

Management of Pelvic Fractures During Pregnancy

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Abstract

Pelvic or acetabular fractures during pregnancy are rare, and information on managing such complex incidents has been limited. Over several years, we have gained significant experience in handling such cases. Of the 1345 pelvic and acetabular fractures treated at our level I trauma center between 1987 and 2002, 15 (1.1%) occurred in pregnant women. Eleven women received conservative treatment, and 4 were treated surgically. Of the 16 fetuses, 12 survived, and 4 pregnant women had nonviable pregnancies. One of the 15 pregnant women died. We describe our cases and propose treatment guidelines. The dilemma presented in a multitrauma situation at various stages of pregnancy necessitates making management modifications involving timing of surgery and delivery, use of radiation for imaging, and choice of appropriate surgical procedure.

In managing pelvic or acetabular fractures during pregnancy, the physician is faced with complex challenges regarding treatment of both mother and fetus. These cases are rare, and there is little clinical experience in the treatment of such patients. The literature also does not provide clear guidelines for managing these cases. In this report on a retrospective study, we summarize our experience and propose several principles for handling these special cases.

PATIENTS AND METHODS

Between 1987 and 2002, 1345 cases of pelvic fractures were treated at our level I trauma center. Fifteen (1.1%) of these patients were pregnant women. We retrospectively reviewed the files and x-rays of these patients (Table I). All

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injuries were sustained in motor vehicle accidents, except for 1 case in which a fall from a height caused the injury. Patient ages ranged from 19 to 40 years (mean, 28 years). Pregnancy terms ranged from 4 to 41 weeks (mean, 25 weeks). One case (Table I, case 15) was a twin pregnancy. Of the 15 cases, 3 were hemodynamically unstable on arrival and required fluid resuscitation; the other 12 were hemodynamically stable, and further evaluation was done under continuous monitoring of both mother and fetus.

Fracture Type

Of the 15 fractures, 12 were isolated pelvic fractures, 1 an isolated acetabular fracture, and 2 combined injuries of the pelvis and the acetabulum. Pelvic fractures were considered to be either mechanically stable or unstable, and acetabular fractures displaced or nondisplaced. Fractures were also classified according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification¹ (61, pelvis; 62, acetabulum).

Of 14 pelvic fractures, 9 were laterally compressed (type 61.A), 3 were rotationally unstable (type 61.B), and 2 were vertically unstable (type 61.C). Of the 3 acetabular fractures, 1 was a displaced posterior wall fracture (type 62.A), 1 was a minimally displaced transverse fracture (type 62.B), and 1 was a displaced transverse fracture (also type 62.B).

Orthopedic and Obstetric Outcomes

Pelvic fractures. The 9 stable pelvic fractures (61.A) were treated conservatively (analgesics and weight-bearing as tolerated) and discharged within a mean of 4 days. Of the 3 rotationally unstable pelvic fractures (61.B), only 2 responded adequately to conservative treatment; the third remained symptomatic and was treated with internal fixation after preterm delivery of a healthy newborn. The 2 vertically unstable pelvic fractures (61.C) necessitated early surgical intervention: In 1 case, open reduction and internal fixation (ORIF) were performed in the same session with termination of pregnancy; the other case was treated with external fixation as part of the resuscitation process, but the patient died shortly afterward from her other injuries.

Acetabular fractures. Of the 3 acetabular fractures, 2 nondisplaced fractures (62.A, 62.B) were managed conservatively with partial weight-bearing or non-weight-bearing for 6 weeks. In 1 case (62.A), results of the long-term treatment were satisfactory; the other case (62.B) developed posttraumatic osteoarthritis. One displaced acetabular fracture (62.B) in a 20-weeks-pregnant patient was treated with ORIF. Pregnancy proceeded uneventfully,

Table I. Patient Data: List of Cases in Order of AO (Arbeitsgemeinschaft für Osteosynthesefragen) Classification*

No.	Age (y)	Gestational Age (wk)	Hemodynamic Status	Mechanical Stability and Displacement	AO Classification
1	27	10	Stable	Stable	61.A1
2	26	32	Stable	Stable	61.A2
3	19	37	Stable	Stable	61.A2
4	33	26	Stable	Stable	61.A2
5	24	24	Stable	Stable	61.A2
6	31	8	Stable	Stable	61.A2
7	38	31	Unstable	Stable	61.A2
8	22	41	Stable	Stable	61.A2
9	30	33	Stable	Stable, minimally displaced	61.A2, 62.B1
10	21	33	Stable	Unstable	61.B2
11	34	6	Stable	Unstable	61.B3
12	20	20	Unstable	Stable, displaced with protrusion	61.B3, 62.B1
13	40	32	Unstable	Unstable	61.C3
14	28	4	Stable	Unstable	61.C3
15	37	29	Stable	Displaced	62.A1

*R, right; SIJ, sacroiliac joint; FWB, full weight-bearing; PWB, partial weight-bearing; ORIF, open reduction and internal fixation; D&C, dilation and curettage.

No.	Fracture Description	Treatment	Hospitalization Period (d)	Obstetric Outcome
1	R ileum	Conservative & FWB	4	Normal delivery
2	R pubis	Conservative & FWB	4	Lost for follow-up
3	R pubis	Conservative & FWB	2	Lost for follow-up
4	R pubis & ischium	Conservative & FWB	7	Caesarian section
5	R ischium	Conservative & FWB	5	Normal delivery
6	R pubis & ischium	Conservative & FWB	5	Normal delivery
7	R ischium	Conservative & FWB	5	Preterm cesarean section
8	R pubis, SIJ	Conservative & FWB	3	Fetal death
9	SIJ, acetabulum	Conservative & PWB	10	Normal delivery
10	"Open book"	ORIF (after birth)	30	Preterm caesarian section
11	"Straddle," sacrum	Conservative & PWB	19	Termination of pregnancy
12	Sacrum, SIJ, acetabulum	ORIF	15	Normal delivery
13	R pubis & ischium, sacrum	External fixation	3	Intrauterine fetal death
14	R pubis & ischium, sacrum	ORIF (after D&C)	49	Termination of pregnancy
15	Acetabulum	Conservative (closed reduction)	24	Normal delivery

and a healthy newborn was delivered in a normal vaginal delivery in due time. Follow-up showed that the mother resumed normal functioning without pain.

Obstetric outcome. The obstetric outcome varied. Nine pregnancies resulted in viable newborns; 7 of these were delivered vaginally, 2 by elective caesarean section. Two early pregnancies were electively terminated because of several complicated reasons, including apprehension of increased radiation dose. There was 1 case of fetal demise before maternal death in a patient with severe multitrauma. One newborn died 3 days postpartum from severe fetomaternal hemorrhage. Two patients were untraceable for follow-up after discharge from hospital during pregnancy.

CASE REPORTS

We present 5 cases that demonstrate some unique issues in managing pelvic or acetabular fractures during pregnancy.

Case 1: Unstable Pelvic Fracture in Multitrauma Patient

A 40-year-old woman in week 32 of pregnancy was involved in a motor vehicle accident as a pedestrian (Table I, case 13). She was brought to the emergency department (ED) in an unconscious state (Glasgow Coma Scale score = 5) and was hemodynamically unstable. Physical exami-

nation revealed head injury and pelvic instability. Initial fluid resuscitation was started. An emergency computed tomography (CT) scan showed subdural hematoma and an unstable pelvic fracture (61.C3) accompanied by a retroperitoneal hematoma. The patient was taken immediately to the operating room, where urgent craniotomy and external fixation of the pelvis were performed simultaneously. Because of the ongoing hemodynamic instability, an angiography was performed. Arterial bleeding from the right iliac artery was diagnosed, and the vessel was embolized (Figure 1). The patient was stabilized hemodynamically and then admitted to the intensive care unit. An obstetric ultrasound showed deceleration in fetal heart rate (FHR). Given the general condition of the mother, an emergency caesarean section was considered too hazardous and was not performed. Fetal demise was noted the next day. Subsequently, the patient's condition deteriorated because of the head injury, and she died shortly afterward.

Case 2: Isolated Unstable Pelvic Fracture During Third Trimester

A 21-year-old woman in week 33 of pregnancy was involved in a motor vehicle accident as a passenger (Table I, case 10). On arrival, she complained of anterior pelvic pain and difficulty walking. Physical examination revealed tenderness

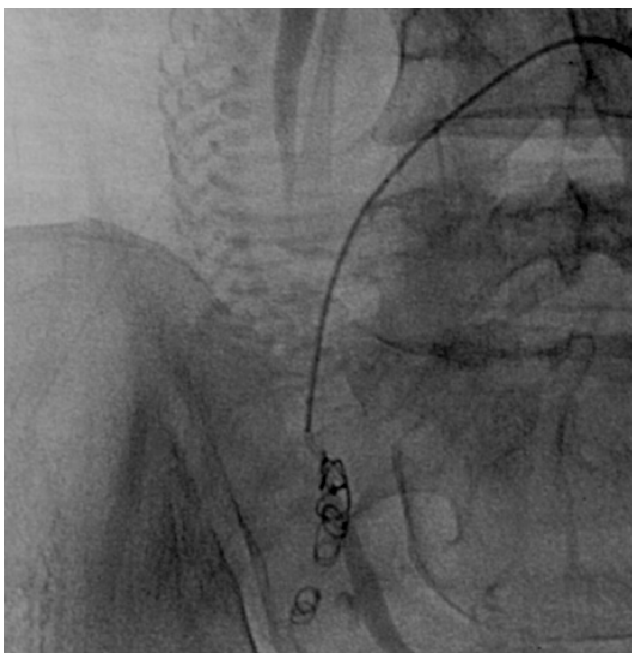


Figure 1. Fluoroscopic image of embolization of the right iliac artery clearly shows fetal spine over the right iliac crest.

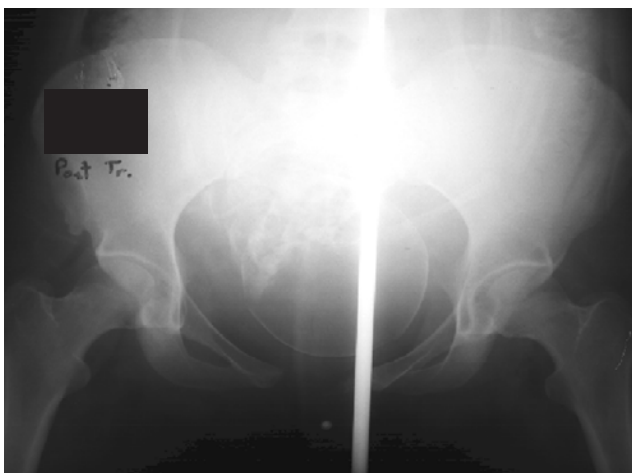


Figure 2. Anteroposterior x-ray of symphysiolysis in week 33 of pregnancy.

over the symphysis pubis. Radiography showed symphysiolysis measuring 5 cm (Figure 2). At this stage, conservative treatment was favored. Because of severe perineal soft-tissue edema and continuous maternal suffering, a preterm caesarean section was performed 2 weeks later (week 35). The neonatal course was uneventful, and long-term follow-up showed a normal, healthy child. As the pain and walking limitations persisted after delivery, ORIF of the symphysis pubis was performed (Figure 3), after which the patient was able to walk without pain.

Case 3: Minor Pelvic Fracture Resulting in Fetal Demise

A 33-year-old woman in week 41 of pregnancy was brought to the ED after sustaining a direct hit to her left



Figure 3. Postoperative x-ray of surgical fixation of symphysiolysis performed after delivery.

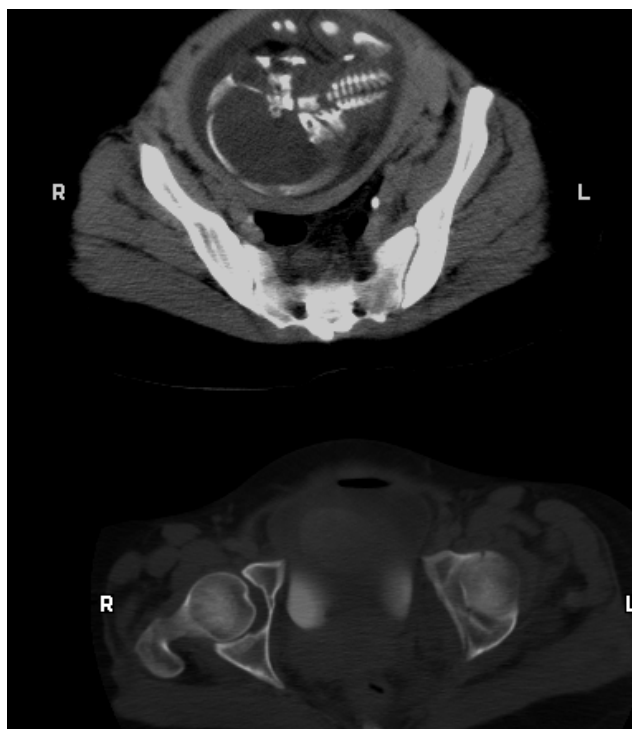


Figure 4. Computed tomography scan of minimally displaced transverse acetabular fracture in a 33-week pregnancy.

flank by an automobile (Table I, case 8). On arrival, she was fully conscious and hemodynamically stable and complained only of a backache. Physical examination revealed a nontender, term-size uterus with no vaginal bleeding. The pelvis was stable, and there was tenderness over the right hemipelvis. The pelvic x-ray was interpreted as normal. Obstetric ultrasound examination, performed in the ED, demonstrated severe FHR deceleration. An immediate caesarean section was performed, and placental abruption was noted. The newborn had an Apgar score of 3 and required prolonged resuscitation. Three days later, he died of severe anemia and shock caused by fetomaternal hemorrhage. Because of persistent pelvic pain and tenderness over the right ramus pubis, an orthopedic reevaluation was performed; new x-rays and subsequent CT scan showed a



Figure 5. Three-year follow-up x-ray of patient treated conservatively for nondisplaced acetabular fracture. Posttraumatic osteoarthritis of the acetabulum is demonstrated.



Figure 6. Anteroposterior x-ray shows acetabular fracture with protrusion of the femoral head into the pelvis in a 20-week pregnancy.

nondisplaced fracture of the right ramus pubis and a slight opening of the left sacroiliac joint (61.A2). On review of the original x-ray, the fracture was barely visible, perhaps because of the low-quality imaging that resulted from avoiding radiation overexposure. This stable pelvic fracture allowed full weight-bearing and walking. Two months later, physical examination of the patient revealed no functional limitations.

Case 4: Conservatively Treated Minimally Displaced Acetabular Fracture

A 28-year-old woman in week 33 of pregnancy was involved in a high-speed, head-on motor vehicle collision (Table I, case 9). On arrival at the ED, she was hemodynamically stable and complained of pain in her left hip joint. Pelvic imaging

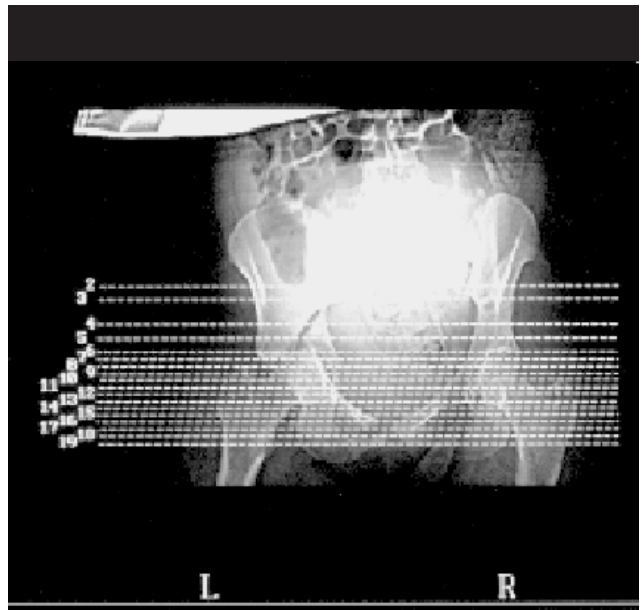


Figure 7. Displaced acetabular fracture in a 20-week pregnancy. The upper half shows a selective computed tomography scan done with varying width between the slices. Only a few slices were done at the level of the uterus to demonstrate the sacroiliac joint, as seen in the lower half. There are more slices at the level of the acetabular fractures.

(Figure 4) showed a minimally displaced transverse acetabular fracture (62.B1) accompanied by a sacroiliac joint fracture (61.A2). In light of minimal displacement of the acetabular fracture, on one hand, and advanced pregnancy, on the other, a trial of conservative treatment was carried out. The patient was discharged 10 days later, after conservative treatment with partial weight-bearing. In week 42 of pregnancy, she gave birth to a healthy newborn in a normal vaginal delivery. However, she continued to complain of pain in the left hip joint and difficulty walking for an extended period. Clinical evaluation showed limited motion in the left hip joint. Three years after the accident, imaging showed degenerative chang-



Figure 8. Postoperative x-ray of internal fixation of acetabular fracture in a 20-week pregnancy.

es of the left hip joint. The patient is presently referred for further surgical treatment (Figure 5).

Case 5: Surgically Treated Displaced Acetabular Fracture

A 20-year-old woman in week 20 of pregnancy was admitted to the ED after being involved in a car accident as a passenger (Table I, case 12). She sustained multiple injuries and was hemodynamically unstable on arrival. Her hemodynamic state was stabilized after vigorous fluid and blood product resuscitation. Obstetric evaluation was normal. X-rays showed a transverse acetabular fracture with significant displacement (61.B1, Figure 6) accompanied by a mild sacroiliac joint opening with ramus pubis and sacral fractures (61.B3). Although an advanced pregnancy would normally hinder surgery, surgical treatment was chosen because of the significant acetabular displacement. As part of presurgical evaluation, a specially designed low-radiation CT scan was obtained (Figure 7). The patient was subsequently taken to the operating room. ORIF through a modified posterior rather than anterior approach was carried out (Figure 8). Twenty weeks later, the patient delivered a healthy, full-term child in a normal vaginal delivery. Follow-up 2 years later revealed that the patient had no pain or functional limitations after the acetabular injury.

DISCUSSION

Blunt abdominal trauma is a leading cause of maternal morbidity and mortality in pregnancy. When blunt abdominal trauma includes pelvic fracture, a high-energy mechanism is evident and has to be approached in the appropriate manner. According to the advanced trauma life support (ATLS) scheme,² the first priority in approaching such cases is evaluation and treatment of situations that jeopardize the mother's life. The second priority should be an evaluation of the fetal state. The pelvic fracture should be approached at a later stage of evaluation. However, treatment of an unstable pelvic fracture in a hemodynamically unstable patient could be a part of

the immediate resuscitation phase. Apparently, management of pelvic fractures that occur during pregnancy can be very complex and call for special considerations. On the basis of our experience and the existing literature, we propose guidelines for managing these special conditions.

Evaluation and Treatment of the Mother

Pelvic fractures during pregnancy are associated with increased maternal morbidity and mortality.³⁻⁵ Our series included 1 case (6.6%) of maternal mortality (Table I, case 13).

Several anatomical and physiologic changes should be taken into consideration when treating a pregnant trauma patient. One particularly significant physiologic change is that, in the third trimester, there is a relative maternal hypovolemia, and maternal blood loss of up to 1500 mL can occur before any signs of hypovolemia can be detected.^{2,6} Therefore, any suspicion of maternal blood loss should be treated vigorously and immediately, and, if necessary, application of external fixation for control of bleeding from pelvic injury should not be delayed. It must be emphasized that these measures are not relevant in the first trimester, during which almost no change in the maternal anatomical or physiologic parameters occurs. However, the mother's resuscitation and initial treatment should not be compromised because of the pregnancy. Treatment priorities for an injured pregnant patient remain the same as for an injured patient who is not pregnant.

Evaluation and Treatment of the Fetus

Pelvic fractures that occur during pregnancy are associated with increased fetal mortality.⁵ Fetal death rates in cases of maternal pelvic fracture occur in 35% to 60% of cases.^{3,4,6} The large variance in death rates can be interpreted by the different types of cases gathered in those reports. In our series, there was 1 case (6.6%) of fetal demise and 1 case (6.6%) of neonatal demise (Table I, cases 13 and 8, respectively). Two cases (13.2%) of elective termination of pregnancy were directly related to the trauma. When pregnancy is electively terminated, it is usually at very early stages, as was the case with these patients (Table I, cases 11 and 14). Clearly, pelvic fracture in itself is not an indication for termination of pregnancy, and the decision is usually based on other factors.

It is a well-accepted principle that, for optimal outcomes for both mother and fetus, the mother should be assessed and resuscitated before the fetus.² Some have attempted to determine parameters predictive of increased fetal death risk. Usually, the worse the maternal injury, the higher the fetal risk, as reflected in parameters such as higher injury severity score,⁶⁻⁹ lower Glasgow Coma Scale score,⁸ and presence of disseminated intravascular coagulopathy.⁷ However, fracture severity does not always correlate directly with fetal demise probability, as in 1 of our cases (Table I, case 8), in which minor pelvic fracture (61.A2) was accompanied by neonatal demise. In a case of a severely injured mother in the third trimester, with low chances for survival, a premortem caesarean section should be considered in an attempt to save the

fetus.^{6,10} However, this is not always possible, as was true in our case in which the procedure could not be performed because of the mother's critical condition, and both mother and fetus died (Table I, case 13).

Evaluation and Treatment of the Pelvic Fracture

Very few reports of surgical treatment of pelvic fracture in pregnant women can be found in the literature. Pals and colleagues,¹¹ Dunlop and colleagues,¹² and Yosipovitch and colleagues¹³ all reported on successful ORIF of acetabular fractures during pregnancy. Pape and colleagues³ reported on 3 cases of pregnant patients who were treated surgically, 2 by external fixation and 1 by internal fixation; 2 other patients who needed internal fixation could not be operated on because of coagulopathy in one and fear of radiation overexposure in the other. Speer and Peltier,⁴ in their 1972 review, described the importance of appropriate treatment for pelvic fractures to enable vaginal delivery, but they admitted that most fractures are managed conservatively, and a wide range of anatomical results is acceptable. They cited authors who have opposed any effort to reduce fracture fragments that obstruct the birth canal, owing to the possibility of delivery by performing caesarean section. Since then, surgical skills for the treatment of pelvic fractures, and for intraoperative monitoring of the fetus, have developed significantly. At present, we can treat pelvic fractures during pregnancy with much more confidence and safety.

In our series, we chose the more progressive approach. Four unstable or displaced pelvic or acetabular fractures were treated surgically, 2 during pregnancy. In 1 case (Table I, case 9), conservative treatment for a minimally displaced acetabular fracture was chosen because of pregnancy. In retrospect, the long-term results of posttraumatic degenerative changes in the hip joint cast doubt on our decision. When a fracture is unstable or in an unacceptable position, physicians should consider surgical treatment.

There are considerations in favor of surgical treatment. It can allow for early mobilization, which lowers the complication rate. In cases of significant intra-articular displacement, surgical treatment can prevent posttraumatic degenerative changes. In considerably displaced pelvic fractures, surgical treatment can allow optimal function and preservation of the pelvis and birth canal for current and future deliveries.

There are considerations against performing surgery during pregnancy. Such surgery is usually associated with an increased complication rate.⁵ Another consideration against surgical treatment is concern over causing direct intraoperative injury to the uterus. In some cases, the mother's general condition, affected by other injuries, coagulopathy or hemodynamic instability, does not permit surgical intervention.³

On the basis of our experience in this series, we recommend that care of complex cases adhere to the ATLS scheme but that some modifications be made in various aspects of management.

Management Modifications

Surgery timing. When surgical intervention is considered in a near term pregnancy, there is the possibility of delaying the operation until after the delivery or inducing a preterm delivery.¹⁴ Risk for prematurity should be weighed against the mother's morbidity in cases in which induced labor is considered. In 1 of our patients (Table I, case 10), who was at the later stages of pregnancy, delivery was predated, and the surgical treatment was performed after delivery. In certain cases, the orthopedic surgical procedure can be combined with the obstetric procedure, such as a caesarean section,¹⁵ or with terminating the pregnancy (Table I, case 14).

Radiation use. Use of ionizing radiation in pregnancy is controversial. It is difficult to determine the dose level at which radiation will not produce any adverse effects on the embryo. According to the guidelines for diagnostic imaging during pregnancy, as provided by the American College of Obstetrics and Gynecology, exposure of less than 5 rad has not been associated with an increase in fetal anomalies or pregnancy loss.¹⁶ However, minor adverse effects, such as corneal injury, are not included in this guideline.

We measured the radiation dose to the uterus in common imaging procedures used for treating pelvic fractures (Table II). The radiation absorbed in the uterus is affected by several variables, such as uterine wall thickness and amniotic fluid volume. The values listed in Table II are the highest estimated values for any imaging procedure and can serve as basic guidelines for imaging. The amount of radiation in the common imaging procedure is much lower than what is considered dangerous. Moreover, as the amount of radiation is cumulative, one should calculate the amount of radiation accumulated during the diagnostic imaging procedures to estimate the safe dose of radiation for intraoperative use. When one is performing a CT scan, a protocol (width, number, and position of slices) can be custom-designed for any special case, as was done with 1 of the patients in our series (Figure 7). In 4 of our cases (26.4%), the diagnosis of pelvic fracture was initially missed because we tend to avoid using high-quality x-rays out of fear of radiation overexposure. We emphasize that concern about the negative effects of radiation should not prevent any of us from performing simple diagnostic radiographic procedures when medically indicated.¹⁷

Surgical procedure. When the decision about surgical treatment is made, some modifications may be applied. In

Table II. Maximum Radiation Dose to Uterus, as Measured by Us, for Common Imaging Procedures Used in Diagnosis of Pelvic or Acetabular Fracture

Imaging Procedure	Maximum Radiation Dose (Rad) to Uterus
Pelvic plain x-ray (anteroposterior, Judet, inlet, & outlet views)	0.5
Pelvic/acetabular computed tomography scan (2.5- to 5-mm slices)	0.6
Pelvic fluoroscopy	0.05 rad/s

the case of pelvic fracture, precise anatomical reduction is not mandatory, and there is some leeway regarding final reduction of the fracture in the interest of shortening surgery and reducing radiation exposure as long as the goal of functional outcome is unimpaired. The surgical approach can be adjusted as far away from the uterus as possible. In 1 case (Table I, case 12), we used a posterior approach to the acetabulum instead of the preferred ilioinguinal approach. In the preoperative stage of the procedure, several preparations should be made: Fetal monitoring and other necessary equipment should be placed in reach in the event that an emergency caesarean section must be performed; the mother's abdomen must be protected both posteriorly and anteriorly against radiation; surgical approach and fixation type should be preplanned, as should alternatives for contingencies; and, starting at midpregnancy, the pregnant patient lying supine should have a left lateral tilt, including at surgery (this maximizes cardiac output by reducing uterine pressure on the inferior vena cava and allows optimal venous return).

Drugs and anticoagulation. Opiates for analgesia are safe for use during pregnancy. Nonsteroidal anti-inflammatory drugs are better avoided in the second and third trimesters because of the risk for oligohydramnios caused by reduced flow in the fetal renal vessels and premature closure of the ductus arteriosus.

For pregnant patients with pelvic fracture, several factors contribute to a high risk for thromboembolic disease: trauma, surgery, immobilization, and pregnancy per se. Therefore, prophylactic anticoagulation is recommended unless the patient is still at risk for active bleeding.

SUMMARY

We know of no clear medical guidelines for managing pelvic and acetabular fractures that occur during pregnancy. Our management of 15 of these cases over a considerable number of years provided us with exclusive and valuable experience. On the basis of this experience and the existing literature, we conclude:

1. The basic principles of trauma management apply to injured pregnant women, and therefore maternal resuscitation is the first priority under all conditions. Moreover, maternal condition has been found to be the main determinant of fetal outcome in trauma during pregnancy.

2. It is a commonly accepted principle that the severity of the mother's injury directly affects the fate of the fetus. However, as pelvic fracture is only a single component of the blunt abdominal trauma sustained by the mother, fracture severity does not always correlate with the condition of the fetus.

3. Most cases of pelvic fracture during pregnancy are not complicated and can be treated conservatively with

good results. However, the more complicated cases, which require special consideration, must be recognized immediately and treated promptly.

4. Unsuitable imaging procedures may lead to misdiagnosis. Therefore, good-quality plain anteroposterior pelvic x-rays for the diagnosis of pelvic fracture in the presence of clinical indication should not be withheld at any stage of pregnancy.

5. In this era, when we can perform surgery in pregnant women with more confidence and efficiency, surgical intervention should not be ruled out in cases of unstable pelvic or displaced acetabular fracture. The pros and cons for this treatment should be weighed in each individual case.

6. Evaluation and treatment procedures require modification, including scheduling surgery in relation to time of delivery, prudent but decisive use of radiation, and changes in surgical procedure.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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