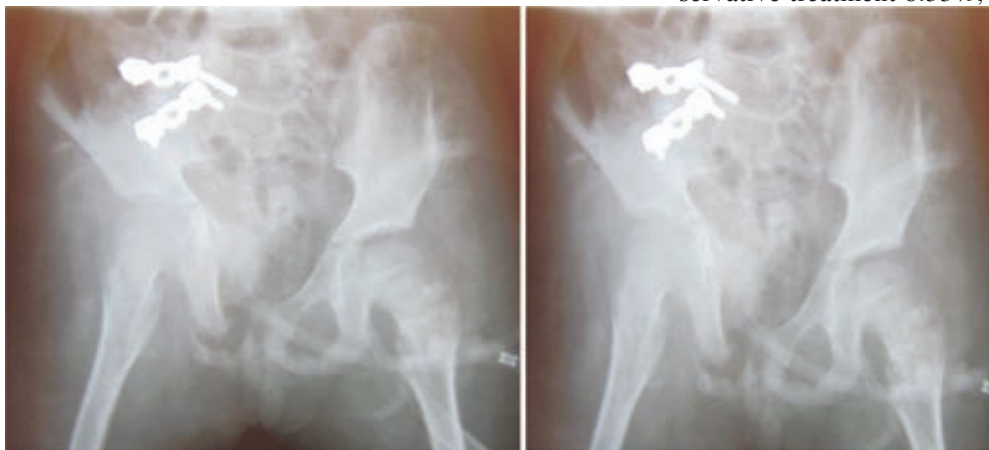


Figure 6. Postop X-ray control.

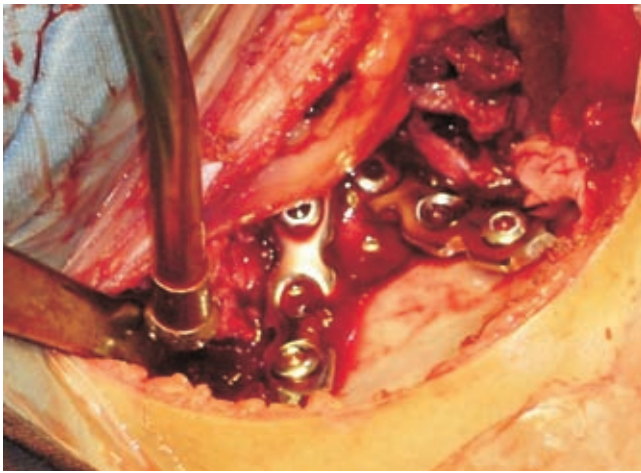


Figure 7. Implant in the sacroiliac joint post reduction.



Figure 9. Symetry of pelvic limbs.



Figure 8. Closure approach 1st Letournel window.

injuries with opening of the sacroiliac joint in patients associated to spinal injury with neurological damage. 37% was treated with a 3.5 reconstruction plate with 3 holes for sacroiliac joint injuries and 2, 3.5 DCP plates with 4 to 5 holes. Percutaneous screws were used in 20.83%, external fixation in 8.32%, straight reconstruction plates through a posterior route that will close the sacrum or posterior arch injuries in 25.09%.

All patients were called to undergo an assessment according to clinical evaluation criteria by D'Aubigne who considers the degree of pain, walking, and mobility, the total range of motion and evaluation of post surgical X- ray results.

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