Complex Pelvic Fractures: Emergency Room to Internal Fixation - A Case Series And Literature Review

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ABSTRACT

A complex pelvic fracture is defined as a pelvic fracture that occurs together with an additional organ injury in the pelvic region, and includes urogenital, gastrointestinal, neurological and retroperitineal vessel injury. Besides these additional organ injuries, complex pelvic fractures are almost always unstable. The orthopedic surgeon managing complex unstable pelvic fractures must conceptually divide their management into the measures taken in the Emergency room setting, intermin measures, and definitive measures aimed to restore pelvic stability. Regarding Emergency room measures, circumferential sheeting, external pelvic fixation device, and the pelvic C-clamp, are all acceptable measures employed as part of patient resuscitation. The more historial pelvic sling, and frequently used external pelvic fixation device are both acceptable intermediate stabilization measures. Definitive management is reserved for unstable pelvic fractures where anatomical alignment cannot be achieved by external means. The complications of prolonged external pelvic fixation is however appreciated, and in centers experienced in the technique, internal plating fixation is preferred. We reported a series of two patients with complex unstable pelvic fractures, further complicated by acetabular fractures that were ultimately managed by internal fixation and a total hip replacement. Our case series followed these two patients from the emergency room setting until their definitive internal plate fixation and concluded by an evaluation of functional outcome assessed with Majeed score. The essential principles in the management of these patients are highlighted together with the frequent complications reported and our series is valuable to those orthopedic surgeons involved in the management of these challenging patients.

Keywords: Pelvic fracture, damage control surgery, Young and Burges, internal fixation

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INTRODUCTION

While pelvic fractures are classically described as accounting for approximately 2% of fractures overall, the increasing global incidence of motor-vehicle accidents has seen this figure being challenged in more recent papers.[1] Besides an increasing incidence, pelvic fractures are further recognized to be the leading cause of morbidity and mortality particularly in patients of more than 65 years of age with injury severity score(ISS) more than 25 and

triage-revised trauma score(T-RTS) below 8.[2-4] Several studies have clearly defined the association between the type of pelvic fracture incurred and the nature of the predominant complication that increases its respective mortality rate. Antero-posterior (open-book) compression fractures substantially increase the volume of the pelvis and are specifically associated with cardiovascular instability secondary to retroperitoneal hemorrhage.[5] With regards lateral compression fractures a clear association with closed head injury (and intra-abdominal solid organ injury) has been shown to be the most significant factor responsible for the mortality associated with this injury type.[3,5]

In terms of classifying these injuries the mechanistic based classification system of Young and Burgess is widely used. This classification system demonstrates not only useful descriptive utility in the emergency room setting but guides both emergency and definitive orthopedic care.[5-7] Antero-posterior compression injuries occur most commonly in head-on motor vehicle accidents either when symmetrical direct force is applied to the anterior pelvis or when asymmetrical indirect force is applied to the pelvis by one lower limb being violently externally rotated. This form of injury opens the anterior pubic ring, and a Type I injury is defined as < 2.5cm of diastasis and is stable, Type II injury is defined as > 2.5cm of diastasis with incomplete sacroiliac joint disruption and is unstable and a Type III injury is defined as > 2.5cm of diastasis with complete sacroiliac joint disruption and is unstable. The lateral compression type occurs during a high-velocity side impact injury where one hemi-pelvis is internally rotated relative to the other. Here a Type I injury refers to an ipsilateral impact and superior and inferior pubic ramii fractures. In these fractures the sacral ala must be carefully examined for no fracture or incomplete fracture(stable) or complete fracture(unstable). A Type II injury refers to superior and inferior pubic rami fractures with disruption of the ipsilateral sacroiliac joint and is regarded as unstable. A Type III injury refers to superior and inferior pubic ramii fractures with disruption of the contra-lateral sacroiliac joint and is regarded as unstable. Vertical shear injuries are the third injury type and occur, for example, in the context of falls from a height where the individual lands on one lower limb causing one hemipelvis to migrate rostrally relative to the other secondary to a bony and/or ligamentous disruption. These injuries are almost invariably unstable.[3,5] Acetabular fractures specifically characterize the Young and Burgess lateral compression and vertical shear types. While not part of the original classification, a mixed type was later added to account for additional variable fracture patterns. These extremely variable patterns are thought to be the result of a mixed application of forces.[8]

The orthopedic understanding of the management of pelvic fractures should be conceptually divided into emergency room management, intermediate management and definitive management. Each of these has its own specific set of surgical considerations for the attending orthopedic surgeon concerned. Regarding definitive orthopedic management, stable pelvic fractures are generally treated non-operatively and unstable pelvic fractures are generally treated operatively.[9] Open reduction and fixation if employed should be undertaken as an elective procedure in a stable patient. Several studies recognize the inherent risks associated with internal pelvic fixation and recommend it be reserved for patients in whom a satisfactory reduction cannot be achieved by closed means.[10,11] The experience of the orthopedic team is a critical consideration of paramount importance and this type of surgery should never be attempted by the inexperienced.

We presented a prospective consecutive case series of two patients that were brought to our hospital after being involved in high-velocity motor vehicle accidents.Cases were collected over a period extending from 20th December 2019 to 3rd March 2020. At presentation both patients were hemodynamically unstable secondary to unstable complex pelvic fractures.Both patients were successfully resuscitated and ultimately taken for definitive internal pelvic fixation. Despite the extreme nature of the injuries sustained by both patients, their subsequent emergency and definitive management enabled a successful outcome to be achieved. Our case series illustrates several of the essential orthopedic considerations regarding the management of complex unstable pelvic fractures and as such it is important for surgeons involved in orthopedic trauma and complex pelvic reconstruction surgery.The PROCESS guidelines[12] have been followed while reporting this case series.

CASE ONE

A 56-year old male patient presented to Orthopaedic unit Helen Joseph Hospital University of the Witwatersrand Johannesburg South Africa after being involved in a high-speed motor-bike accident. At presentation he was intubated and ventilated secondary to a head injury. He was hemodynamically

unstable secondary to blunt abdominal trauma with a grade III liver injury, as well as a retroperitoneal hematoma from a Young-Burgess mixed, antero-posterior compression type grade III, and lateral compression type I, pelvic fracture with pubic symphysis disruption >2.5cm and a complete fracture through the left superior pubic ramus and left iliac crest.Furthermore there was an associated posterior dislocation of the right hip with a fractured posterior acetabular wall. He was resuscitated in the emergency department and as part of this process a pelvic sheet was initially placed and shortly replaced with an external pelvic fixation device. A full body CT scan revealed non surgical head injury,blunt chest trauma with left sided rib fractures and pulmonary contusions, blunt abdominal trauma with the grade III liver injury, hemoperitoneum, and extra-peritoneal bladder rupture. As part of this process a 3-D CT pelvic re-construction was created. [Fig 1-III].

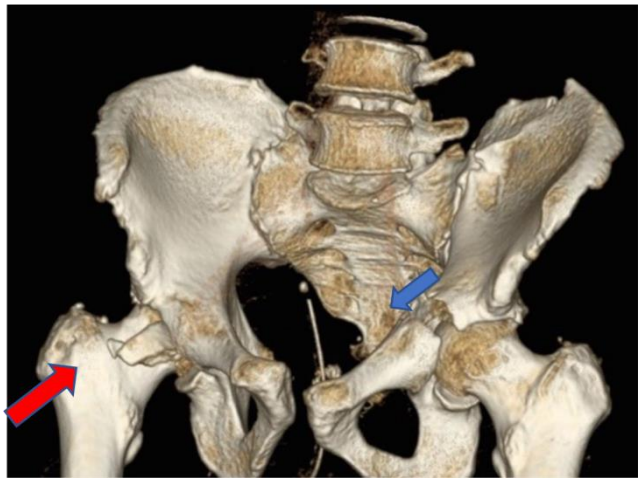

Figure I (Case One): 3-D CT pelvic re-construction antero-posterior view showing pubic symphysis disruption >2.5cm and a complete fracture through the left superior pubic ramus (blue arrow) and left iliac crest. A posterior dislocation of the right hip with a fractured posterior acetabular wall (red arrow) can also be seen.

As part of the resuscitation he was taken to the operating room where a percutaneous supra-pubic catheter was placed into the bladder and laparotomy was performed whereby the liver laceration was repaired. The abdomen and pelvis were packed and closed. The right hip was reduced by closed means and maintained in traction. After abdominopelvic packing, intra-operative fluoroscopic imaging was used to re-align the pelvis by manipulating the external pelvic fixation device. The patient was transferred back to the Intensive Care unit where his resuscitation was successfully completed over the following 48 hours. On the 3rd day he was taken back to the operating room where the abdominal and pelvic packs were removed and the abdomen closed. Over the course of the following 2-weeks, although he progressively improved from a neurological and cardiorespiratory perspective the right hip kept dislocating posteriorly during daily nursing activities.

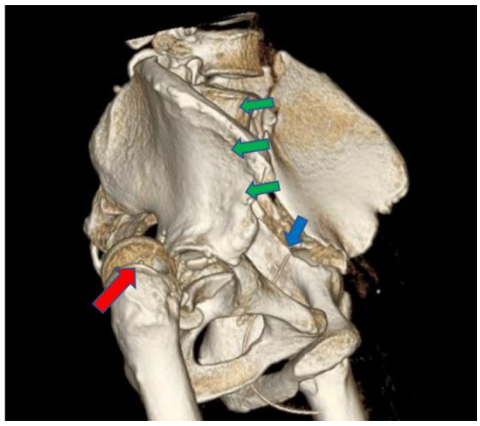

Figure II (Case one): 3-D CT pelvic re-construction lateral view where the pubic symphysis disruption >2.5cm, the complete fracture through the left superior pubic ramus (blue arrow), and left iliac crest (green arrows) can be better appreciated. The posterior dislocation of the right hip with a fractured posterior acetabular wall can also be seen (red arrow).

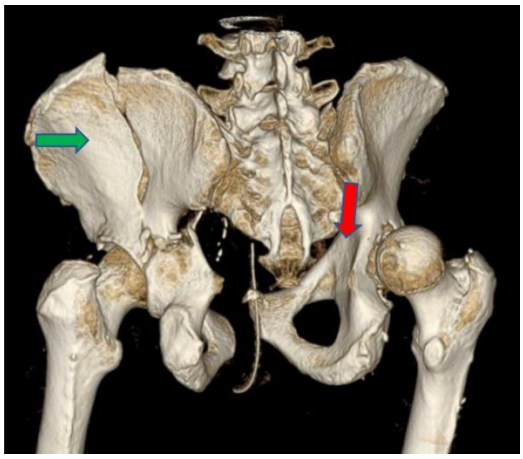

Figure III (Case one): 3-D CT pelvic re-construction posterior view showing the pubic symphysis disruption >2.5cm and complete fracture through the left ischium and iliac crest (green arrow). The posterior dislocation of the right hip with a fractured posterior acetabular wall can also be seen (red arrow).

As an elective procedure and having been fully resuscitated to normal blood gas and full blood count results, he was taken back to the operating room for definitive internal pelvic fixation. He was placed supine and after being cleaned and draped, an extended left-sided ilioinguinal approach was utilized. The pubic symphysis was re-aligned and plated with a pelvic re-construction plate. An additional pelvic reconstruction plate was then fixed on the medial side of the left superior pubic ramus with 2 screws. The pelvic reconstruction plate was then coursed superolateral across the fracture line on the superior pubic ramus to lie lateral on the iliac crest where 2 screws were used to secure it. The same pelvic reconstruction plate was then coursed superior-medially now crossing the fracture line on the iliac crest and secured medially in a curvilinear manner with 7 screws. Intra-operative fluoroscopic imaging was used to confirm the pelvic reduction and fixation.

Figure IV (Case one): Post-operative patient photograph taken at 4-months post-operatively, showing that he could stand without assistance. Upon ambulating he demonstrated a mild Trendelenburg gait.

After internal pelvic fixation the patient was placed in the lateral position with the right side up. Upon opening the right hip utilizing a posterior approach the right hip was noted to be dislocated. Using traction on the right thigh, the right hip was reduced into the fractured acetabulum. With the femoral head reduced the posterior acetabular wall was plated with a 180-degree circumferential pelvic reconstruction plate. The right hip was then intentionally dislocated and a hybrid right total hip replacement was performed. A cemented acetabular cup was placed into the re-constructed, reamed, and prepared acetabulum. A femoral head replacement with an uncemented stem was utilized on the femoral side. The wound was closed in layers and the patient was transferred back to the Intensive Care unit.

The patient was extubated and commenced with rehabilitation. He began ambulating with a walker utilizing limited weight bearing at 6-weeks post-operatively. By 3-months post operatively he could stand without assistance however needed a crutch to ambulate [Fig IV].

He was assessed utilizing the Majeed Pelvic Score,[9] and his score of 74 was interpreted as a good functional outcome. A follow-up X-ray confirmed fracture union and the pelvic alignment was satisfactory [Figure V]. He continued with his out-patient rehabilitation appointments and was booked for 1-year review.

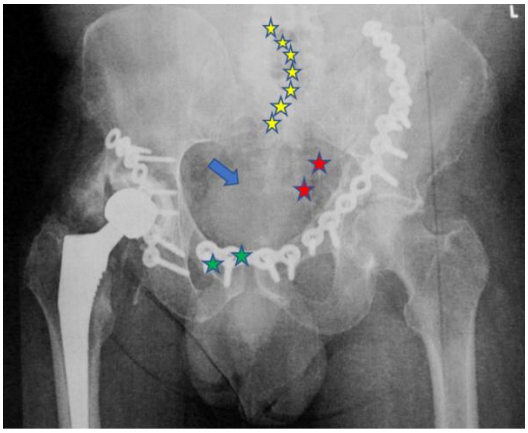

Figure V (Case one): Antero-posterior pelvic X-ray taken at 4-months post operatively, demonstrating both fracture union and satisfactory pelvic alignment. The pubic symphysis plate and right sided hybrid total hip replacement augmented by a posterior acetabular pelvic reconstruction plate are clearly visualized. On the left side the 2 screws fixing the pelvic reconstruction plate medial to the superior pubic ramus fracture line,can be seen (green stars). The 2 empty holes are then visualized as the plate passes over the fracture line on the superior pubic ramus (blue arrow). Once across this fracture line the same plate is secured with 2 screws into the dense supra-acetabular bone (red stars). The pelvic reconstruction plate is then coursed superomedial crossing the fracture line on the iliac crest and secured medially in a curvilinear manner to increase the pull-out strength with 7 additional screws (yellow stars).

CASE TWO

A 26-year old female patient arrived at Orthopaedic unit Helen Joseph Hospital University of the Witwatersrand Johannesburg South Africa after having been involved in a high-speed motor vehicle accident. She had been intubated and ventilated on scene by the paramedic staff due to a low Glasgow Coma Score and was being resuscitated for hemodynamic instability. Her hemoglobin level was low and together with a distended abdomen and solid organ damage was suspected. A screening antero-posterior pelvic X-ray confirmed a Young-Burgess lateral compression grade III fracture. On this X-ray image right sided superior and inferior pubic ramus fractures, a complete pubic symphysis dislocation and a contra-lateral sacroiliac joint disruption was noted. A left posterior hip dislocation with an associated posterior acetabular wall fracture was also diagnosed [Figure VI].

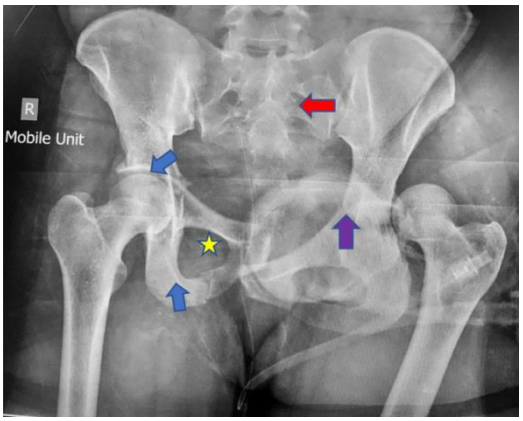

Figure VI (Case two): Emergency room anteroposterior screening pelvic Xray showing a lateral compression type injury with right sided superior and inferior pubic ramus fractures (blue arrows), complete pubic symphysis overlapping dislocation (yellow star), and contra-lateral sacroiliac joint disruption (red arrow). A left posterior hip dislocation with associated superior pubic ramus and posterior acetabular wall fractures were also noted (purple arrow).

An external pelvic fixation device was placed as an emergency room measure to assist in the cardiovascular resuscitation. Once the patient was stabilized a full body CT scan was performed. This showed a contralateral closed head injury, blunt abdominal trauma with a grade II liver injury and grade IV splenic injury and the pelvic fracture as described. She was taken to the operating room where an emergency laparotomy was performed.The liver laceration sutured and the shattered spleen removed. The left hip dislocation was reduced by closed means and intra-operative fluoroscopy was used to add additional Schanz screws and adjust the external pelvic fixation device to ensure pelvic reduction and temporary stabilization had been achieved [Figure VII-VIII].

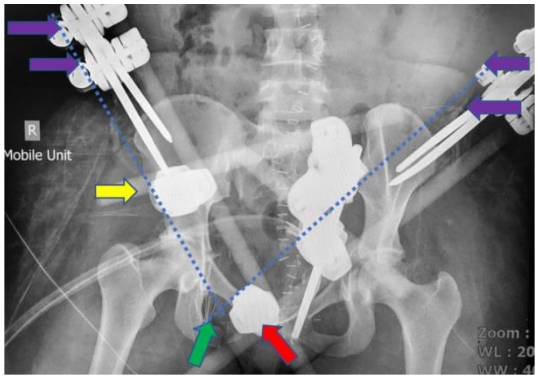

Figure VII (Case two): Intra-operative fluoroscopic image showing 2 Schanz screws inserted into both iliac crests bilaterally (purple screws). One Schanz screw was then inserted into the right anterior superior iliac spine (yellow arrow). An additional Schanz screw was then inserted into the body of the left pubic bone (red arrow) and another into the body of the right pubic bone (green arrow). These were then linked with a series of graphite radiolucent bars to maintain the reduction. The reduced left hip is also seen.

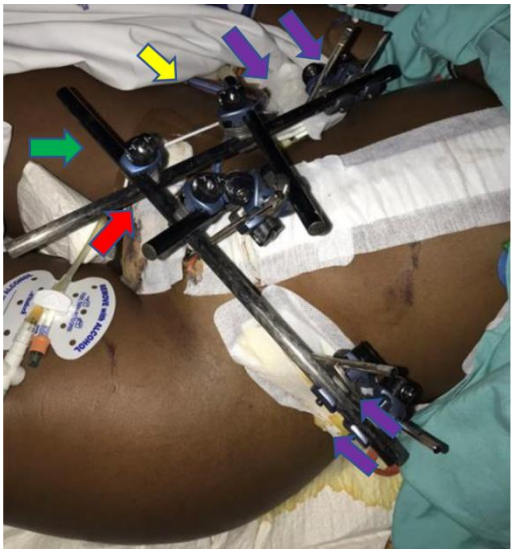

Figure VIII (Case two): Intra-operative patient photograph after laparotomy showing the final external pelvic fixation device in place. The arrow colors marking the Schanz screws correspond to those in Figure VII above.

The patient was transferred back to the Intensive Care Unit where the resuscitation was completed and a CT pelvis with 3-D reconstruction was performed [Figure IX-XI].

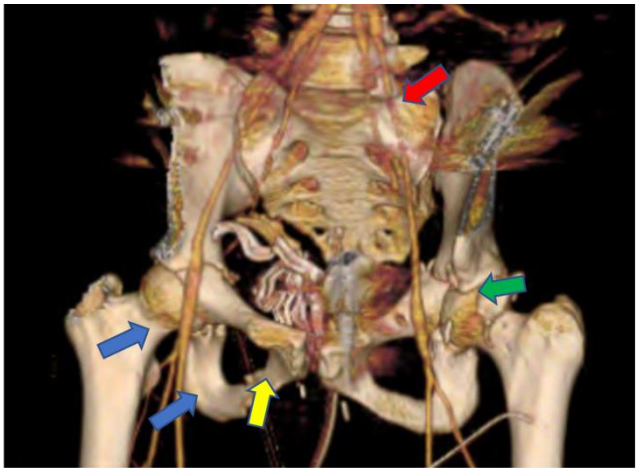

Figure IX (Case two): CT pelvis 3-D reconstruction (anteroposterior view) showing right sided superior and inferior pubic ramii fractures (blue arrows), reduced pubic symphysis (yellow arrow) and disrupted contralateral left sacroiliac joint (red arrow). Although the left hip is reduced, a large displaced fragment of the posterior acetabular wall can be seen lying superior to the femoral head (green arrow).

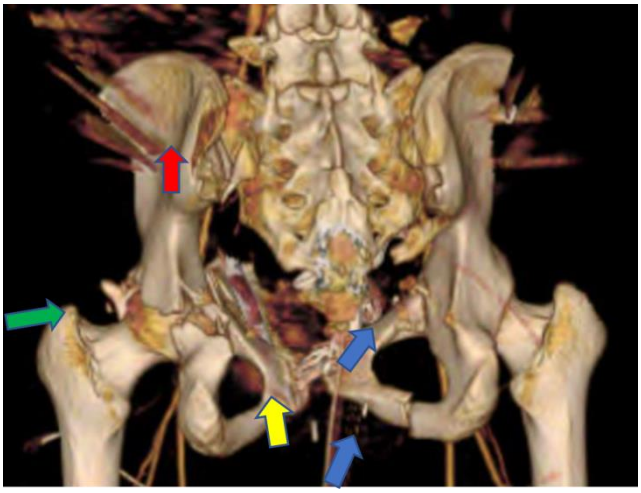

Figure X (Case two): CT pelvis 3-D reconstruction (posterior view) showing the same abnormalities as [Figure IX] and marked by corresponding colored arrows.

At 2-weeks post-injury the patient had improved considerably and she was booked for definitive internal pelvic fixation. She was taken back to the operating room and the external pelvic fixator was removed. A bilateral ilioinguinal approach was used whereby the femoral vessels and nerves and psoas muscle were identified and isolated with vascular loops. A 5-hole pelvic reconstruction plate was then placed centrally over the pubic symphysis and leaving the central hole empty, 2 screws were inserted in to the 2 holes on either side of the midline. A second pelvic reconstruction plate was then slid beneath the right neurovascular bundle and used to plate across the fractured right superior pubic ramus. A 3rd pelvic reconstruction plate was then slid beneath the left neurovascular bundle and used to plate the fractured left superior pubic ramus [Figure XII].

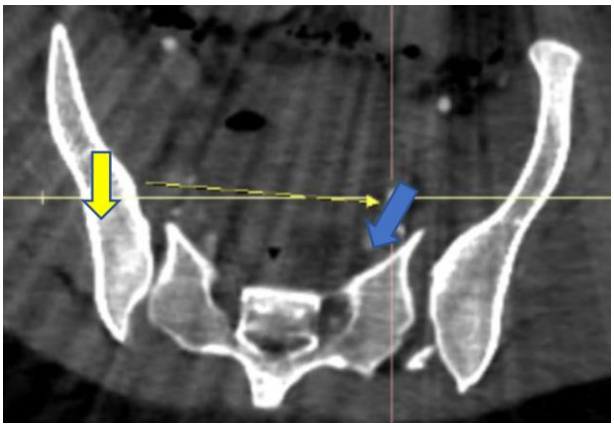

Figure XI(Case two): CT pelvis axial view showing that while the left sacroiliac joint was confirmed to be completely disrupted (blue arrow), the right sacroiliac joint was also partially disrupted anteriorly (yellow arrow).

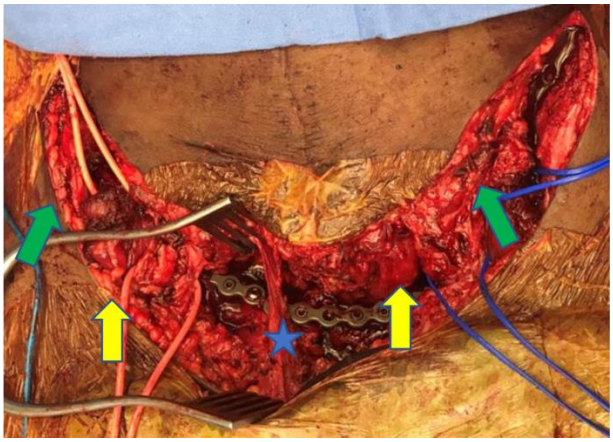

Figure XII (Case two): Intra-operative patient photograph showing the vascular loops behind the left and right neurovascular bundles (red arrows). Additional loops are noted beneath the left and right psoas muscle tendons (green arrows). The central pelvic reconstruction plate can be seen straddling the pubic symphysis (blue star).

Once the anterior pelvic plating was complete with the patient remaining in the supine position, two bilateral percutaneous self-cannulated sacroiliac screws were inserted under fluoroscopic guidance. The pelvis had now been afforded 360-degree fixation. She was transferred back to the Intensive Care Unit.

One-week after the anterior pelvic and bilateral posterior sacroiliac joint plating and fixation procedures, she was taken back to the operating room. During this visit she was placed in the lateral approach and a posterior approach to the left hip was used to reconstruct the posterior rim of the acetabular cup with a pelvic reconstruction plate. An anteroposterior pelvic fluoroscopic image was taken which illustrated the extensive pelvic reconstruction undertaken [Figure XIII].

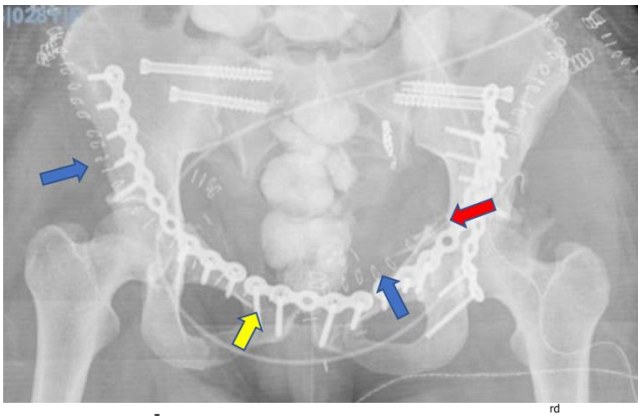

Figure XIII (Case two): Intra-operative fluoroscopic image taken after the 3rd surgery where the left posterior acetabular rim was re-constructed. The central symphyseal pelvic reconstruction plate (yellow arrow), left and right superior pubic ramii pelvic reconstruction plates (blue arrows) and the pelvic reconstruction plate used to re-construct the posterior lip of the left acetabulum (red arrow), are all clearly visible.

The patient commenced rehabilitation with non weight bearing on the left hip for 3-weeks followed by limited weight bearing for another 6 weeks. She was independently ambulant with crutches by the 3rd post-operative month and discharged from our rehabilitation center for out-patient care. Despite progressing well towards the middle of the 6th month she began to experience severe recurring left hip pain and then suddenly regressed in her ambulation. She was referred back to our unit were on examination her left hip was internally rotated with abduction limited to 20 degrees and external rotation limited to 10 degrees. An anteroposterior pelvic X-ray confirmed avascular necrosis of the left femoral head which had subluxated posteriorly. The same bony fragment from the posterior acetabular wall was noted to have refractured,and had displaced posteriorly [Figure XIV].

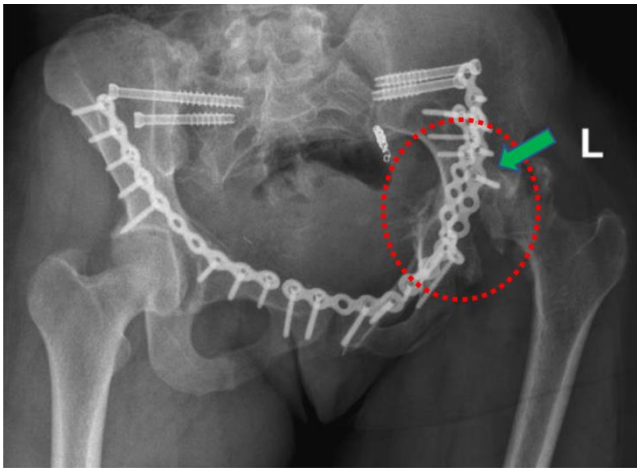

Figure XIV (Case two): Anteroposterior pelvic X-ray taken at 6-months post injury- showing healed bilateral superior pubic ramii fractures and right inferior pubic ramus fracture.On the left side the femoral head is noted to have undergone avascular necrosis (red dotted circle) and had subluxated posteriorly (green arrow).

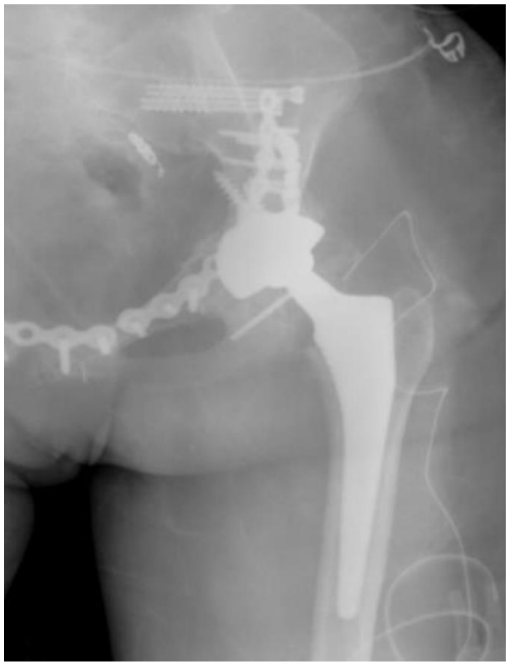

Figure XV (Case two): Intra-operative fluoroscopic Xray showing the left non-cemented total hip replacement.

Figure XVI (Case two): Patient photograph taken at her 3-week outpatient appointment showing the surgical scarring of her abdominal wall pelvis,and left thigh.

Figure XVII (Case two): Patient photograph at her 3-week out-patient appointment where she could stand independently and was independently ambulant, with crutches.

She was taken back to the operating room where, as a 4th major surgical procedure she was again placed in the lateral position and a posterior approach utilized to gain access to the left hip. During this surgery the femoral head was noted to be significantly deformed and the acetabular cartilage irreparably damaged. A left sided uncemented total hip replacement was performed and the wound closed in layers. An intra-operative anteroposterior pelvic X-ray confirmed the extensive pelvic reconstruction and now in addition showed the left total hip replacement in situ [Figure XV].

She re-commenced her rehabilitation and by 3-weeks post operatively her wounds had healed. She could stand independently and was independently ambulant with crutches [Figure XVI-XVII]. She was assessed by Majeed functional score and her total score of 67 indicated a fair functional outcome.

DISCUSSION

A complex pelvic fracture is defined as a pelvic fracture that occurs together with an additional organ injury in the pelvic region. These additional organ injuries may include a urogenital injury (extraperitoneal bladder rupture), gastrointestinal injury (rectal/sigmoid colon injury), vascular injury (retroperitoneal vessels), and neurological (lumbosacral plexus).[1] Both of the patients in our case series presented with hemodynamic instability secondary to retroperitoneal bleeding and hence both of our cases meet the definition to be regarded as complex pelvic fractures. By its very definition complex pelvic fractures patients demand multi-disciplinary team care comprising a trauma surgeon, orthopedic surgeon, urologist, radiologist with interventional radiology capabilities.[1] The priority in managing these patients is firstly hemodynamic resuscitation and bleeding cessation and for the latter urgent emergency room pelvic ring stabilization is of paramount importance.[9] Pelvic binding, the external pelvic fixation device and the pelvic C-clamp are all still acceptable options in today's Emergency room setting.[7,13] Once the patient has been resuscitated, unstable pelvic fractures are managed by definitive internal pelvic fixation. Waiting one-week post injury is the commonly advocated period before performing internal pelvic fixation.[14] This is furthermore what we practice in our unit as can be seen from our case series. There is however a school of thought that advocates waiting for as long as 7-12 weeks to avoide the "second hit" of an inherently extensive second surgery by waiting, is reported to significantly lower the complication rate.[10,15]

Internal pelvic fixation has a relatively high complication rate. One paper evaluated open surgical intervention in 406 subjects with unstable pelvic fractures who underwent internal plating, reported a complication rate of 4.5%.[10] While most studies report only survival rates, functional outcome was assessed in one paper[14] post plating of complex pelvic fractures using the Majeed functional score.[9] This scoring system uses 5 parameters, namely pain,

standing, sitting, dyspareunia, and the ability to work. In this paper[14] good and excellent outcomes were reported in 90% of their 26 patients after internal pelvic fixation of complex unstable pelvic fractures. In our case series our first patient had a good outcome while our second patient had a fair outcome using the Majeed functional score. Our results are hence lower but comparable to the results in this study. The fact that both of our patients were complicated by posterior wall acetabular fractures ultimately requiring a total hip replacement complicates the utilization of the Majeed functional score to purely assess outcome of the internal plate fixation of their complex pelvic fractures.

Regarding outcome, chronic pain is a frequent problem reported by several studies post internal fixation of complex pelvic fractures.[16] Sacroiiliac joint disruption is recognized in one paper as an independent risk factor for chronic pain.[17] In our series our first patient had no sacroiliac joint disruption but reported pain that was tolerable.The second patient in our series reported pain that was intense with activity. Utilizing Majeed functional score the higher pain score in our second patient who had sacroiliac joint disruption compared to our first patient who did not have sacroiliac joint disruption supports the finding of this study. Sexual dysfunction is the most frequent complaint of women post complex pelvic fractures reported in another study.[18] The fact that one of the patients in our case series was male and the other female makes the result of our study non comparable with the results of this study that only considered women. However in 20% of patients spontaneous recovery of sexual function had been reported at 18 months after surgery.[19] Regarding occupational outcome another study reports that 70-80% of patients whom incurred a pelvic fracture never return to their previous work.[1] In our study neither patient returned to work after their injury which supports the result of this study. Lastly,the operating surgeon must have a through knowledge of pelvic and acetabular anatomy because successful outcome of operative fixation depends upon through understanding of pelvic and acetabular anatomy.[20]

Although we had managed four patients with complex pelvic fracture but complete record of only two was available which were presented here.We recommend further case series with enough patients to confirm the effectiveness of our protocols and procedures for treating such patients.Furthermore longer follow up of such patients are needed for assessment of optimum functional outcome.

CONCLUSION

The orthopedic management of complex pelvic fractures begins in the emergency room setting where the orthopedic surgeon forms part of a multidisciplinary team. Here the priorities are resuscitation and acutely reducing and stabilizing a pelvic fracture.Once the patient has been stabilized definitive internal pelvic fixation aims to optimize functional outcome. Our case series highlights several of the emergency room challenges as well as the challenges associated with the definitive management of these patients and as such is valuable to orthopeedic surgeons involved in the care of these patients.

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