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A study on functional outcome of surgical management in unstable pelvic fractures: A prospective study

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Abstract

The initial management of life-threatening haemorrhage associated with unstable pelvic fractures has long been a source of debate. A review of the literature reveals that many advocate emergent orthopaedic external fixation (EX-FIX) for severe pelvic fractures, whereas others claim greater success with angiographic embolization (ANGIO- EMBOLIZATION) as the first line of treatment. Subsequent management either to retain the External-fixator or to proceed with ORIF after the patient's clinical condition stabilizes is a matter of debate. Although many have attempted to outline management options by the nature of fracture pattern, to date there has been no prospective trial comparing outcomes for each method of treatment. We offer a prospective study of unstable [Tile type B and C] pelvic fractures in patients admitted to our Trauma Centre between March 2017 to Feb 2018. Patients were classified according to the fracture pattern and the degree of haemo-dynamic instability. Those patients who presented in a haemo-dynamically unstable condition, had their clinical condition stabilized. Certain of these cases had preliminary External- Fixators applied for their pelvic fractures. All cases, subsequently were definitively treated with Open Reduction and Internal Fixation. In our series of 20 patients whose functional outcomes were evaluated at the end of 8 months post -operatively, 20% ($n = 4$) had Excellent, 60% ($n = 12$) had Good, 10% ($n = 2$) had Fair and 10% ($n = 2$) had Poor outcome, as evaluated by the Cole *et al*; Scoring System. Our study concluded that in unstable pelvic fractures Open Reduction and Internal Fixation after haemo-dynamically stabilizing the patient, gives good clinical, radiological and functional outcomes.

Keywords: unstable pelvic fractures, Cole *et al*; tile classification, pelvic fixators

Introduction

Fractures and injuries of the pelvic ring, which may or may not be associated with severe trauma, are infrequent and account for only 2 to 8% of all fractures encountered in orthopaedic skeletal trauma. However, in the poly -traumatized patients with other system injuries, the occurrence of pelvic ring injury is much higher, being observed in as frequently as 20 to 25% of cases ^[1].

Of late, a considerable number of studies related to the care and immediate or late complications of this type of injuries have been published have been guiding the orthopaedic professionals involved in the protocol management of such care, especially in the poly-traumatized ^[2-3].

Patients who sustain these injuries fall into two categories, viz; survivors and non -survivors. In non - survivors, mortality is of a bimodal distribution. Early death is commonly because of haemorrhage or associated brain injury. Late death is usually because of overwhelming sepsis and or multi -organ failure. Survivors frequently experience long-term medical and socio - economic implications of fractures of the pelvis. In most trauma units, the initial management of a pelvic fracture is based on the guidelines of Advanced Trauma Life Support (ATLS) system developed by the American College of Surgeons (ACS) Committee on Trauma. The sooner that the bleeding is brought under control, the greater are the chance of avoiding the "Lethal Triad" of hypothermia, coagulopathy and acidosis secondary to the

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hypotension or hypoperfusion of tissues. [4] Early pelvic stabilization by external mechanical compression (EMC) with different devices, such as C-clamps, external fixators, and sheets, can definitely reduce pelvic volume and control haemorrhage [5].

The present short term study shall aim to analyse the clinical, radiological and functional out comes in patients with unstable pelvic fractures (Tile classification Type B and C).

Materials and Methods

Ours is a prospective study involving 20 cases of unstable pelvic injuries (Tile type B and C) managed surgically. Patients who were haemo-dynamically unstable were treated initially with external fixation and upon haemo - dynamic stabilization proceeded with definitive ORIF. Other patients who were haemo -dynamically stable were primarily take up for definitive procedures. Thus all cases eventually ended being treated by ORIF definitively. No cases were treated with external fixators alone.

These patients included those who presented at the Causality of Sree Balaji Medical College and Hospital, Chrome pet, Chennai, during the period from March 2017 to Feb 2018 (duration 12 months). The study was concluded by the end of October 2018, thus ensuring a minimum follow - up period of 8 months (range 8 -20 months).

Inclusion Criteria

1. Both male and female patients in the age group 21 to 45 years were included.
2. Pelvic injuries only conforming to Tile Type B and C alone were included.
3. Cases with other major associated closed injuries were included.

Exclusion Criteria

1. Patients not conforming to the above age group were excluded.
2. Patients with open abdominal and crush injuries of the pelvis were excluded.
3. Patient failing anaesthetic fitness and those with life threatening head and chest injuries were excluded.
4. Tile type A fractures.

Resuscitatory transfusions was based on the concept of P:P:P as 1:1:1, i.e. packed cells, fresh frozen plasma and platelets were transfused in the above mentioned ratio. Decision on emergent external fixation or elective internal fixation was made on a case by case basis, depending on the haemo-dynamic stability of the patient and the fracture pattern.

A detailed clinical examination and radiologic al assessment was done in all patients by means of which the injury pattern and stability of the injured pelvis was ascertained. A 3D CT reconstruction imaging was done for all cases conforming to Tile type B and C variants, prior to surgical intervention.

After getting anaesthetic and medical fitness patient were taken up for surgery. Piperacillin, Tazobactam, Amikacin and Metroglol were initiated upon arival at the casualty. Injection Tetglob 500 IU was administered for all cases. Three units of cross matched blood were kept ready, prior to shifting the patient to the operation theater.

Treatment Protocol

Surgical Procedure

External Fixation

For the construction of the frame the following components

are needed [Fig: 1].

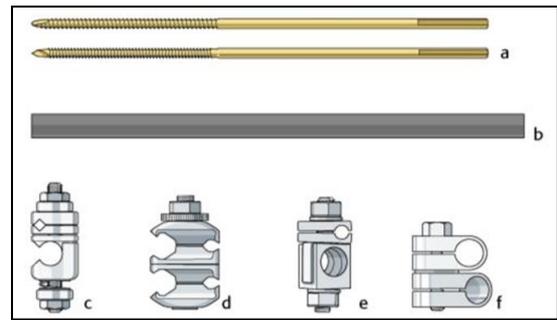


Fig 1: Pins, rods and clamps used for external fixation of pelvic ring fracture.

- a. Threaded pins (Schanz type pins, standard or self - drilling/self - tapping with radial preload; 5 or 6 mm).
- b. Carbon fiber rods or metal tubes (diameter of 11 mm).
- c. Rod-to- pin clamps (titanium, MRI safe).
- d. Combination clamps (rod -to-rod or rod -to- pin, self - holding, titanium, MRI safe).
- e. Rod-to- pin clamps.
- f. Rod-to- rod clamps.

A percutaneous or open approach through small incisions was used. It is advantageous to use transverse incisions (about 1.5 cm) angled across the iliac crest and directed towards the umbilicus.

Step by step pictographic depiction of pelvic external fixator Placement: [Fig: 2a to 2d]

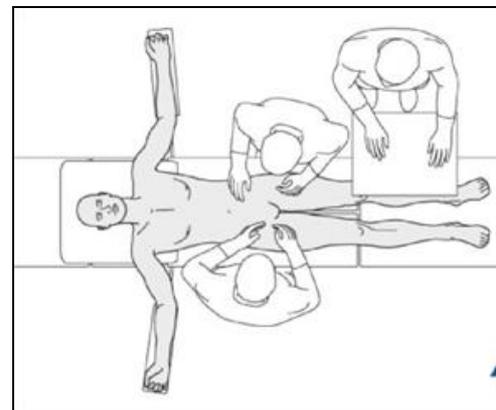


Fig 2a: Place the patient in supine position on a Radiolucent table.

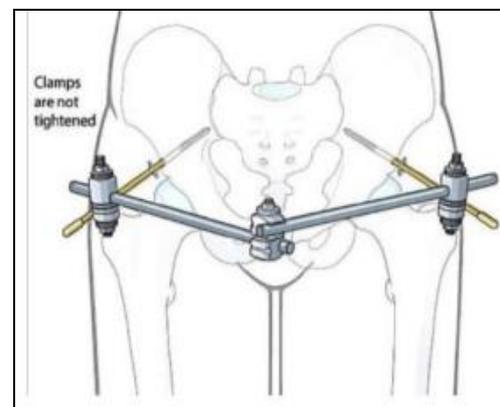


Fig 2b: The pins are connected anteriorly using two rods connected with a rod to rod clamp.

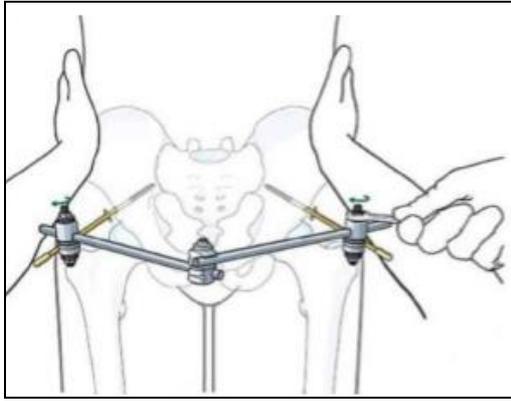


Fig 2c: Once reduction is achieved clamps are tightened.

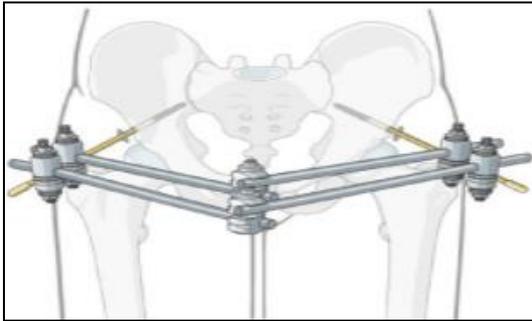


Fig 2d: An additional rod may be placed to increase the stability.

Definitive procedure, open -reduction and internal fixation

Anterior Fixation: Pubic Symphysis

The surgical approach to the anterior part of pelvic ring is useful for; Pubic symphysis disruption or diastasis. [Fig: 3]. Fracture of the anterior pelvic ring [Fig: 4, 5].



Fig 3: X-Ray pelvis showing pubic symphysis disruption



Fig 4: X-Ray pelvis showing fracture of the anterior pelvic ring

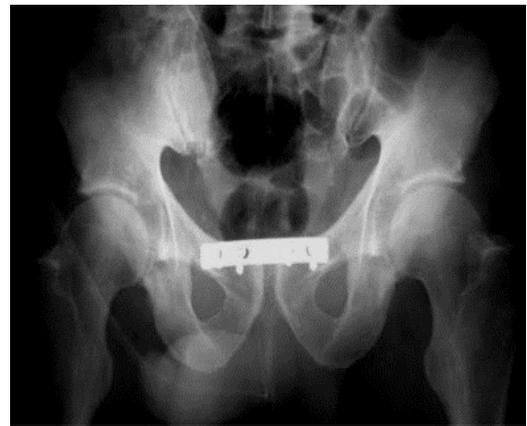


Fig 5: X-Ray pelvis showing pubic symphysis disruption surgically fixed with a single plate.



Fig 6: X-Ray pelvis showing fracture fixation with trans-iliac bar and reconstruction plate.

Post-operative management

The patient may be up in a chair by 3 to 10 days, weight bearing is permitted with crutches by 4 weeks. In women of child bearing age, consideration should be given to removing the plate when healing is complete (usually at 1 year post - injury), to allow for the natural diastasis of the symphysis to occur during pregnancy and delivery.

Posterior fixation of the sacro-iliac joint

The following approaches were used

- a) Anterior (Intra -pelvic) Approach.
- b) Posterior (Extra -pelvic) Approach.

Post-Operative Management

The anterior injury were treated either by an internal or external fixation, the stabilized hemi -pelvis was protected by partial weight bearing with ambulatory aids for 6 weeks. If only posterior fixation is done, the patient was restricted to bed to chair transfer using uninjured leg as pivot. Aid -free ambulation begins at 3 to 4 months post - operatively. Progressive return to full activities usually begins after 4 to 6 months.

Other techniques of posterior sacro -iliac or sacral fixation

Trans-iliac bars or rods can be used safely and effectively for posterior fixation. [Fig: 6] The bars are placed between the two intact posterior tubercles of the iliac wing. This technique is most useful for unilateral unstable sacral fractures, but if combined with a posterior screw into the ala it may be useful for sacro-iliac dislocations or bilateral disruptions.

Other techniques of posterior fixation include the use of 4.5 or 3.5 mm plates, which can be contoured to go across the posterior aspect of the sacrum and down the iliac wing.

Fixation of iliac wing fractures

Anterior approach was used keeping the stripping of the muscles to a minimum. Reduction was performed under direct vision using either a reduction forceps or schanz screws as joy-sticks. Temporary fixation was obtained by fixation of K-wires. Anatomical reduction was obtained with reduction clamp and the fragments were fixed with 3.5 mm reconstruction plate.

Other soft tissue injuries

After preliminary stabilization of the pelvic injury, other injuries to the genitals, perineum, bowel (blunt or penetrating), vascular and urological injuries were managed in consultation with specialist surgeons, in the same anaesthetic sitting. After recovery from the visceral injury repair, patients were taken up for open reduction and internal fixation of their pelvic bony injuries.

Functional Outcome

Functional outcome of the patients were assessed using the pelvic outcome scale by Cole *et al*; [11] at 8 months post-operatively. It is based on a 40 point scale for pain, ambulation, work and activity status, clinical examination and radiographic appearance. (Table 1).

Table 1: Score Garding of Cole *Et al*; [11]

Grade	Cole <i>et al</i> : score's	
Excellent	36-40	
Good	31-35	
Fair	26-	30
Poor	< 26 (25&	Below)

Table 4: Surgical Procedures:

Surgical procedure undertaken	No: of cases	% of sample total
External fixation	08	40%
<i>ORIF of sacroiliac joint</i>		
Anterior approach	05	25%
Posterior approach	03	15%
ORIF of ilium	06	30%
<i>ORIF of pubis (plating)</i>		
Pubic distasis	05	25%
Locked symphysis	01	5%
Total	20	100%

Table 5: Cole *et al*; [11] Functional outcome detailed Scoring table:

Grade	Excellent	Good	Fair	Poor	Total
	'n'(%age)	'n'(%age)	'n'(%age)	'n'(%age)	'n'(%age)
B1	4	2	--	--	6 (30%)
B2	--	3	--	--	3 (15%)
B3	--	5	--	--	5 (25%)
C1	--	2	1	--	3 (15%)
C2	--	--	1	--	1 (5%)
C3	--	--	--	2	2 (10%)
Total	4	12	2	2	20(100)

30% (n=6) of the cases were in the age group of 21 to 25 years, 35% (n=7) of the cases were in the age group of 26 to 30 years, 15% (n=3) cases were in the age group of 31 to 35 years and 20% (n=4) cases were in the age group of 36 to 40 years. There was a male preponderance in our sample study and the M:F ratio was 7:3. In 60% (n=12) cases the mode of injury was RTA, in 30% (n=6) cases the cause was a fall from significant height and 10% (n=2) cases were victims of earthquake. The average time between injuries to surgery was 2.4 hours (range 1-5 hours). The average operative time for the

Results

Table 2: Fracture Pattern Distribution

Tile's type	Number of	%age
patients (n)		
B1	6	30%
B2	3	15%
B3	5	25%
C1	3	15%
C2	1	5%
C3	2	10%
Total	20	100%

Table 3: Associated Injuries

Associated non-skeletal	Number of	%age
Injuries	patients (n)	
Nerve injury (L4 -L5)	1	5%
Injury to urethra	1	5%
Injury to urinary bladder	1	5%
Injury to external iliac artery	1	5%
Head injury	1	5%
Total	5	25%

Various surgical procedures and approaches that we used are as follows:

one's needing external fixation was 36 minutes and 114 minutes for the internally fixed group (range: 75 to 130 minutes). 3 of the 8 patients who had external fixation, had superficial infection which responded to parenteral antibiotics and regular dressings. Near anatomical reduction was achieved in 19 of the 20 cases. Thrombo-prophylaxis was used in all our patients and we did not encounter any case of deep vein thrombosis. There was no evidence of impotence in our patients. Our mean follow-up period was 13.6 months (range: 8 to 20 months).

In our series of 20 patients whose functional outcomes were evaluated at the end of 8 months post-operatively, 20% ($n=4$) had Excellent, 60% ($n=12$) had Good, 10% ($n=2$) had Fair and 10% ($n=2$) had Poor outcome, as evaluated by the Cole *et al*; [11] Scoring System.

Case illustration



Fig 7(a): X-ray shows the right side of the pubic was trapped in the obturator ring of left hemi-pelvis.



Fig 7(b): Intra - operative picture showing the cord structures secured on either side by umbilical tape. The right pubis is found posterior and inferior to the left pubis entering its obturator foramen.



Fig 7(c): A post-operative antero-posterior pelvis radiograph shows restoration of normal pelvic anatomy after superior and anterior symphyseal plating.

Discussion

Patients who survive disruption of the pelvic ring eventually have few late musculo-skeletal problems [6]. Despite aggressive resuscitation including application of external fixators, the mortality of 10-20% remain unchanged. This led to clinical trials on internal fixation and several studies have shown that early open reduction and stable internal fixation improves the chances of survival and more importantly,

reduces the incidence of late musculo -skeletal morbidity [7, 8, 9]. The mean age of the patient in our study was 29.25 years (range: 21 to 40 years) which is in close comparison to the Sunny Brook Medical Centre [10] series which had a mean age of 30.9 years. Cole *et al*; [11] reported an average age of 32 years. Sunil *et al*; [12] reported on 78 cases with an average age of 29.99 years (range 10 -65). There was extreme male preponderance in our series with 70% of male patients. The Sunny Brook medical centre [10] study reported only slight male dominance with 55%. Cole *et al*; [11] reported a male preponderance with 56.25%.

The most common mode of injury was road traffic accident (60%) in our study. Sunny Brook Medical Center's [10] prospective study reported it at 81%. Skeletal, visceral and vascular injuries, comprised the major associated injury (25%) in our series. Sunny Brook Medical Center [10] study reported a 38% incidence of head injury as their major associated injury. Tornetta *et al*; [13] reported associated skeletal injuries in 61.5% patients who suffered a rotationally unstable pelvic disruption.

Radiological assessment was done with three standard views of X-rays (AP, inlet and outlet projections) and a 3D CT scan when warranted. 70% ($n=14$) cases suffered Tile's type B injury against 30% ($n=6$) cases of type C injury. Cole *et al*; [11] in their series of 64 cases reported Tile's type C in 75% of cases. Miranda *et al*; [14] in his series of 80 patients, reported 38.75% cases of Tile's B type and 61.25% cases of Tile type C injuries.

In our series a rare case of type B injury, a locked symphysis pubis was treated successfully by open reduction and internal fixation with dual symphyseal plating. The patient had regained excellent functional status at 4 months. Few other authors like Shanmugasundaram and Webb [15-16] have also reported such rare type of injury.

We had 8 patients with pubic symphysis diastasis and these patients were treated with elective open reduction and internal fixation with symphyseal plating, all these 8 patients had good functional results.

A single plate was used in most of our fractures. One patient, in whom anterior plating was done did had an implant loosening with screw migration down to the thigh. But this did not affect the good functional outcome. Thus in our series all the Tile B1 fractures, all had excellent to good outcome. Tornetta *et al*; [13] reported on 29 patients operated with a single symphyseal plate. They also had reported 96% excellent results and four cases of hardware failure. Webb *et al*; [16] in his series of 14 cases treated with a two holed plate fixation encouraged early mobilization of his patients and concluded that single plating allows some normal motion to take place at the symphysis pubis. However McGowan *et al*; [17] and Schied [18, 19] in their studies concluded that two plates at 90° would give excellent stability, especially to the unstable pelvis. Our outcomes did not support the view that dual plate is mandated.

In our study, 6 patients were treated with open reduction and posterior internal fixation, including one case of combined fixation. Two patients had anterior plating of the sacro-iliac joint, three patients were treated with open reduction and posterior ilio -sacral screw fixation and three others had 3.5 mm reconstruction plating for ilium. In two patients treated with ilio-sacral screws, reduction was unsatisfactory with sacro -iliac joint malalignment. One of them had further a vertical displacement at the sacro -iliac joint after he started early weight bearing. Both the patients had posterior pain. Their functional outcomes were poor.

Tornetta *et al*; [13] reported on 48 patients of unstable posterior pelvic ring disruptions treated with open reduction and internal fixation. 67% of their patients had good functional results [13]. Cole *et al*; [11] reported on 51 patients treated with posterior internal fixation for type C injuries reported that 15 patients had functional deficits with a mean pelvic score of 29 points (Range 8 -40).

Analyzing the significant associated intra-pelvic soft tissue injuries in our study, we had one case each of urethral and vascular injury. We had 1 case of L4, L5 nerve palsy. Sunil *et al*; [12] reported 21.79% urogenital injuries, of which 10.25% were urethral injuries. Miranda *et al*; [14] reported urological injury in 15 of 27.27% patients with Tile's type B and C injuries. Cole *et al*; [11] had reported an incidence of 9.3% urethral injuries with Tile type C pelvic fractures.

However, Cole *et al*; [11] reported 19 cases of neurological injury in his series. We had one patient with L4, L5 palsy on admission and he improved to a motor power of 4+ (MRC grading) in 8 months. Another case of post-operative L5 palsy recovered to grade 4 in 6 months. Thus our incidence of lower neurological injuries (10%) could be attributed to the fact that in our series C2 and C3 fractures constituted only 15% of all cases. Tornetta *et al*; [13] reported 35% of significant neurological injury in their study of 48 unstable posterior pelvic ring disruptions. Probably their higher incidence was because their series dealt only with Tile type C fractures.

Injury to the intra-pelvic vasculature is probably the single most important associated injury in pelvic trauma, since the major cause of mortality in pelvic fractures is haemorrhage. Direct injury to arteries is reported in 10 -20% of patients with massive haemorrhage. The incidence of direct tear of a large bore artery like external iliac artery is rare (Wolfgang K Ertel). Metz *et al*; [20] reported on 39 consecutive patients with haemo-dynamic instability who underwent pelvic angiography. In their study, bleeding from either internal iliac artery or its branches were the cause of haemorrhage in all of their patients. In our study, we came across only one patient with external iliac artery injury which was managed by the vascular surgeon and emergent pelvic external fixation. This was followed 2 weeks later with ORIF. It was a Type C3 pelvic fracture. However the outcome in this case was poor. The incidence of deep vein thrombosis in major pelvic fracture patients is reported at being between 10 to 80% in various studies. We used thrombo-prophylaxis in all cases and in our series we did not have any symptomatic deep vein thrombosis.

Conclusion

After The Advent of High Resolution Imaging and contrast angiography facilities, understanding the 'personality' of the acutely injured and mangled pelvis is an enigma. Despite modern aggressive treatment modalities, the mortality rates still remains high. Early aggressive and thoughtful management of the patients with unstable pelvic injuries is essential for maximizing the immediate survival and the long-term functional outcome. Pre-operative thorough clinical and radiological assessment is mandatory to identify any occult injury. The role of team approach with various super specialists cannot be over emphasized. Emergent external skeletal fixation alone is not sufficient to restore haemo-dynamic stability in all patients who fail to improve after initial resuscitation. Vascular repair after angiography is mandated. Further, internal fixation should be opted for in all cases once the patient is clinically stable. Anatomic reduction

and internal fixation of unstable pelvic injuries gives excellent stability, allows for early mobility with good functional outcome. Delayed internal fixation was not associated with increased peri-operative morbidity. These cases achieve better reductions than those that are obtained with external fixation alone. Delaying the fixation, however, increased the difficulty of obtaining anatomic reduction in certain cases. Techniques of safe internal fixation are demanding, but functional outcomes are rewarding. Constant dedication to improvement is and must be the goal of the pelvic orthopaedic surgeons.

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