TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES

Dissertation submitted to

THE TAMILNADU DR.MGR MEDICAL UNIVERSITYCHENNAI- 600032

In partial fulfilment of the regulations for the award of the degree of

M.S (ORTHOPAEDIC SURGERY)
BRANCH II
Registration Number: 221712301

GOVERNMENT TIRUNELVELI MEDICAL COLLEGE & HOSPITAL

MAY- 2020

CERTIFICATE

This is to certify that this dissertation entitled **"TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES"** is a record of bonafide research work done by **Dr.S.AZARIAH HERBERT**, post graduate student under my guidance and supervision in fulfilment of regulations of The Tamilnadu Dr. M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2017 to 2020, in the Department of Orthopedics, Govt. Tirunelveli Medical College, Tirunelveli,627011.

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DECLARATION

I declare that this dissertation entitled "**TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES" submitted** by me for the degree of M.S., is the record of work carried out by me during the period of **2017 to 2020** under the guidance of **DR. M. PALANI KUMAR, M.S.Ortho.,** Professor and Head of the Department, Department of Orthopaedics, Govt. Tirunelveli Medical College Hospital,Tirunelveli. This dissertation is submitted to **The Tamilnadu Dr.M.G.R. Medical University**, Chennai, in partial fulfilment Of the University regulations for the award of degree of M.S. ORTHOPAEDICS (BRANCH - II) examination to be held in May 2019.

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PROTOCOL TITLE: TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES.
PRINCIPAL INVESTIGATOR: Dr.S.AZARIAH HERBERT., MBBS.,
DESIGNATION OF PRINCIPAL INVESTIGATOR: PG STUDENT
DEPARTMENT & INSTITUTION: TIRUNELVELI MEDICAL COLLEGE, TIRUNELVELI

Dear Dr.S.AZARIAH HERBERT, MBBS, The Tirunelveli Medical College Institutional Ethics Committee (TIREC) reviewed and discussed your application during The IEC meeting held on 27.10.2017.

THE FOLLOWING DOCUMENTS WERE REVIEWED AND APPROVED

1.	TIREC Application Form	☐
2.	Study Protocol	☐
3.	Department Research Committee Approval	☐
4.	Patient Information Document and Consent Form in English and Vernacular Language	☐
5.	Investigator's Brochure	☐
6.	Proposed Methods for Patient Accrual Proposed	☐
7.	Curriculum Vitae of The Principal Investigator	☐
8.	Insurance /Compensation Policy	☐
9.	Investigator's Agreement with Sponsor	☐
10.	Investigator's Undertaking	☐
11.	DCGI/DGFT approval	☐
12.	Clinical Trial Agreement (CTA)	☐
13.	Memorandum of Understanding (MOU)/Material Transfer Agreement (MTA)	☐
14.	Clinical Trials Registry-India (CTRI) Registration	☐

THE PROTOCOL IS APPROVED IN ITS PRESENTED FORM ON THE FOLLOWING CONDITIONS

1. The approval is valid for a period of 2 year/s or duration of project whichever is later
2. The date of commencement of study should be informed
3. A written request should be submitted 3weeks before for renewal / extension of The validity
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   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in The original project. (Page no. Clause no. etc.)
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STANDS APPROVED UNDER SEAL

Dr.K.Shantaraman, MD
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CERTIFICATE - II

This is certify that this dissertation work title **"TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES" of** the candidate **Dr.S.AZARIAH HERBERT**, with registration Number **221712301** for the award of **M.S.** Degree in the branch of **Orthopaedics (II).** I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion page and result shows **3 PERCENTAGE** of plagiarism in the dissertation.

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5993893/
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CONTENTS

INTRODUCTION

Pelvic ring fractures are in the increasing trend due to increase in RTAs. Low velocity injuries usually result in stable fracture patterns. High energy pelvic fractures cause unstable pelvic ring injuries and are usually managed operatively, with the treatment method determined by the degree of pelvic stability. Unstable pelvic injuries are usually associated with sacroiliac disruptions or sacral fractures[24].

A multidisciplinary approach is needed in the management of pelvic fractures[23], Wherein the primary goal is hemodynamic stability. Patients usually presents with associated bladder, bowel and urethral injury. Internal degloving injuries and compound pelvic fractures complicate the treatment[23]. Initial treatment of unstable pelvic injuries involves application of a circumferential pelvic binder or wrapping a bedsheet around the pelvis at the level of greater trochanter. It reduces the pelvic volume, stabilizes the raw surface and produces a tamponade effect[25]. An external fixator can also be applied to the pelvis while allowing access to the abdomen and perineum.[20]

Conservative treatment needs prolonged immobilsation and patient can have chronic pain, sleep loss, decreased mobility and increased dependency.

Main aim of surgical procedure is to provide the patient a stable pelvic ring allowing optimum weight transmission to the limbs. Anatomic reduction of the pelvic ring is very important[23]. Surgical fixation of unstable pelvic injuries provides improved fracture reduction, early weight bearing and mobilization, shorter hospital stays, and superior functional outcomes compared to non-operative treatment. Percutaneous Sacroiliac screw fixation provides a minimally invasive technique which uses either one or two screws under C-arm guidance.

It was first described by Routt and has steadily gained popularity, with advantages of minimal invasion to compromised soft tissue, limited blood loss, and decreased infection rates, compared to conventional open techniques.[24]

The goals of treatment are not only to ensure the survival of patient, but also to achieve optimal anatomical and functional restoration after surgery. Percutaneous sacroiliac screw insertion is a high demanding surgical technique and a detailed three-dimensional anatomic knowledge is required to obtain this kind of a configuration[23]. The anatomical variations in individual pelvic morphology has to be taken in to account before planning for surgery. Radiological evaluation includes the pelvis AP views, Inlet views, Outlet views and High-Resolution CT scan with 3D reconstruction is a must for preoperative evaluation[16].

AIM OF THE STUDY

The aim of the study is to prospectively analyze the functional and radiological outcome of percutaneous sacroiliac screw fixation of pelvic ring injuries in unstable fractures. The study period of this study is from October 2017 to October 2019.

REVIEW OF LITERATURE

HISTORY

French surgeon Joseph-Francois Malgaigne (1806-1865) first described Mechanisms of sacroiliac injuries and pelvic fractures.[1]

Holdsworth in 1948 studied on 50 pelvic fractures and demonstrated the mechanism of pelvic fracture. His studies show association between anatomic reduction and prognosis in form of functional outcome.

Peltier in 1965 studied on 186 patients with pelvic disruptions to give the classification of pelvic injuries based on whether the injury affects the weight bearing area of pelvis or not.

Marvin Tile in 1983 done research on patients with pelvic injury. The classification made by him was based on the stability of pelvis and the direction of the injuring force vector is most commonly followed. The biomechanics, classification and management of pelvic fractures with surgical techniques was explained in his book entitled “fractures of pelvis and acetabulum”.[2]

Edwards et al in 1985 studied 50 patients with unstable pelvic injury treated with external stabilisation. Their study concluded that vertically unstable pelvic injuries cannot be stabilised with anterior external frame.[21]

Kellam et al in 1987 studied 53 patients with unstable pelvic injuries end functional outcome in patients with sacroiliac joint disruption depends on the anatomical reduction of sacroiliac joint and stability of internal fixation.

Initially most of the pelvic fractures are managed conservatively, but due to the advance in the radiographic imaging and three dimensional knowledge in anatomy , percutaneous sacroiliac screw fixation became possible.

ANATOMY OF PELVIS

Pelvis is an irregular bony structure at the base of the spine. It consists of paired hipbones connected in front at the pubic symphysis and behind by the sacrum along with coccyx[2]. Pelvis consists of three bones which include the ilium, the ischium and the pubis.

The ilium is the uppermost and largest part of pelvis, the ischium forms the posterior-inferior part and the pubis forms anterior part.

PELVIC CAVITY:

The pelvic cavity is of two parts:

1. The Greater Pelvis
2. The Lesser Pelvis

THE GREATER PELVIS:

The Greater pelvis also known as false pelvis is the extended portion of pelvic cavity which lies above and in front of the pelvic brim.

THE LESSER PELVIS:

The Lesser pelvis also known as true pelvis lies inferior to pelvic brim. Pelvic outlet is the inferior margin of lesser pelvis.

JOINTS OF PELVIC RING:

1. Symphysis Pubis

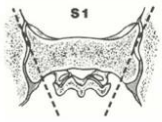
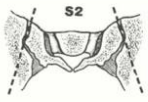
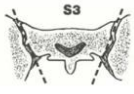
2. Sacroiliac joint

SACROILIAC JOINT:

Sacroiliac joint is the joint between left and right articular surfaces of sacrum with left and right iliac bones respectively. It is formed by direct embryological contact between sacrum and ilium. Due to strong anterior and posterior ligament attachment, there is very little or no movement in the joint. It is of diarthrodial synovial type of joint, comprising of two parts – anterior and posterior.[13]

Anterior part - True synovial joint.

Posterior part – Syndesmosis

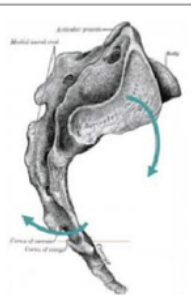
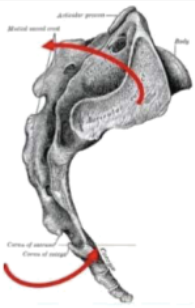
TRANSVERSE SECTION OF SACROILIAC JOINT AT THREE LEVELS SHOWING THE PLANES OF MOVEMENT	
AT THE LEVEL OF **S1**	
AT THE LEVEL OF **S2**	
AT THE LEVEL OF **S3**	

Gradual obliteration and fibrous adhesions of sacroiliac joint occurs in both male and female with incidence earlier in males. Sacroiliac joint may be fibrosed or even ossify in older age group. Obliteration occurs after 50 years of age when it's evident radiologically.[2]

Articular Surfaces:

As we age, the characteristics of sacroiliac joint change. The surface is flat in infants, which is irregular in adults. Curvatures and irregularities of the joint are reciprocal and greater in males. Hyaline cartilage covers the sacral surface of the joint, which is anteriorly thick compared to posterior. Cartilage on iliac surface of the joint is also a hyaline cartilage, but thinner.

The articular surfaces of the sacrum and iliac bones allows little movement inside the joint because of stabilising action by the strong ligaments of the joint. They are said to move anterior and lateral, and the movements of the iliac bones are referred as nutation and counternutation.[13]

Nutation: iliac bones move posterior and medial, resulting in decrease of distance between two ASIS.	
Counternutation: the iliac bones move anterior and lateral, resulting in increase of distance between two ASIS.	

INNERVATION:

Anterior: Lumbosacral plexus

Posterior: Medial branches of L4, L5 and lateral branches S1 to S4

Hyaline cartilage covering the sacral surface and fibro cartilage covering the surface of ilium acts as dual wedge in axial and anteroposterior directions. This serves an important aspect in transmitting weight to lower limbs.[2]

LIGAMENTS:[11]

Ligaments of sacroiliac joint are divided into superficial and deep ligaments.

SUPERFICIAL LIGAMENTS

These are further divided into anterior and posterior sacroiliac ligaments.

Anterior Sacroiliac ligaments:

These consists of numerous thin, flat, strong bands composed of oblique and transverse fibres. They connect the anterior surface of lateral part of sacrum to margin of auricular surface of ilium, which is adjacent to sacrum. These are capsular and the first ones to get disrupted in a pelvic injury.

Posterior Sacroiliac ligaments:

Has two different bands

1. Oblique Fibres: constitute short posterior sacroiliac ligament runs from the tubercle of sacrum to posterior inferior iliac spine. Also known as Bichat's sacrospinous ligament.

2. Longitudinal fibres: constitutes long posterior sacroiliac ligament which runs from lateral surface of sacrum to posterior superior iliac spine.

DEEP LIGAMENT

Interosseous sacroiliac ligament:

It is the strongest ligament of the body, connecting the sacral tuberosities and ilium.

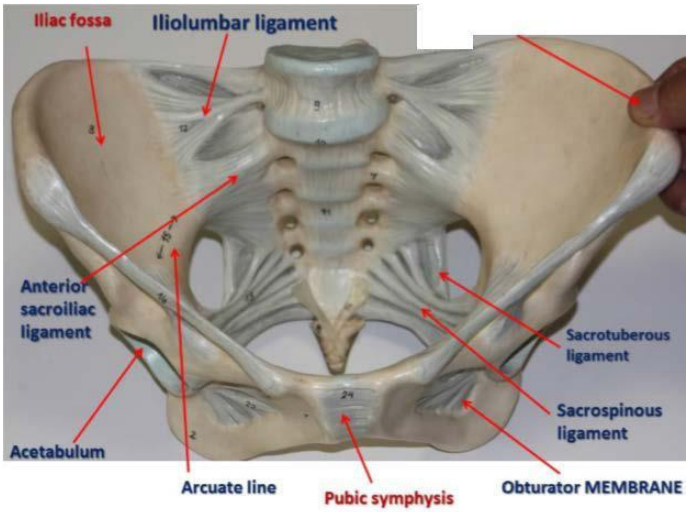
CONNECTING LIGAMENTS

Sacrotuberous ligament:

This is also a strong, broad band ligament which extends from the posterior surface of posterior superior iliac spine and posterior inferior iliac spine and dorsum of lateral border of sacrum, connecting to ischial tuberosity.

Sacrospinous ligament:

This is a triangular strong ligament, which stretches between the lateral border of sacrum and coccyx to ischial spine. This converts two notches to two foramens.

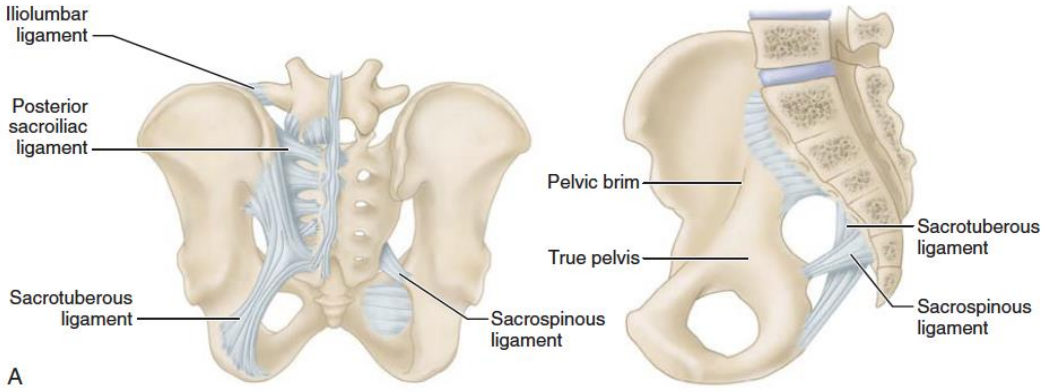


Iliolumbar Ligament:

Iliolumbar ligament covers the quadratus lumborum and attaches the tip of transverse process of fifth lumbar vertebra to the iliac crest bilaterally.

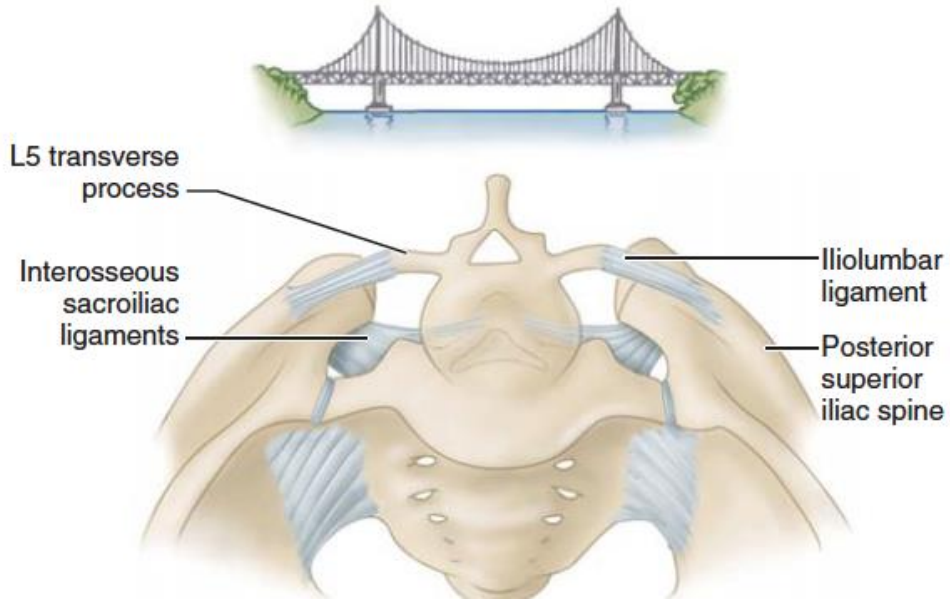
Lateral Lumbosacral Ligament:

This ligament extends downward from transverse process of L5 to ala of the sacrum.



SACROILIAC COMPLEX

The posterior part of sacroiliac complex transfers weight bearing forces to lower down from spine. Ligaments acts as posterior stabilizers. The posterior sacroiliac interosseous ligaments, which are the strongest in the body, maintains sacrum in normal ring position along with iliolumbar ligaments and enhance the suspensory mechanism. The anterior sacroiliac ligaments also resist external rotation and shearing forces, but not as powerful as posterior ligaments. The whole complex appears and acts as suspension bridge as said by Tiles.[16]



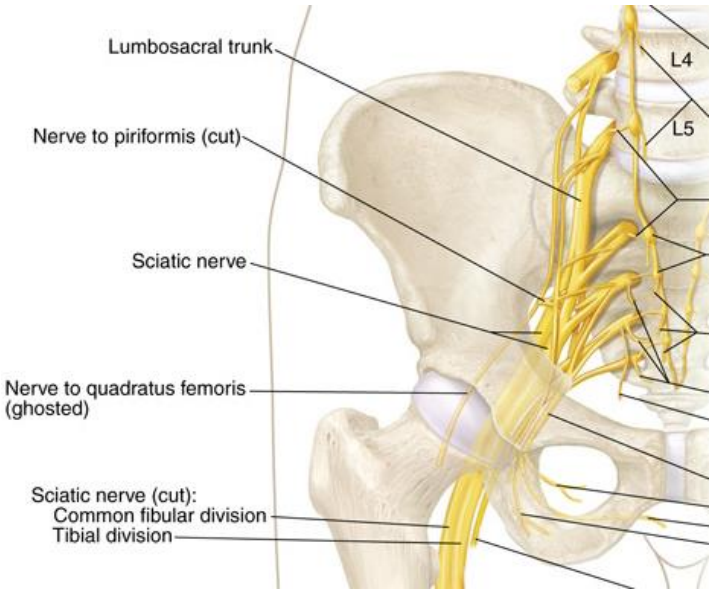
PELVIC FLOOR

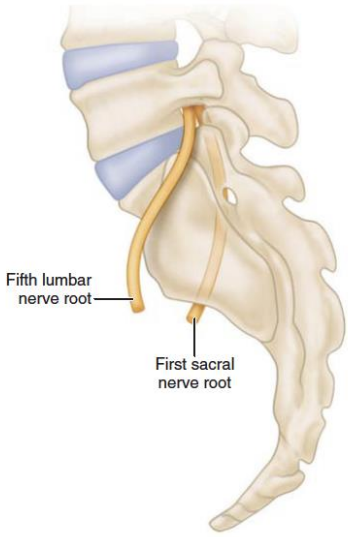
Part of pelvis floor is formed mainly by two main ligaments- sacrospinous and sacrotuberous ligament. The sacrospinous ligament plays an important role in preventing the external rotation of pelvis, because the fibers of sacrospinous ligament runs transversely from lateral border of sacrum to ischial spine. The sacrotuberous ligament lies posterior to sacrospinous ligament and its fibers arises from sacroiliac complex and extends to ischial tuberosity. This plays an important role in resisting vertical shear forces applied to hemipelvis. Hence these two ligaments oriented at 90 degrees to each other and resists major forces which acts on pelvis and prevents injury.[13]

STRUCTURES AT RISK DURING DISRUPTION OF PELVIC RING

NERVE PLEXUS

Anterior rami of T12 to S4 forms lumbosacral nerve plexus and coccygeal nerve plexus. Nerve roots of S1 to S4 and L4 to L5 are at risk of injury during disruption since it lies anterior to sacroiliac joint. L4 and L5 are also risk of injury during percutaneous fixation of SI joint because L5 crosses ala of sacrum and L4 transverses the transverse process of L5.[2,13]





VASCULAR ANATOMY[2]

It is very important to know the vascular structures present in the pelvis because massive hemorrhage being the most important cause of mortality in injuries of pelvis and pelvic surgeries.

Median Sacral Artery

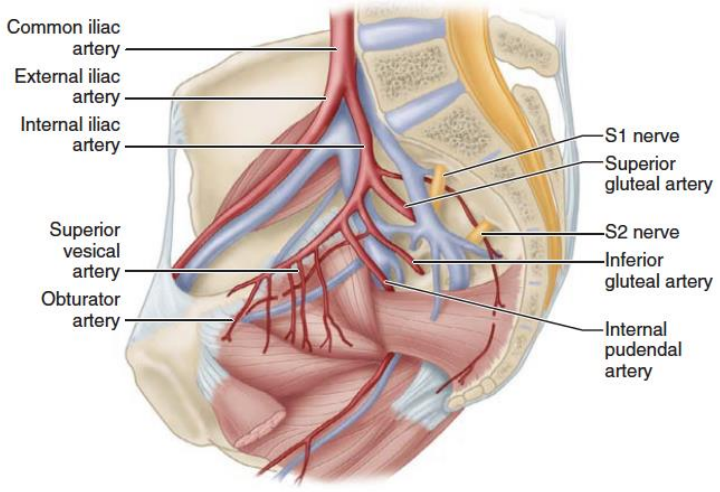
It's a direct branch of aorta and can be injured in sacroiliac joint disruptions.

The Internal Iliac Artery

It is a branch of common iliac artery. Both common and internal iliac are at risk during disruption of sacroiliac joint. Internal iliac artery at the level of pelvic brim further divides into anterior and posterior divisions. Superior gluteal, iliolumbar and lateral sacral arteries which are the branches of posterior division of internal iliac are also at risk of injury.[2]

PELVIC VEINS

Pelvic veins have thin wall and hence bleeding can occur easily.



VISCERAL ORGANS

Most common viscera to be injured are gastrointestinal tract, urinary bladder and urethra.

URINARY BLADDER

Bony spikes of fracture ends can cause injury of bladder particularly when its full and it also happens in pubic rami fractures. Rupture of urinary bladder occurs extraperitoneally.[9]

URETHRA

Membranous and bulbar portion of the urethra are most commonly injured.

GASTROINTESTINAL TRACT

Lower part of gastrointestinal tract – sigmoid colon, rectum and anus are mostly involved in case of compound pelvic fractures and it is associated with increased risk of sepsis and hence mortality.

BIOMECHANICS OF PELVIC RING[7,8]

Pelvic ring along with the pelvic ligaments play an important role in the stability of the pelvic ring.

Pelvic stability is maintained mainly due to posterior sacroiliac complex which has a network of ligaments which are responsible for transference of weight of the body from spine to lower limbs and prevents posterior displacement.

Anterior sacroiliac ligaments maintain the stability of pelvic ring from shearing forces and during external rotation.

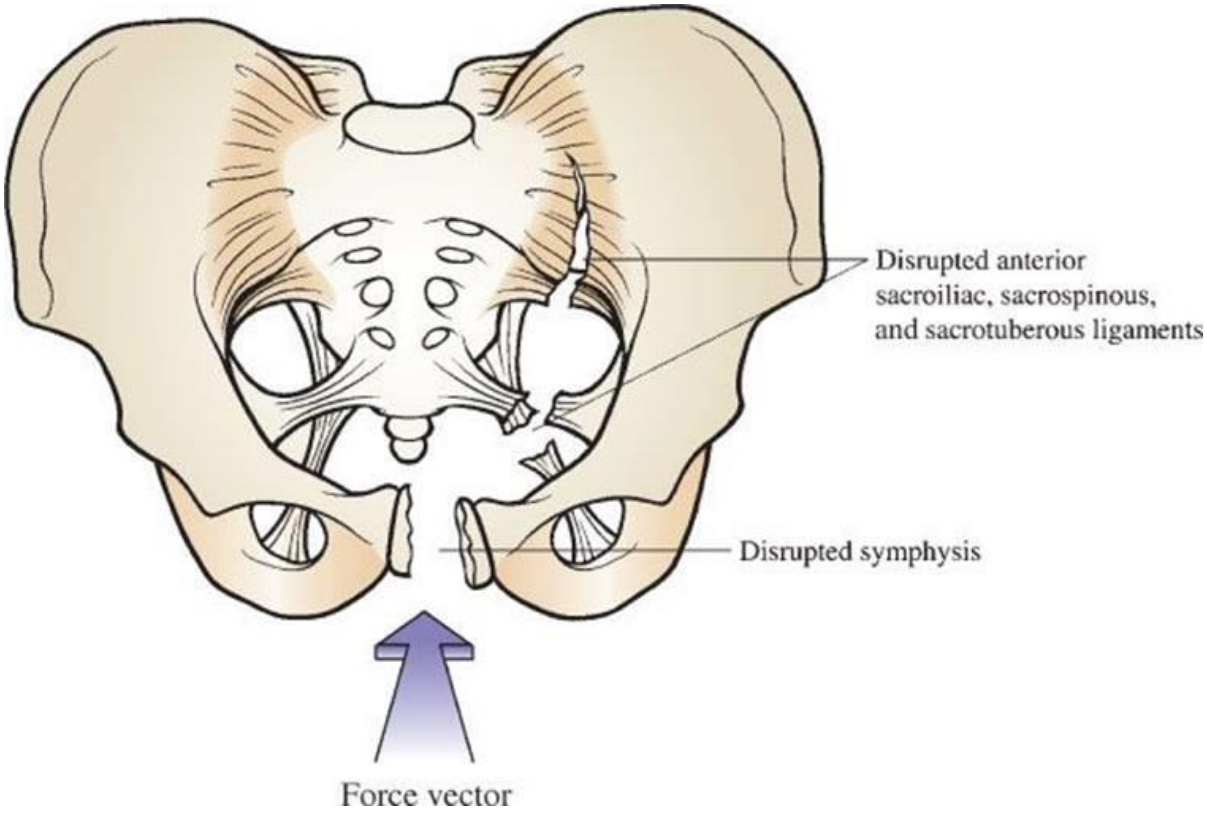
Pubic symphysis prevents anterior collapse of weight bearing and also resists external rotation. Sacrotuberous ligament prevents vertical displacement because of its vertical alignment and external rotation is prevented with the help of sacrospinous ligament because of its horizontal alignment.

CONCEPT OF SACROILIAC STABILITY

The energy of the insult or force is directly proportional to the degree of pelvic instability and the pelvic injuries are broadly classified as stable, partially unstable or completely unstable.

STUDIES ON BIOMECHANICS OF SACROILIAC JOINT

During 1961, Pennal said that the disruption of pubic symphyseal ligament alone can cause a pelvic opening of 2.5 cm and further opening occurs on disruption of posterior sacroiliac ligament. On cutting of anterior sacroiliac ligament, pelvis will open like a book. Division of posterior sacroiliac ligament causes translations. These ligaments merges with the hyaline cartilage both anteriorly and posteriorly which are further strengthened by fibrocartilage and fibrous tissue bonding.[12]



Understanding the Injury

To understand the management of the injury, knowledge of pelvic biomechanics is crucial. Pelvis is a ring structure with the sacrum in center and two innominate bones on either side. Stability of the ring is maintained mainly by the ligaments and soft tissues surrounding it because of the lack of inherent stability between the bony structures. Hence the stabilizers are posterior sacroiliac complex rather than anterior structures (though they contribute 40% for the integrity of the ring), pubic symphysis and pelvic floor.[14,12]

Ring Structure of the Pelvis

Human pelvis is a true ring structure and hence break or displacement of one side can cause fracture or dislocation of the other side too. This is noted by Gertzbein and Chenoweth in 1977 by polyphosphate bone scan done for cases of undisplaced anterior pelvic fractures showed positive reading in posterior sacroiliac complex indicating posterior lesion. This is again confirmed by Bucholz in 1981 when autopsy of patients with pelvis trauma revealed posterior lesions though radiography showed only anterior lesions.[13]

Anatomical lesion

The lesion of posterior part of sacroiliac complex may be either fracture of ilium in coronal plane or fracture of the sacrum alone or dislocation or fracture-dislocation of sacroiliac joint. On radiograph, lesion of displacement of posterior sacroiliac complex can be seen as posterior displacement of sacro-gluteal line, which can also be confirmed by computed tomography scan. So, the posterior lesions may present either undisplaced and have intact posterior ligaments or may be displaced and present with rupture of ligaments.

Stability of Pelvis

Although surgical management is the treatment course of any anatomical disruption of pelvis, stability of pelvis is important in overall decision making. Pelvic joint stability is defined as ability of the pelvis to withstand any physiological forces without any significant displacement. So, it is obvious that the pelvic stability depends both on bony structures (two innominate bones and sacrum) and ligamentous attachments which binds the bones together.[19]

Classification of pelvic injuries based on stability

Type A - stable fractures

Type B - partially stable fractures

Type C – unstable fractures

The pelvic ring stability depends upon the integrity of pelvic floor with posterior sacroiliac complex of ligaments mainly sacroiliac, sacrospinous and sacrotuberous ligaments.[2]

TYPES OF FORCES CAUSING PELVIS INJURY[23]

Pattern of pelvic fracture depends upon the direction of force applied. Four types of forces are:

1. Lateral compression or internal rotation (LC)

2. Anterior-posterior compression or external rotation (APC)

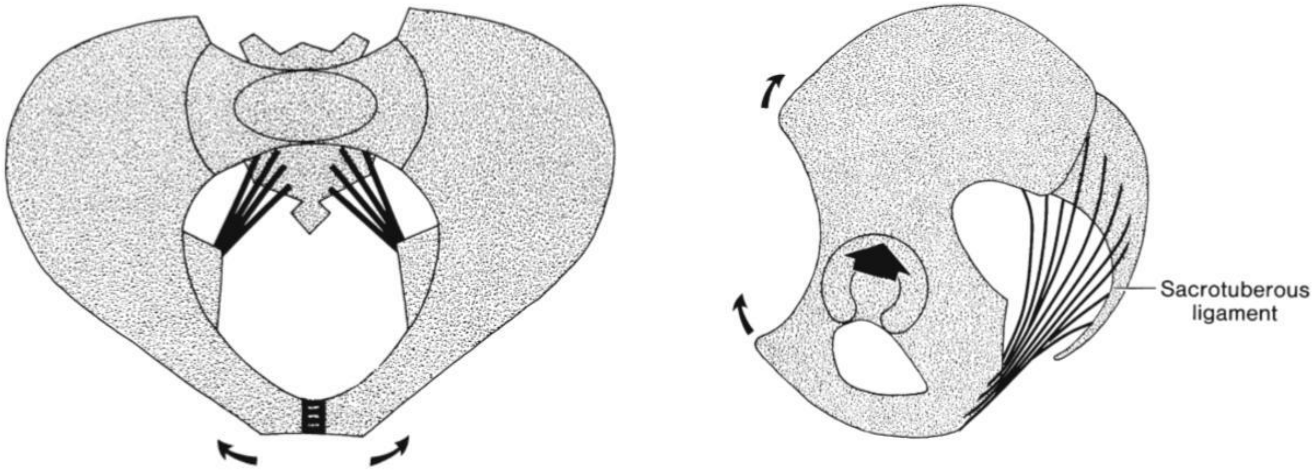
3. Vertical shear injuries (VS)

4. Combined mechanical injuries (CM)

LIGAMENTS AND ITS CONTRIBUTION DURING FORCES

Sacrospinous ligaments joining the sacrum and ischial spines resist external rotatory forces.

Sacrotuberous ligament joining the sacrum and ischial tuberosity resist rotatory shearing forces.



LATERAL COMPRESSION (LC)[23]

Lateral compressive force acts directly on iliac crest and causes internal rotation of hemipelvis, crushes anterior part of sacrum and displaces anterior pubic rami. It can also act directly on greater trochanter and fractures the pubic rami through anterior column of acetabulam. Ipsilateral sacroiliac complex can also be crushed in this type of injury. Pelvis collapses in midline mainly due to involvement of posterior sacroiliac complex. Posterior sacroiliac complex injuries may be either impacted sacral fracture with intact posterior complex or crushed anterior sacrum with ruptured posterior complex or impacted sacroiliac joint with ruptured posterior complex.

ANTEROPOSTERIOR COMPRESSION (APC) [23]

Anteroposterior compression causes open pelvic fracture. Further divided into two types of forces.

Direct force – Anterior and posterior direct forces acts on anterior superior iliac spine and posterior superior iliac spine respectively.

Indirect force – causes external rotation of femur.

VERTICAL SHEAR (VS)

This force acts right angle to main trabecular pattern and results in highly unstable pelvis with complex ligamentous disruption called as traumatic hemipelvectomy. [23]

COMBINED MECHANICAL INJURIES (CM)

When both compression and shearing forces are combined, it results in both unstable anterior and posterior lesions. [23]

Effect of forces on viscera and soft tissue

Lateral compression causes damage to urinary bladder or urethra. When there is compression of sacrum, it results in sacral nerve root injury. Vertical shear injury causes avulsion of vessels due to violent traction.

CLASSIFICATION

Classification is utmost important because it aids in the proper management of injuries.

Historical considerations

First classification system for pelvic fractures was described by French Surgeon Joseph Francois Malgaigne in 19th century. Classification by Pennal and Sutherland (1961) are based on major force vectors.

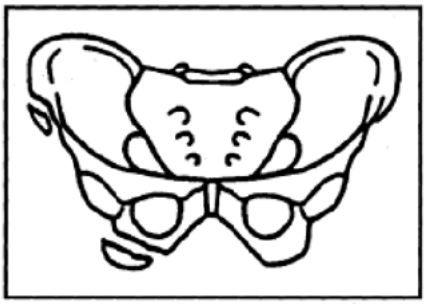
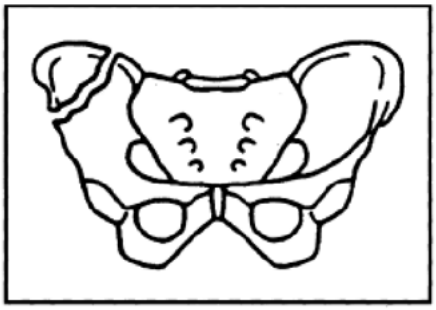
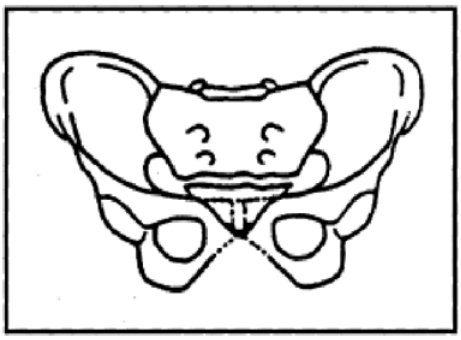
The Young – Burgees classification is almost same as Pennal's along with addition of complex group[23]. Later in 1988, Tile put forth a classification, which is a modified version of Pennal's classification in addition of stability of pelvis along with force vector. Modified Tile's classification is now followed worldwide and adopted by AO working group.[2]

AO comprehensive classification[22]

Categorized into types A, B and C, based on increasing severity and resulting instability of pelvis.

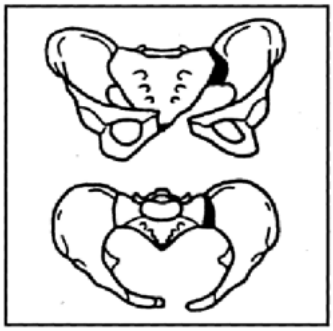
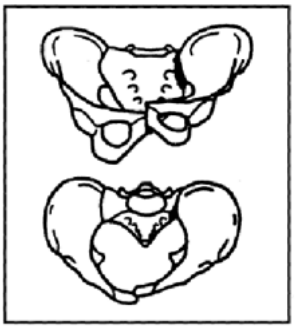
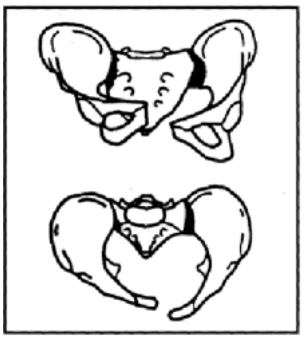
TYPE A:

Type A fractures are stable ones with no major instability of posterior ring of pelvis. Further divided into A1, A2 and A3.

A1 – Avulsion Fracture: these are avulsion fractures only and doesn't involve pelvis ring, hence it is stable. Involves mostly adolescent age group.	
A2 – stable iliac wing fracture or minimally displaced pelvic ring fracture. In this type, either iliac wing or anterior arch is involved without any posterior injury.	
A3 – these are transverse fractures of sacrum and coccyx and can be considered as spinal injuries.	

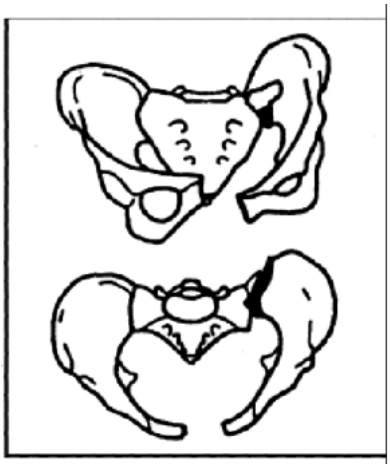
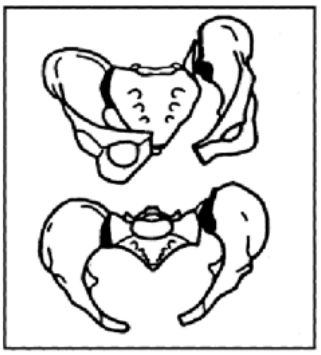
TYPE B PARTIALLY STABLE

These types of fracture are vertically and posteriorly stable and unstable during rotation.

B1 – open book fracture of pelvis or external rotational instability. Disruption of pubic symphysis, avulsion fracture of pubis near symphysis, pubic rami fracture, symphysis avulsion or disruption can occur.	
B2 – lateral compression causing internal rotational instability. B2-1: ipsilateral anterior and posterior injuries B2-2: contralateral anterior and posterior injuries (bucket handle type)	
B3 – bilateral injuries of type B	

TYPE C UNSTABLE

These type of injury results in complete posterior sacroiliac complex disruption mainly due to vertical shear forces.

C1 UNILATERAL C1-1: fracture of ilium C1-2: dislocation or fracture dislocation of sacroiliac joint. C1-2a1: anterior dislocation of sacroiliac joint with posterior iliac fracture C1-2a2: pure sacroiliac joint dislocation C1-2a3: sacroiliac dislocation with sacral fracture C1-3: fracture of sacrum	
C2- bilateral with type B injuries on one side and type C on other side	
C3: bilateral with type C injuries on both sides C3 VARIANT: bilateral sacroiliac dislocation with intact anterior arch.	

TILE CLASSIFICATION[2]

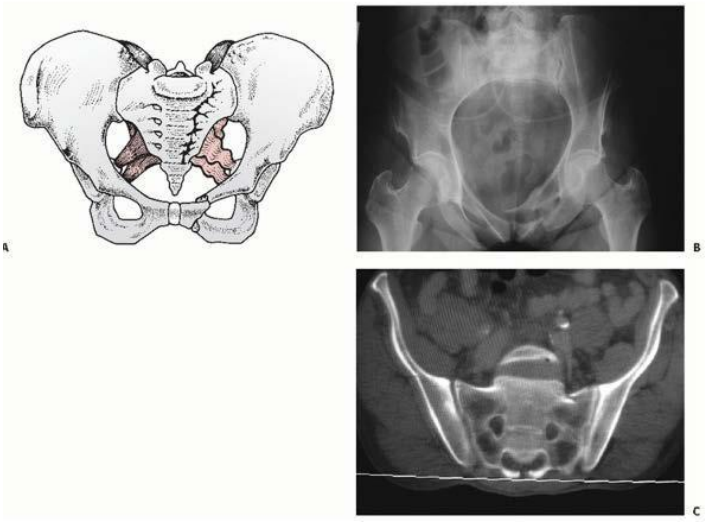
TYPE A: Pelvic ring stable
A1: Fractures doesnot involve the pelvic ring eg: avulsions, iliac wing or crest fractures.
A2: stable, very minimally displaced pelvic ring fractures. **A3:** transverse sacrococcygeal fracture
TYPE B: vertically stable due to incomplete disruption of posterior arch and rotationally unstable
B1: Open book injury of pelvis (external rotation)
B2: Lateral compression injury (internal rotation) B2-1: Ipsilateral injuries both anterior and posterior B2-2: Contralateral injuries or bucket handle injuries
B3: Bilateral injuries
TYPE C: Both rotationally and vertically unstable pelvic ring
C1: unilateral C1-1: iliac fracture C1-2: fracture dislocation of sacroiliac joint C1-3: sacral fracture
C2: Bilateral with type B fractures on one side and type C fractures on one side
C3: Associated acetabular fracture

YOUNG AND BURGESS CLASSIFICATION:

LATERAL COMPRESSION: Anterior injury = rami fractures	LC I	Sacral fracture on side of impact
	LC II	Crescent fracture on side of impact
	LC III	Type I or II injury on side of impact with contralateral open book injury
Antero Posterior compression (APC): anterior injury = symphysis diastasis/rami fractures	APC I	Minor opening of symphysis and SI joint anteriorly
	APC II	Opening of anterior SI, intact posterior SI ligaments
	APC III	Complete disruption of SI joint
VERTICAL SHEAR	VS	Vertical displacement of hemipelvis with symphysis diastasis or rami fractures anteriorly, iliac wing, sacral facture, or SI dislocation posteriorly
COMBINED MECHANISM	CM	Any combination of above injuries

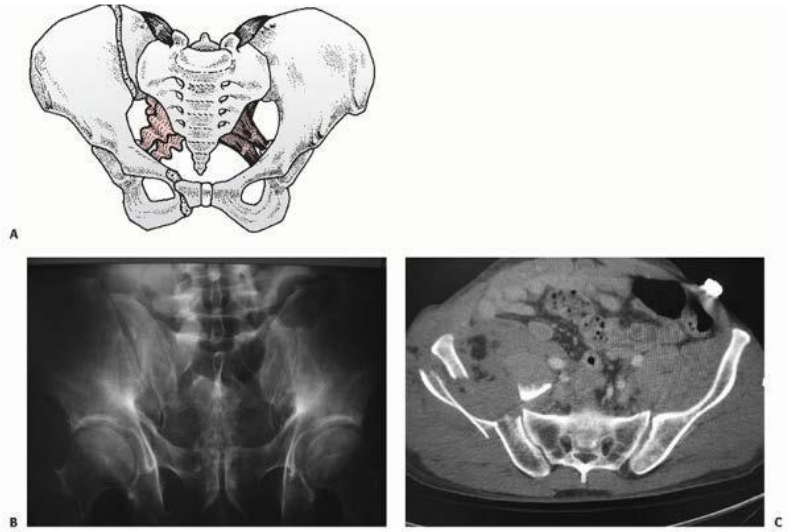
Lateral Compression Injury:[23]

Typical LC 1 injury with rami fractures anteriorly and sacral impaction fracture posteriorly.

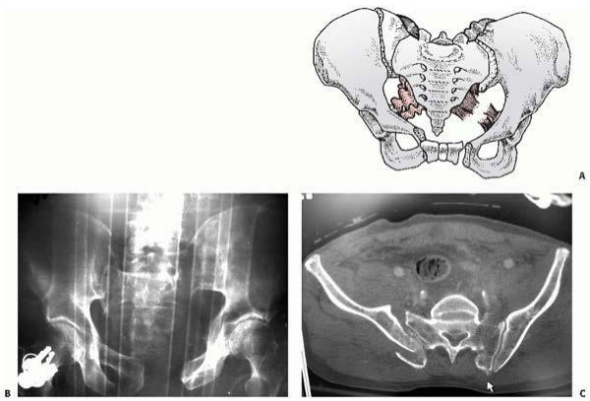


AP radiograph shows “locked symphysis” which is less commonly associated with LC 1 injury.

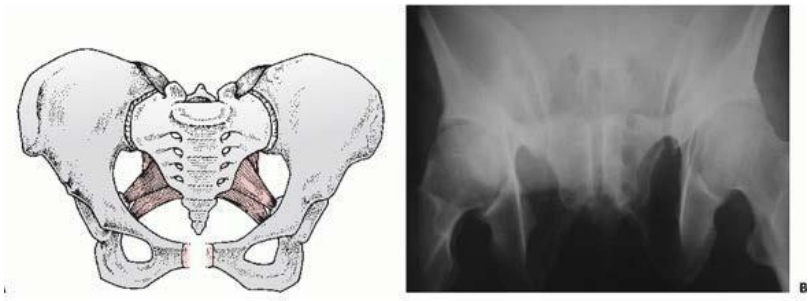
LC 2 injury associated with iliac wing fracture.



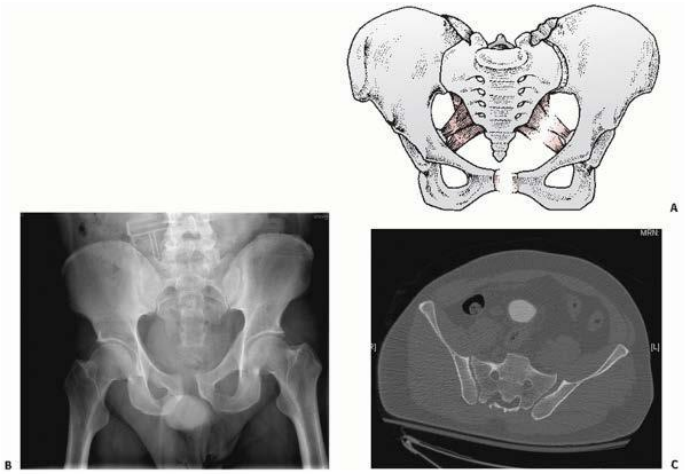
LC 3 INJURY



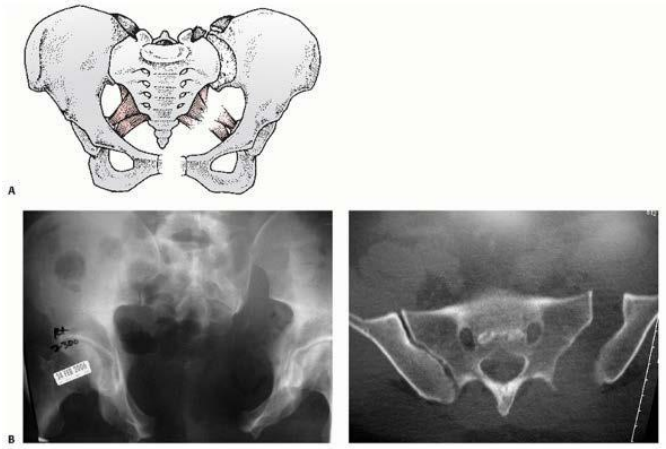
APC TYPE 1



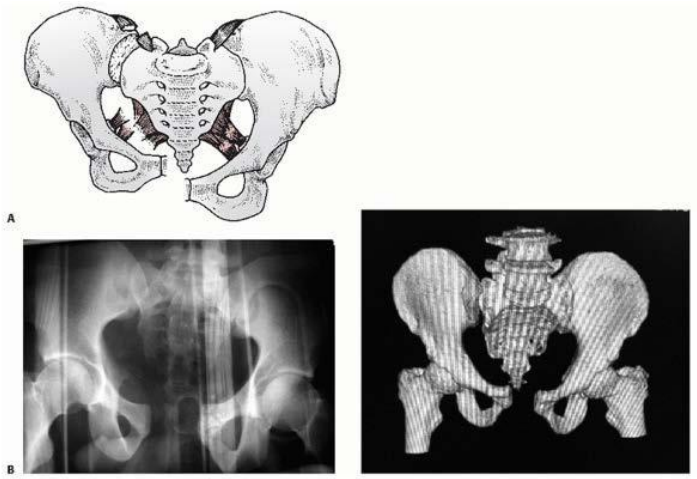
APC TYPE 2



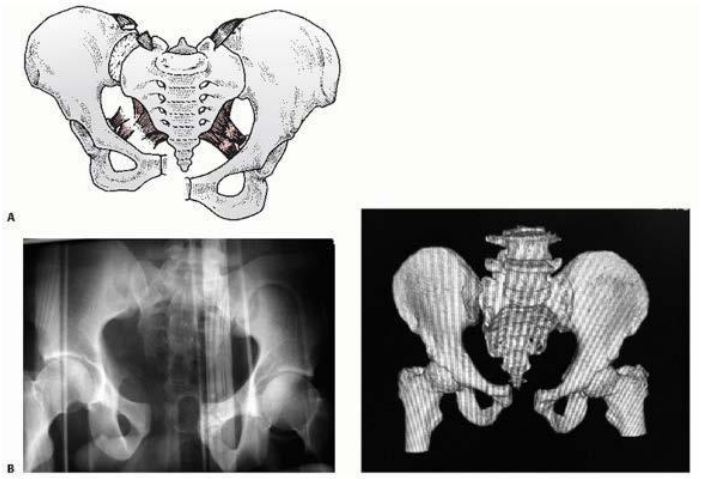
APC TYPE 3



VERTICAL SHEAR TYPE



COMBINED MECHANICAL INJURY



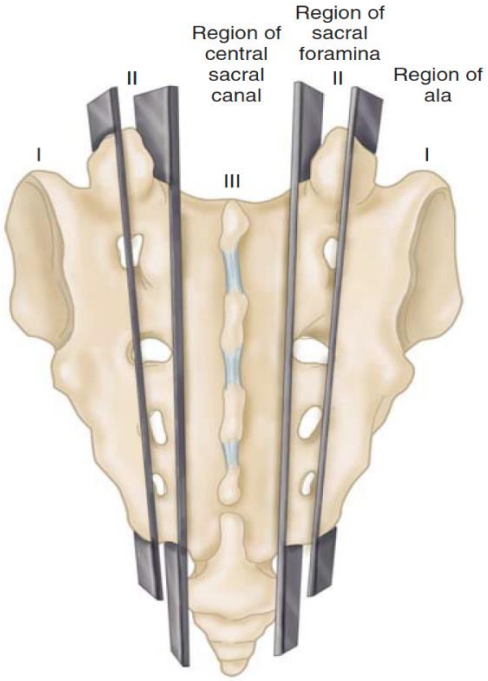
Jones classification of Open Pelvic Fractures:[19]

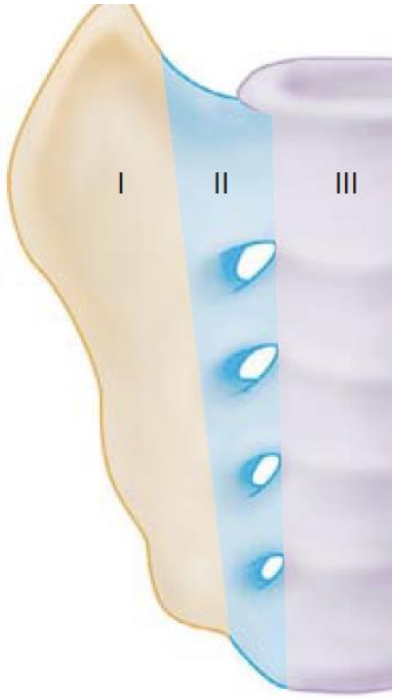
This particular classification deals with pelvic ring stability and rectal injury. It is distinctly categorized based on retrospective multicenter analysis

CLASS 1	Open pelvic ring fractures which are stable (very low mortality)
CLASS 2	Open pelvic ring fractures which are unstable and without any rectal injury (33% mortality)
CLASS 3	Unstable open pelvic ring fractures with rectal injury (50% mortality)

CLASSIFICATION FOR SACRAL FRACTURES

DENIS CLASSIFICATION[26]





ZONE	Fracture pattern
Zone 1	Fracture lateral to foramina Most common type
Zone 2	Fracture through the foramina Fractures with shear component highly unstable
Zone 3	Fracture medial to foramina Highest rate of neurological deficit

CLINICAL AND RADIOLOGICAL ASSESSMENT

A polytrauma patient with a pelvic fracture possess therapeutic challenge for operating surgeon since mortality is 10% and it can vary upto 31% in unstable pelvic injury[25] (according to Pohlemann and Tscherne). These patients must be given immediate and appropriate treatment in an intensive care unit from the time of injury until they are stabilized appropriately. Management is based on simultaneous approach rather than sequential approach.[23]

Primary survey:

Primary survey deals with airway problems, any bleeding which can cause hypovolemic shock and involvement of central nervous system like head injury has top importance. First, immediate lifesaving approaches in regard to airway and circulation to be ensured. Shock maybe profound in a case of pelvic injury because of retroperitoneal haemorrhage.[23]

Secondary survey:

Secondary survey deals with further detail examination of airway, breathing, circulation, examination of central nervous system, digestive system, excretory system and other skeletal injuries.[23]

Specific Musculoskeletal Assessment:

Assessment of musculoskeletal injury is focused in determination of pelvic ring stability.

Clinical assessment

Proper history of the incident leading to the trauma is important because high energy injury like fall from height or motor cycle accident are likely to result in unstable pelvic ring injury than low energy trauma. Physical examination is also important in determining the stability of pelvis as important as radiographs.[23,25]

Inspection

Proper inspection of all external injuries like abrasions, contusions and wounds to be made. Look for any major bruises or continuous bleeding from urethral, vaginal orifices and rectum. Inspect the pelvic symmetry and also look for any limb length discrepancy[8]. Undress the patient fully before inspection of pelvic injuries. Any limb shortening or rotatory deformities in absence of lower extremity fractures implies pelvic injury. [5]

Palpation

Palpation to be done under anaesthesia. Pubic symphysis examination, compression and distraction tests, bitrochanteric compression with SI joint, pelvic traction test and pelvic stability test along with vaginal examination are to be done. Any crepitus or abnormal motion on direct palpatory examination of iliac crest indicates pelvic instability. [5,8]

Open book pelvis injuries result in maximal external rotation and these can be reduced by applying compression on both anterior iliac spines. Lateral compression injuries regain anatomical position unless and until it is impacted inside. Further internal rotation by compression of iliac crest may result in displacement of fracture, which imposes risk of further injuries.[2]

Hence, assessment of displacement of fracture is must while applying traction, which can be done by two examiners. One examiner to palpate iliac crest and another one should apply traction to the leg. By this way, displacement in vertical plane can be assessed. These are done under image intensification to check the displacement personality and to check whether vertical displacement is present.[2,5]

RADIOLOGICAL ASSESSMENT

ANTEROPOSTERIOR VIEW

On directing the xray beam at right angle to midpelvis, both anterior and posterior injuries can be figured out. This view can also show avulsion of L5 transverse process and avulsion of sacrospinous ligament, if present.

INLET VIEW

Position of the patient to be in supine position and beam is directed at 25 degrees to midpelvis.[26] This view can also the following injuries:

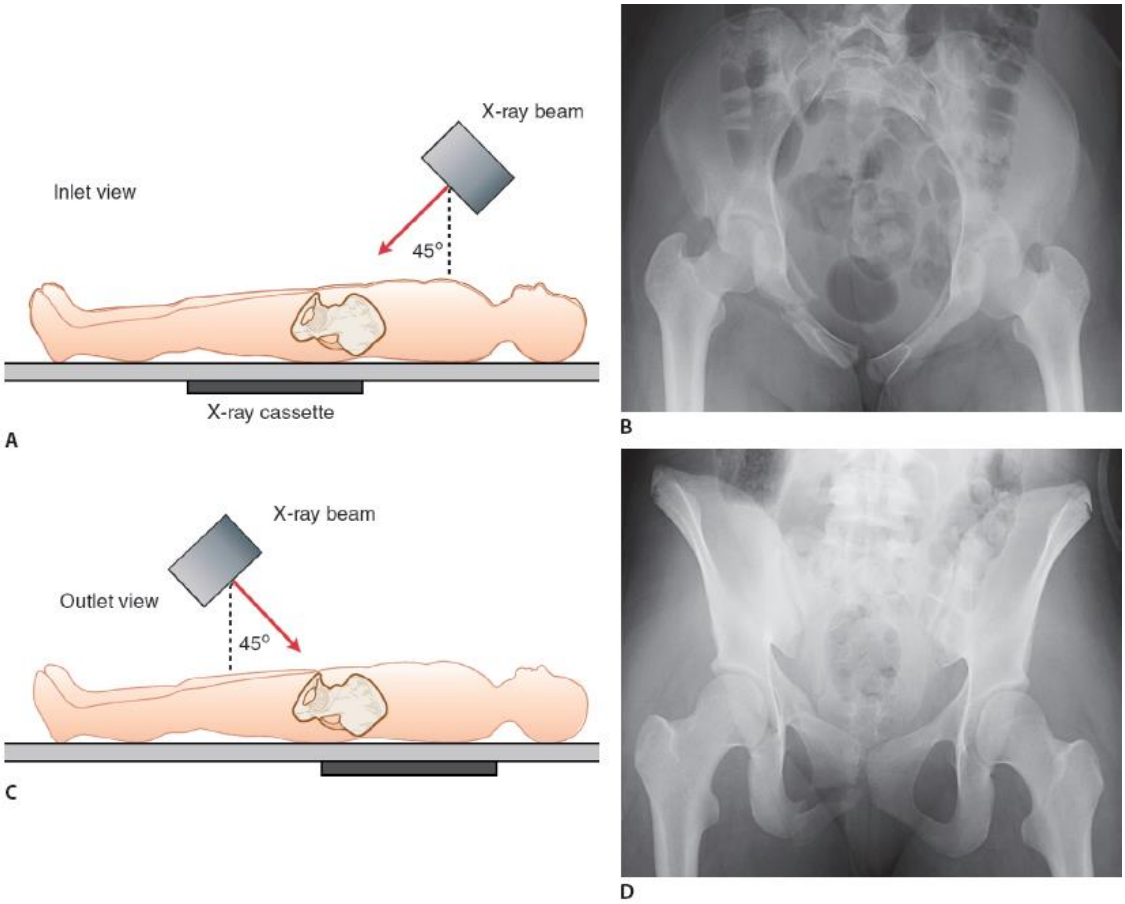
a. Anterior or posterior pelvic ring displacement

b. Fracture of sacrum

c. Severity and degree of rotation of hemipelvis

d. Widening of pubic symphysis

e. Widening of sacroiliac joint



OUTLET VIEW

Patient to be in supine position and beam is directed 45 degrees from the foot to detector[26]. Following injuries are best seen in this view:

a. Fracture of sacrum

b. Pubic rami fractures

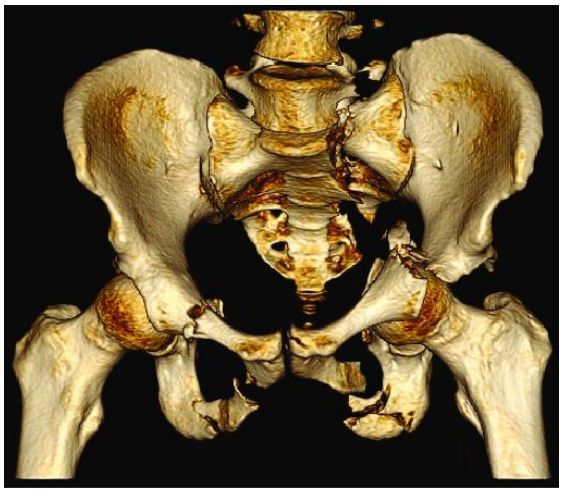
c. Superior or inferior pelvic ring displacement

d. Posterior iliac wing

e. Sacroiliac joint widening

COMPUTED TOMOGRAPHY

CT is very helpful in assessing the stability of pelvis and also helps in preoperative planning. Distinction between unstable and stable sides are also assessed by three-dimensional reconstruction.[7]



ASSOCIATED INTRAPELVIC INJURIES

ANGIOGRAPHY

Angiography has both diagnostic and therapeutic values. Therapeutic uses include embolization in regards to haemodynamic stabilization, when external measures are not useful in haemorrhage control and in corona mortis injuries.[1]

MANAGEMENT PROTOCOL

GENERAL ASSESSMENT

On general assessment, Advanced Trauma Life Support Protocol must be followed for resuscitation purposes and in skeletal injury diagnosis.[1]

INITIAL MANAGEMENT

PELVIC DAMAGE CONTROL

- Closed reduction should be done in trauma ward
- External fixation:[20]
    - Either with pelvic binder or sheets, pelvis should be wrapped at the level of greater trochanter with knee flexion and internal rotation of limb.
    - External fixation by iliac crest or supraacetabular fixation
    - Pelvic C clamp
    - Pneumatic antishock garments
    - Necrotic tissue debridement
    - Repair of rectal or genitourinary injuries for infection control

MANAGEMENT PROTOCOL FOR A PATIENT WITH SUSPECTED PELVIC INJURY

DECISION MAKING

Four types of Injury can occur:[22]

1. haemodynamically stable with stable sacroiliac injury
2. haemodynamically unstable with stable sacroiliac injury
3. haemodynamically stable with unstable sacroiliac injury
4. haemodynamically unstable and unstable sacroiliac injury

As of first, always stabilize the patient haemodynamically before assessing the skeletal injuries.

Patients who are both haemodynamically unstable with unstable pelvic injuries must be resuscitated aggressively. Pelvic binder with upper tibial pin traction can be done initially, if needed embolization can also be done.[1]

APPLICATION OF EXTERNAL FIXATION

Anterior external fixators (with or without skeletal traction)

1. supra acetabular external fixation (lower way)
2. iliac crest fixation (upper way – Slatis)

Posterior external fixators (with or without skeletal traction)

1. C-Clamp

Anterior external fixation through iliac wings (upper way or anterosuperior technique)[20]

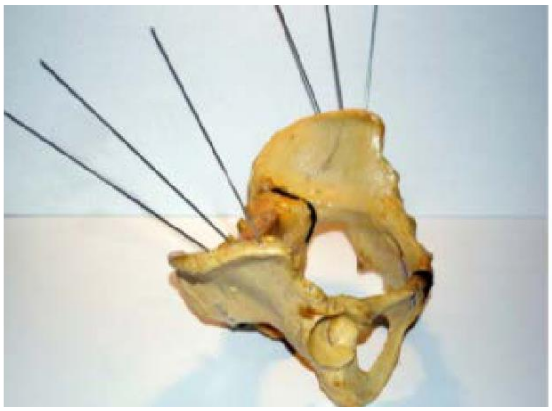
Pins of 5mm diameter are used (4 to 6)

Entry hole for half pins are on the borderline between middle and internal one third of bone width

Pins are placed 1cm apart

Pins are angulated at 45 degrees

K wire is inserted along the internal and external iliac cortex, so as to give the direction of insertion.



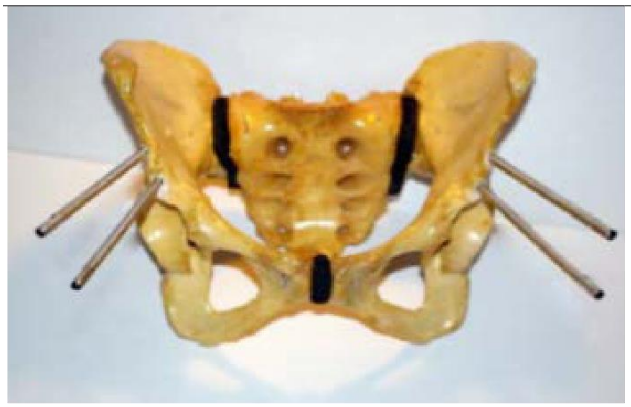
Supra acetabular exterior fixation (lower way or anterior or anteroinferior technique)[20,26]

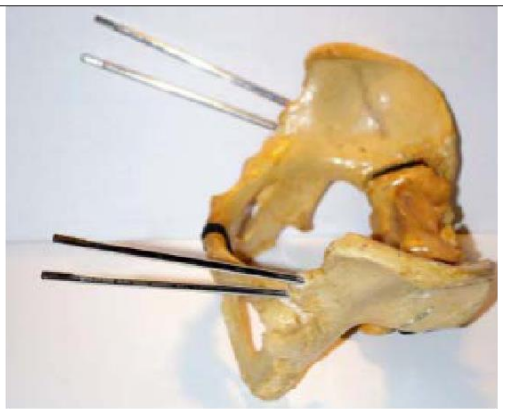
In this, SI joint is fixed above acetabulam, because it is solid and ensures tight grip of the pin. This fixator gives better result than others like 'upperway' in stability of SI joint according to Biomechancial studies.

Risks could be:

a. penetration of pin into hip joint

b. neurovascular structure present in great incisure's region are prone to injury





Advantages:

a. Ensures tighter spongiosis by firm pin anchorage to bone

b. Pins used are of greater diameter (6 mm)

c. Bone is fixed with greater insertion depth

d. Even weight distribution over SI joints

e. Stability is greater in posterior pelvic ring

f. Low risk of infection

g. Any abdominal operative scan can be freely done

C-clamp (posterior exterior fixation)

- According to Biomechanical studies, C-Clamp produces better fixation than other pelvic fixators.
    - Hemostasis is achieved effectively because of compressing the fracture surfaces
    - Also known as self-tamponade
    - Vital signs are seen immediately improved after C-Clamp application

ILIAC CREST FIXATION:

PREPARATION:

Patient placed in supine position with area anterior ilium exposed from umbilicus to groin.

REDUCTION:

- Manual reduction with compression at trochanter level
- Pelvis is tied with a twisted towel to help in compression and reduction of diastasis

- Supra acetabular pin and traction are used to reduce vetical displacement

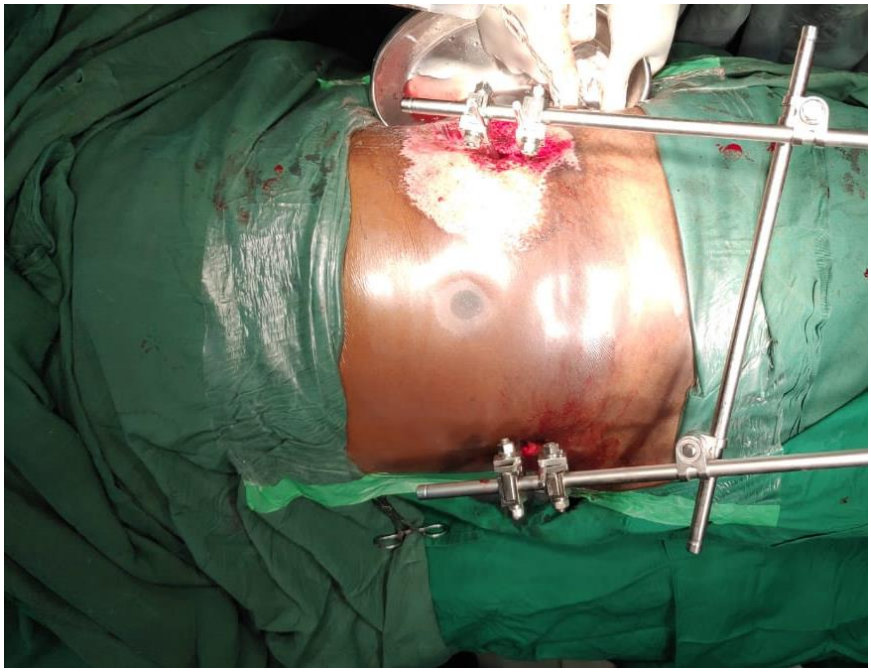
PINS AND FRAMES:

DIAMETER AND LENGTH:

- Pins used are of 5 mm diameter
- 4mm pins are used for smaller pelvis to avoid loss of purchase
- adequate length of pins to allow surgical procedures

FRAME TYPE:

- to maintain the reduction after the procedure and to prevent post op manipulation, double frame construct is used.
- Avoid placing bars closed to abdomen and cross bars



TECHNIQUE: [20,26]

- skin incision is put 2-3 cm behind the ASIS
- 1ST pin to be placed 2cm behind the anterior superior iliac spine
- K wires placed in the outer table and inner table to facilitate direction
- pins are placed in the lateral 3rd in order to avoid damage to inner table
- converging pins are placed and connected with rods and then tube to tube clamps
- pins are directed 20 degrees to 30 degrees medially
- in oblique view of iliac, apex of anterior inferior iliac spine corresponds to mediolateral direction

MATERIALS AND METHODS

PLACE OF STUDY: Tirunelveli medical college hospital

TYPE OF STUDY: Prospective study

SAMPLE SIZE: 22

PERIOD OF STUDY: 2017 - 2019

INCLUSION CRITERIA

- Closed pelvic fractures
- Tile type B pelvic fractures (rotationally unstable)
- Tile type C pelvic fractures (rotationally and vertically unstable)
- Sacroiliac joint disruption more than 1 cm
- Denis zone 1 sacral fractures
- Denis zone 2 sacral fractures

EXCLUSION CRITERIA

- Compound pelvic fractures
- Tile type A pelvic fractures
- Morel-Lavallée lesions
- Zone 3 sacral fractures

PREOPERATIVE EVALUATION

- **ATLS** protocol followed and the patients are hemodynamically stabilized
- **Primary and secondary survey** to look for any associated injuries
- Pelvic binder / Pelvic external fixator to give a tamponade effect thereby reducing the blood collecting in the pelvic cavity
- Radiographic evaluation of pelvis (anteroposterior view, Inlet and Outlet views)
- CT pelvis with 3D reconstruction to understand the fracture pattern and to decide the management

IMPLANTS AND INSTRUMENTS

6.5 MM partially threaded cannulated cancellous screws	
6.5 MM fully threaded cannulated cancellous screws	

Screw head	
Washer 13 mm- to prevent screw from sinking into osteoporotic bone	
2 mm guide wire	
Cannulated drill bit	
Direct measuring device	
Cannulated tap	
Cannulated screw driver	

SURGICAL PROCEDURE

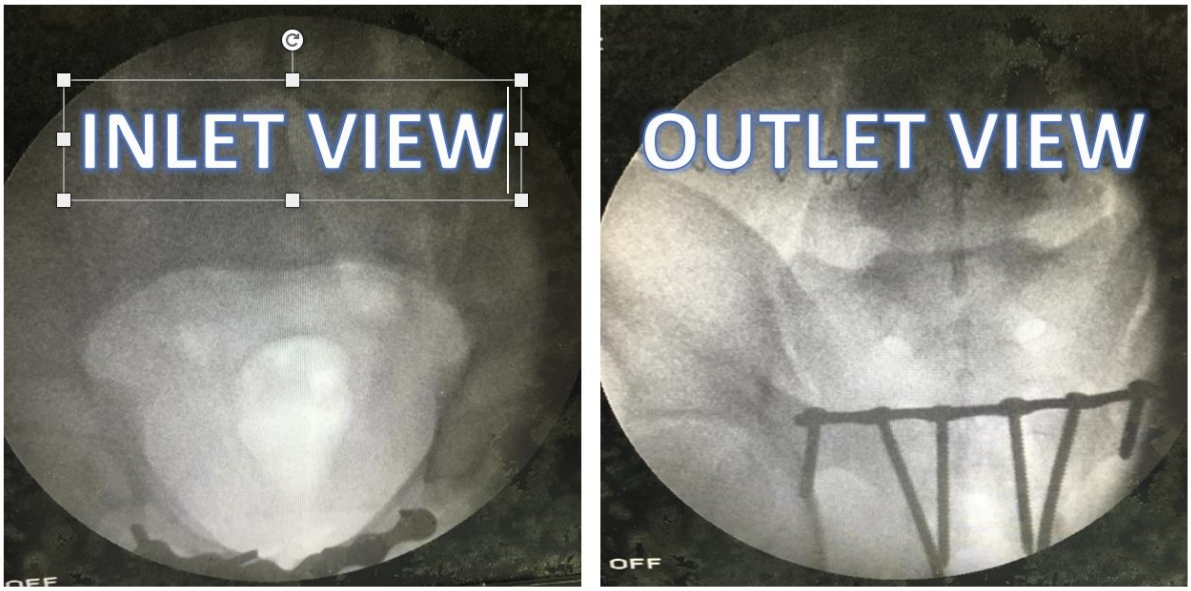
PERCUTANEOUS ILIOSACRAL SCREW FIXATION

Percutaneous technique for sacroiliac screw fixation is introduced with the aim of decreasing morbidity to the patient while maintaining an anatomic reduction. With recent advances in imaging technology and an improved understanding of sacral anatomy and intraoperative assessment of fracture reduction, percutaneous insertion of sacroiliac screws has become possible. This technique was popularized by Routt[10]. He was the first to report a series of patients operated with percutaneous sacroiliac screws in supine position.

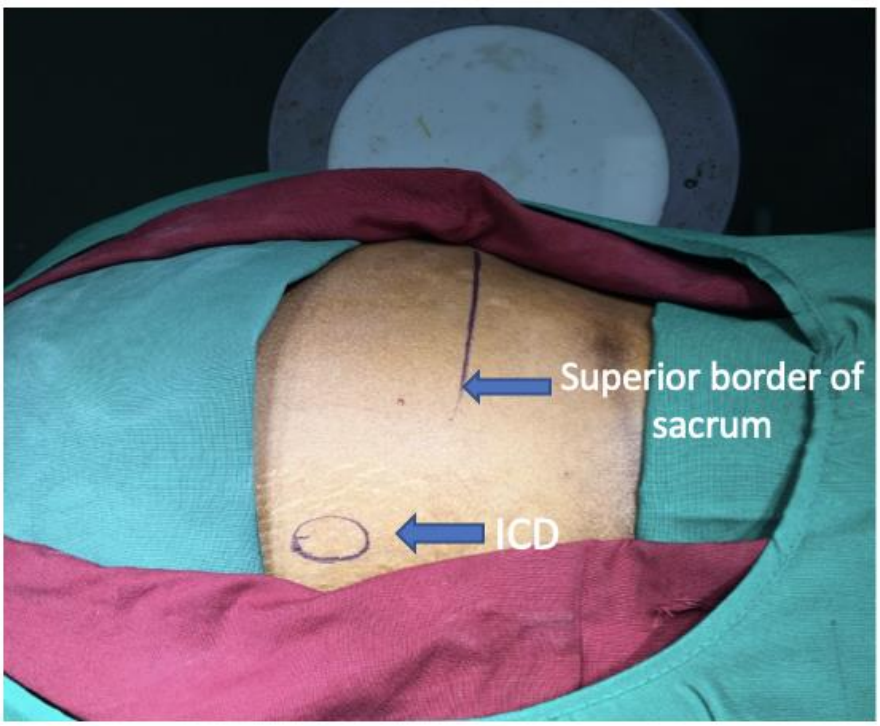
With the patient in supine position, entire lower abdomen is draped from nipple line distally, including the involved leg in case of traction is required.

A radiolucent bump is used to lift the buttock off the bed to achieve a better access to the entry point.

Position the OT table in such a way that Anteroposterior, lateral, inlet and outlet views are possible for radiographic evaluation

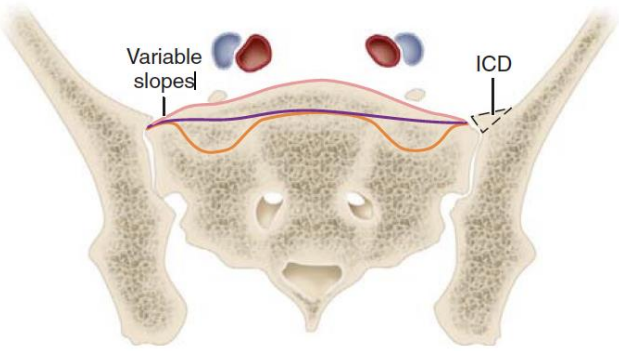


To identify the entry point, on lateral view of pelvis, trace out the dorsal and ventral aspects of sacrum along with the superior border of sacrum. Identify the Iliocortical density(ICD) and mark on the skin.[10]



ILIOCORTICAL DENSITY:

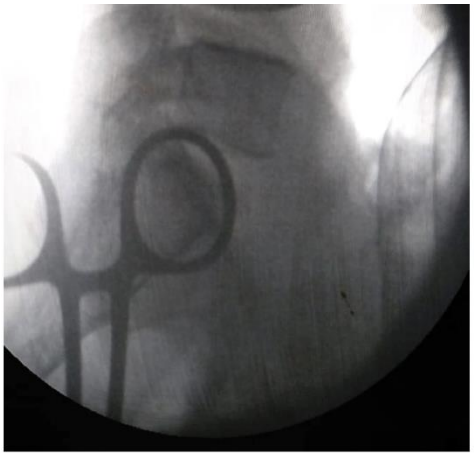
It marks the superior border of the sacroiliac joint which demarcates the anterior cortical thickening of iliac portion of sacroiliac joint.[26]

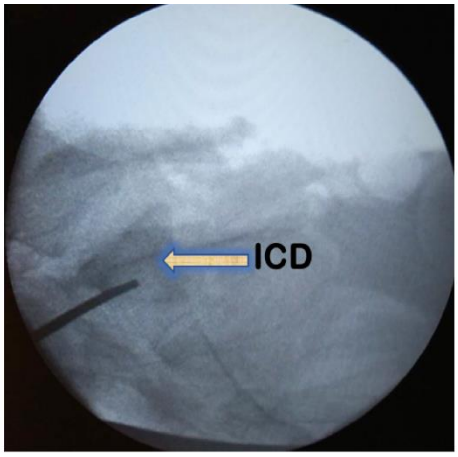


True lateral view:

True lateral view is the one in which both the greater sciatic notches and the two iliocortical densities superimposes.

A stab incision is made over the marked site, after dissecting the soft tissues a 2mm guide wire is inserted. Entry point of the guide wire in the ilium is, behind the anterior border of the sacrum and below the iliocortical density.[10]



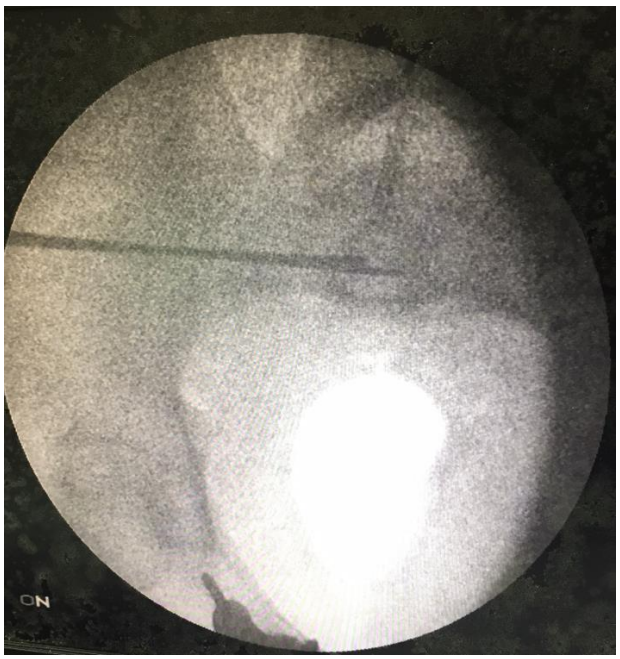


Closed reduction technique:

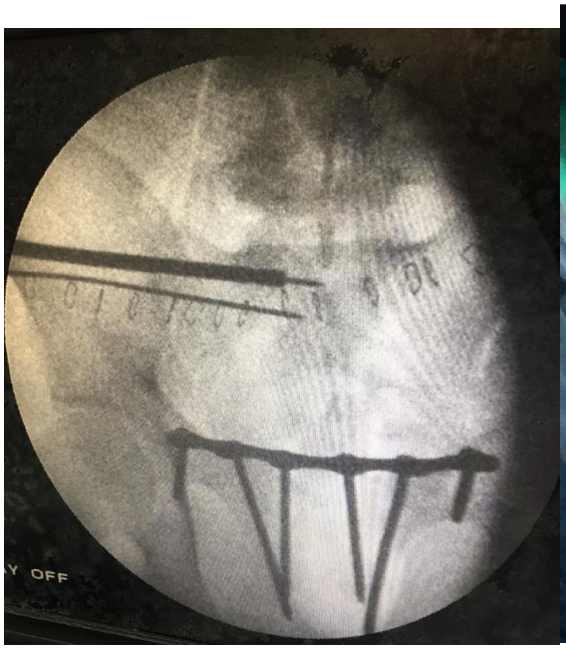
If there is vertical displacement first it has to reduced before inserting the guide wire. The lateral fracture fragment is mostly displaced superiorly and posteriorly. The best way to reduce this displacement is to apply mild traction to the leg while the hip is held in flexion. Depending on the mechanism of injury, the leg may need to be abducted for lateral compression injuries and externally rotated for anteroposterior compression injuries to reverse the deforming forces while maintaining traction. A shanz pin placed in the ilium can aid in manipulation and reduction. This schanz pin can be used as a joystick to maneuver the hemipelvis to a reduced position.[10]

Once reduction is achieved, the guidewire is advanced through the ilium across the sacroiliac joint into the sacrum. The guide wire is advanced till the sacral foramina and the position is checked on the outlet view to make sure the guide wire is above the first sacral foramen. Then inlet view is then used to check for the anteroposterior position of the guide wire. The wire should lie below the iliac cortical density and between the anterior and posterior bony margins of the sacrum.

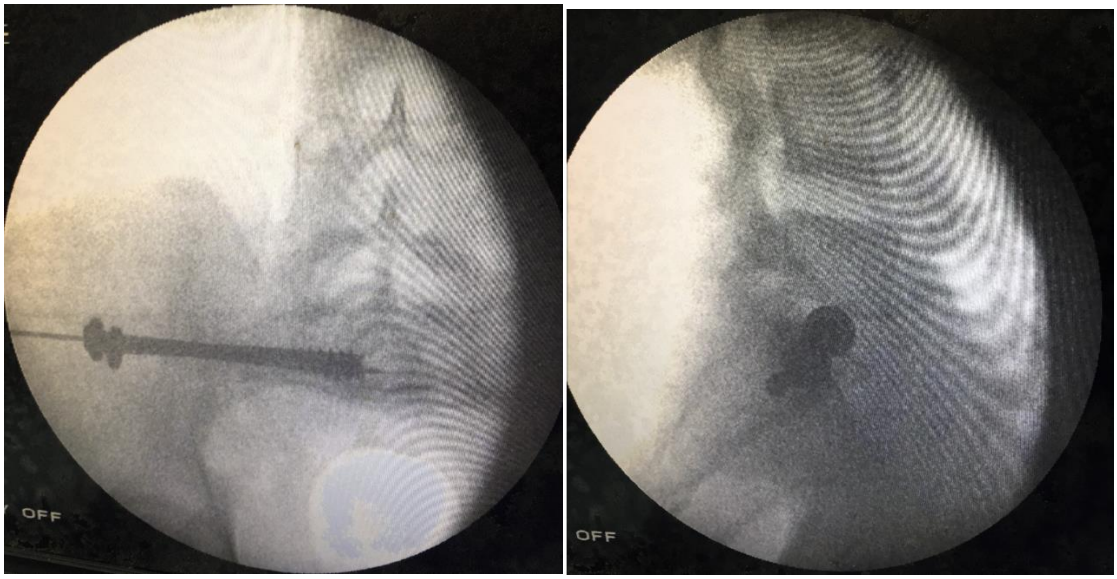
In inlet view the guide wire should be in the anterior half of sacral body



In outlet view the guide wire should be above the sacral foramen and below the superior aspect of sacrum



Once the guide wire position is confirmed using inlet and outlet views cannulated drill bit is passed and screws inserted with washer



Screw trajectory:

Sacroiliac joint – Perpendicular to sacroiliac joint from **posteroinferior to anteriosuperior direction.**

Sacral fracture – **Horizontal trajectory**

Screws:

Partially threaded 6.5 mm cannulated cancellous screw –For **Sacroiliac joint disruption and Denis zone 1 sacral fracture**

Fully threaded 6.5 mm cannulated cancellous screw- **Denis Zone 2 sacral fracture.**

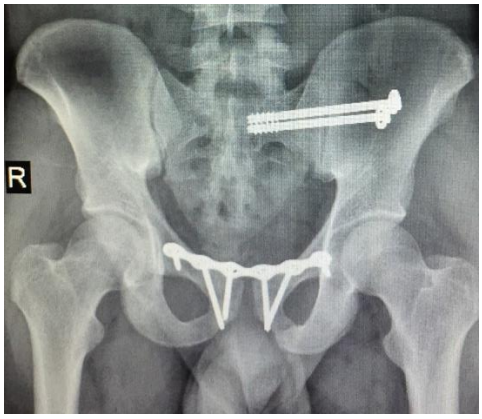
Screws inserted with washer for compression. Usually single screw is inserted, but for highly unstable dislocations two screw may be inserted. Inserting screw in second sacral body is difficult so both screws are inserted into the first sacral body.

Advantages

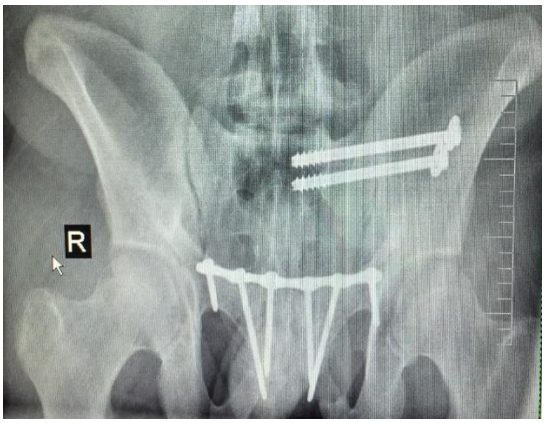
- Early mobilisation
- Decreased soft tissue dissection
- Decreased blood loss
- Less operative time
- Cost effectiveness
- Less wound healing problem

POST OPERATIVE RADIOGRAPHY

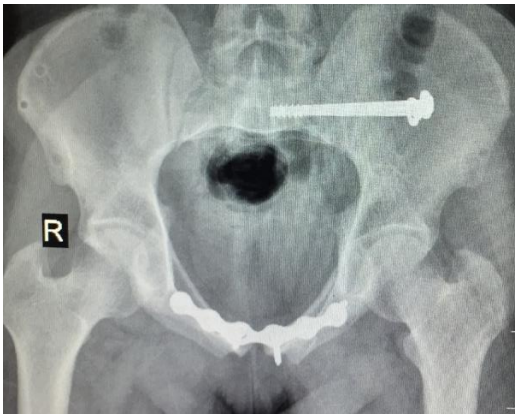
AP VIEW



OUTLET VIEW

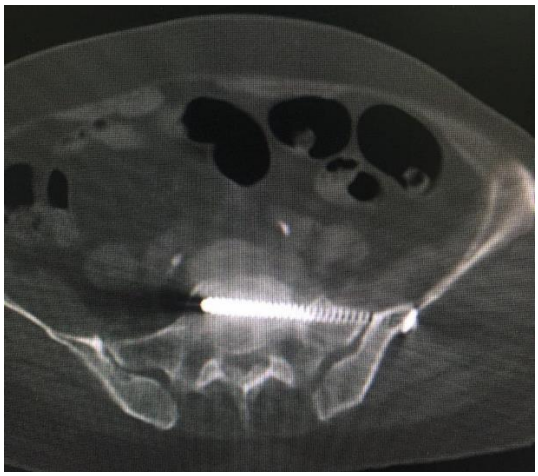


INLET VIEW



LATERAL VIEW

POST OP CT



FOLLOW UP

Patients were followed at 4 weeks, 8 weeks, 12 weeks and at 6 months and 1 year. At each visit patient is subjected to the following,

- Stress test of the sacroiliac joint (Faber`s and Ganselon`s test)
- Functional ability of the patient (history)
- Assesment of implants (radiographs) for:
    - Loosening
    - Infection
    - Failure
    - Radiographic assessment of sacroiliac joint
    - AP view
    - Inlet view
    - Outlet view
    - Functional outcome of patient with pelvic outcome scale (Majeed scoring)
- Mean follow up of all patients was 15 months.

Functional assessment of patients with Pelvic fractures

MAJEED SCORE SCALE[6]

I. Pain -30 Points	
Intense and continuous at rest	0-5
Intense only with activity	10
Tolerable, but limits the activity	15
Only with moderate activity, but abolished by rest	20
Mild, intermittent, normal activity	25
Slight, Occasional or no pain	30
II. Work -20 Points	
Regular work could not be performed	0-4
Light work	8
Change in job	12
Same job, but reduced performance	16
Same job, but same performance	20

III. Sitting -10 Points	
Painful	0-4
Painful if prolonged / awkward	6
Uncomfortable	8
Free	10
IV. Sexual Intercourse -4 Points	
Painful	0-1
Painful if prolonged / awkward	2
Uncomfortable	3
Free	4
V. Standing (36 Points) A Walking aids -12 Points	
Bedridden or almost	0-2
Wheel chair	4
Two Crutches	6
Two Sticks	8
One Stick	10
No Sticks	12
VI. B Gait Unaided (12 Points)	
Cannot walk or almost	0-2
Shuffing small steps	4
Gross limp	6
Moderate limp	8
Slight limp	10
Normal	12

VII. C Walking distance (12 Points)	
Bedridden or few metres	0-2
Very limited time and distance	4
Limited with sticks difficult without prolonged standing possible	6
One hour with a stick limited without pain	8
One hour without sticks slight pain or limp	10
Normal for age and generation condition	12

Points	Functional outcome grading
>85	Excellent
70-84	Good
55-69	Fair
<55	Poor

OBSERVATION

AGE INCIDENCE AND DISTRIBUTION

The age of the patients ranged from 16 to 70years. The mean age was 39 years.

Age in years	No. of patients	Percentage
11-20	01	4.5
21-30	06	27.2
31-40	08	36.3
41-50	04	18.1
51-60	04	18.1
61-70	03	13.6
Total	22	100

SEX INCIDENCE

In our study, male patients predominated with male to female ratio of 16:6

FRACTURE PATTERN

Type of injury	Number of patients
Sacroiliac disruption	7
Sacral Fractures	15

MODE OF INJURY

Majority of patients suffered road traffic accidents followed by fall from height.

Mode of injury	**No. of patients**	**Percentage**
RTA	19	85.7
Fall from height	03	9.5

TYPE OF INJURY (CLASSIFICATION)

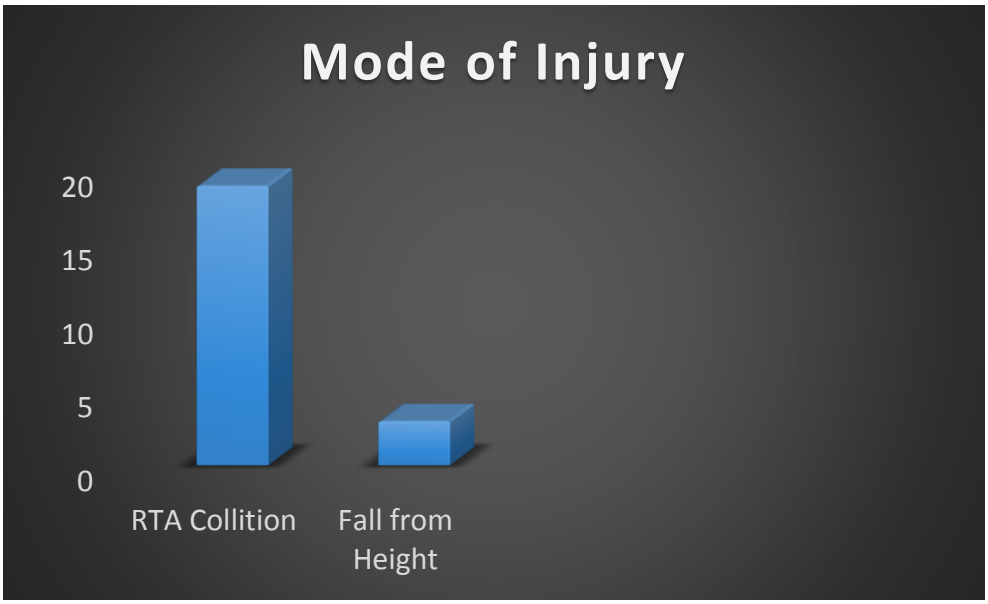
Classification	No. of patients
B1	03
B2	05
B3	01
C1	07
C2	05
C3	01

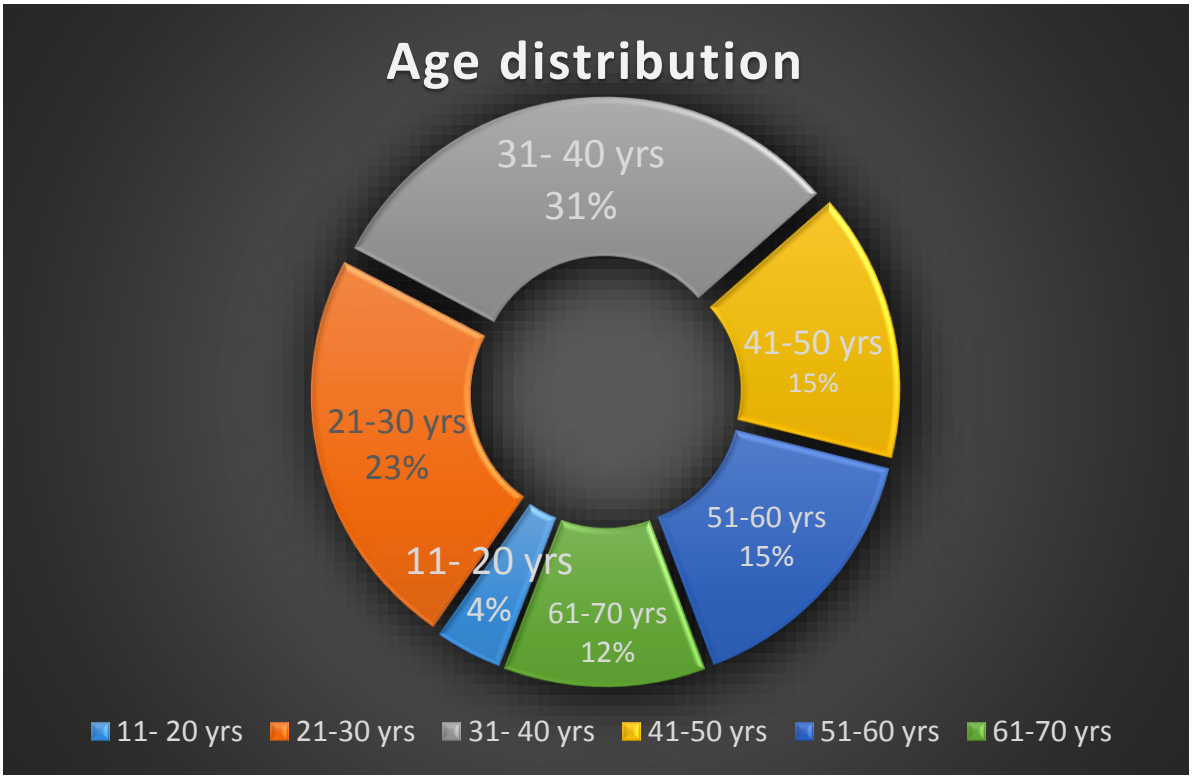
ASSOCIATED INJURIES

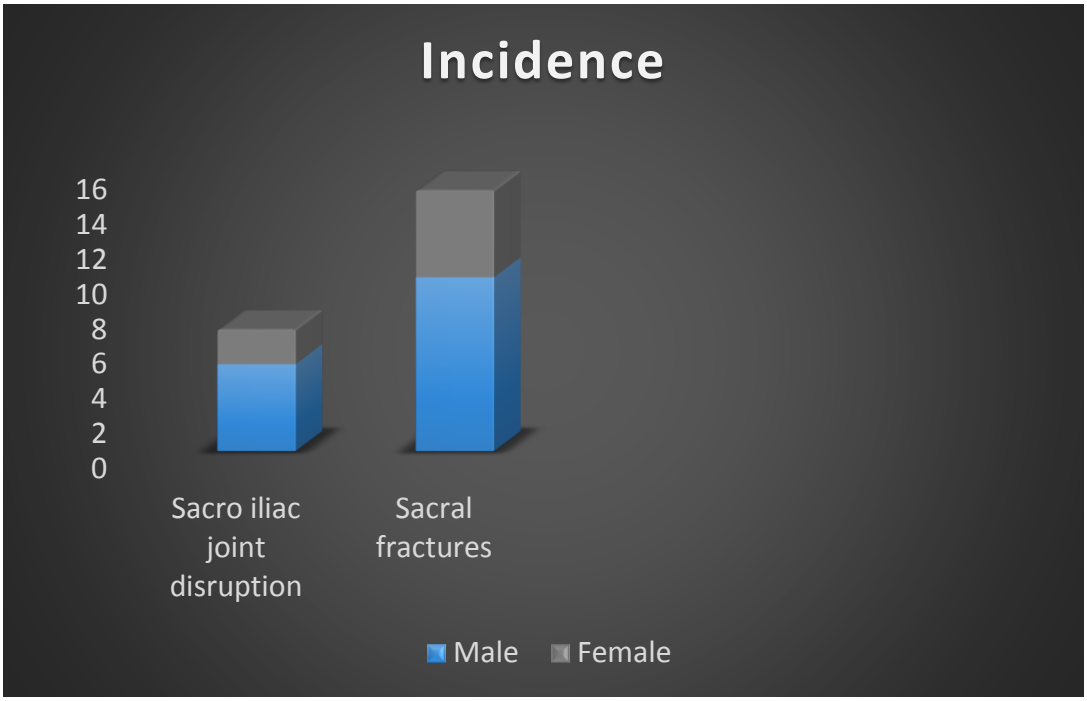
In our, study 11 patients (52.4%) had associated skeletal and/or soft tissue injuries. Four patients had associated acetabular fracture and two patients had multiple associated injuries.

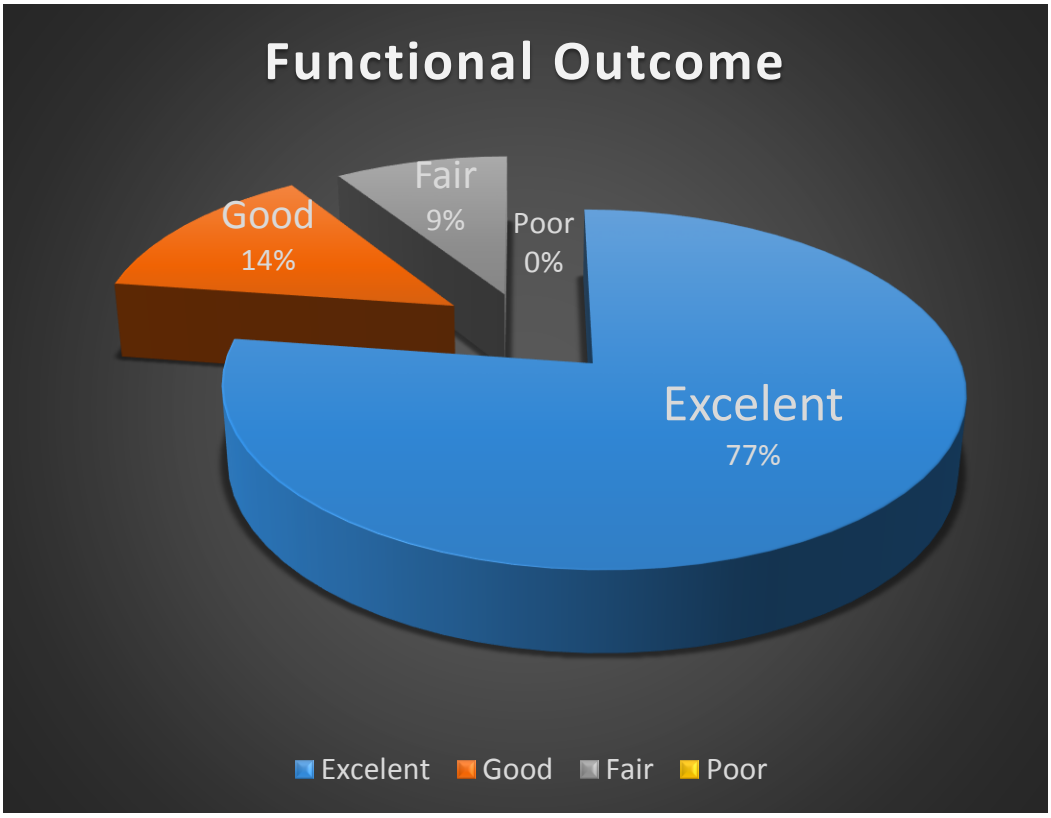
Associated injury	No. of patients
Fracture of shaft of humerus	01
Fracture of distal radius	01
Fracture of clavicle	02
Fracture of shaft of femur	01
Fracture shaft of tibia	02
Fracture of acetabulum	04
Nerve injury (L5 root)	01
Injury to urethra	02
Injury to urinary bladder	01
Head injury	03
Chest injury	04

OBSERVATION






Incidence
16
14
12
10
8
6
4
2
0
Sacro iliac joint disruption
Sacral fractures
Male
Female


Functional Outcome
Fair
9%
Good
14%
Poor
0%
Excelent
77%
Excelent
Good
Fair
Poor

ANALYSIS OF THE STUDY

Twenty-two patients with unstable pelvic fractures (sacroiliac joint disruptions and sacral fractures) were treated surgically and analyzed with an average follow up of 15 months (range 4- 24 months). The following analysis was made.

1. Two third of patients belong to fourth and fifth decade.
2. Commonly males are affected with male: female ratio of 16:6
3. Road traffic accidents, most of them high velocity injuries were the cause in majority of patients.
4. Eleven patients (50%) had associated injuries, of which skeletal injuries were common.
5. One patient with associated sacral fracture had nerve palsy (L5 root) which recovered after surgery
6. The average time delay between injury and surgery was 4.3 days (range 1-12 days).
7. The average surgical time was 53minutes (range 28-155).
8. In two patients in external fixation applied initially followed by percutaneous sacroiliac screw was inserted to obtain anatomical reduction.

RESULTS

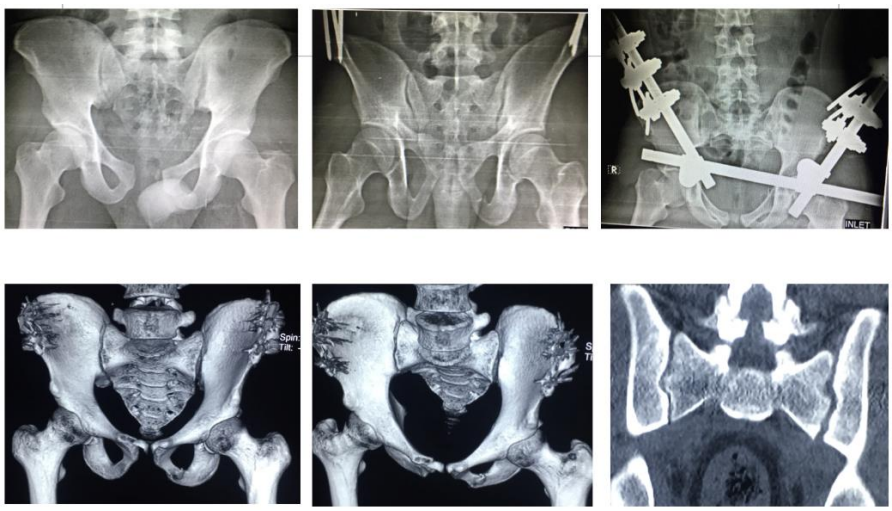
In our study, 22 patients with unstable sacroiliac joint disruptions and sacral fractures were treated with percutaneous sacroiliac screw fixation and followed for an average period of 15 months (range 4-24 months). The functional outcome of patients based on pelvic outcome scale by Majeed scoring was excellent for 17 patients, good for 3 patients and fair for 2 patients.

CASE ILLUSTRATION

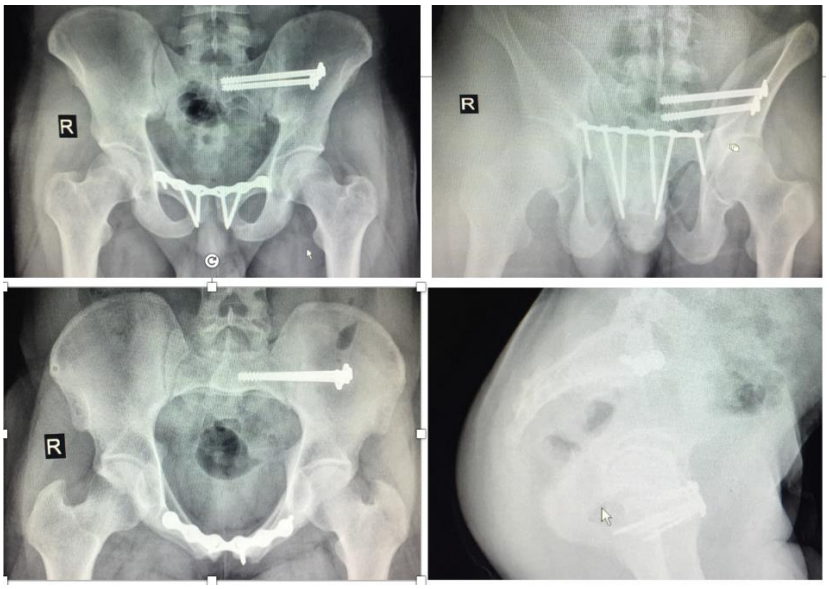
Case 1

A23-year-old patient sustained RTA and presented with Sacroiliac joint disruption Right side with Pubic diastasis. Patient initially managed with pelvic external fixator, after 5 days patient operated with Pelvic recon plate for pubic diastasis and Ilio sacral screw for Sacroiliac joint disruption

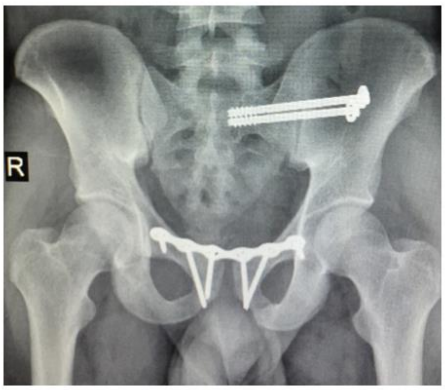
Preoperative Radiograph

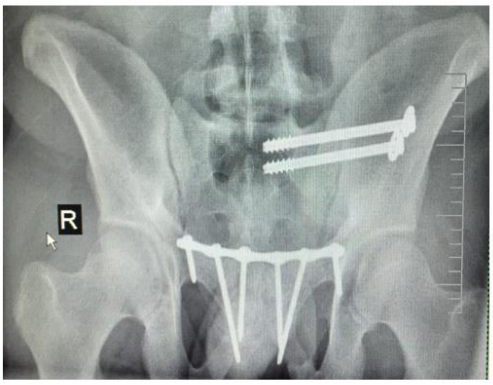


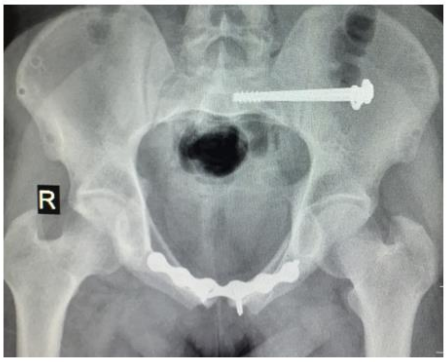
Post op Radiograph



Follow Up



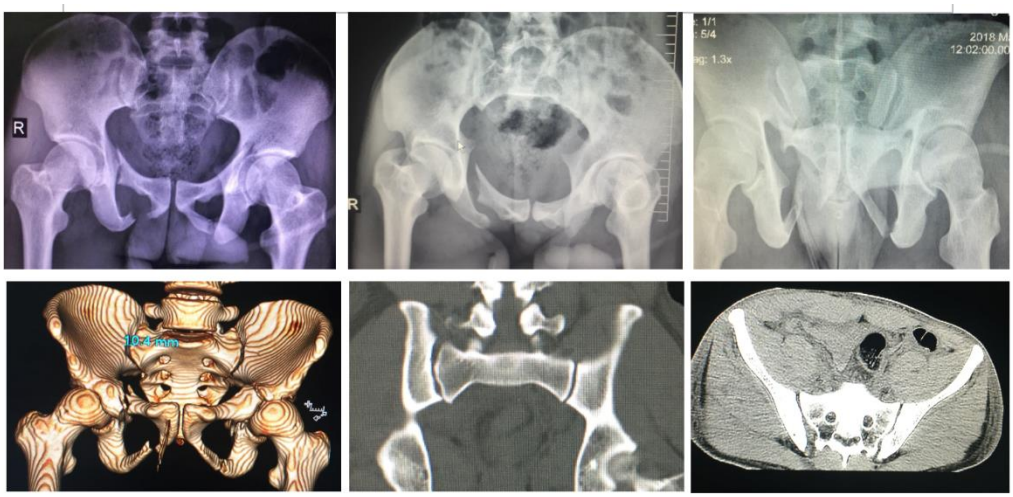




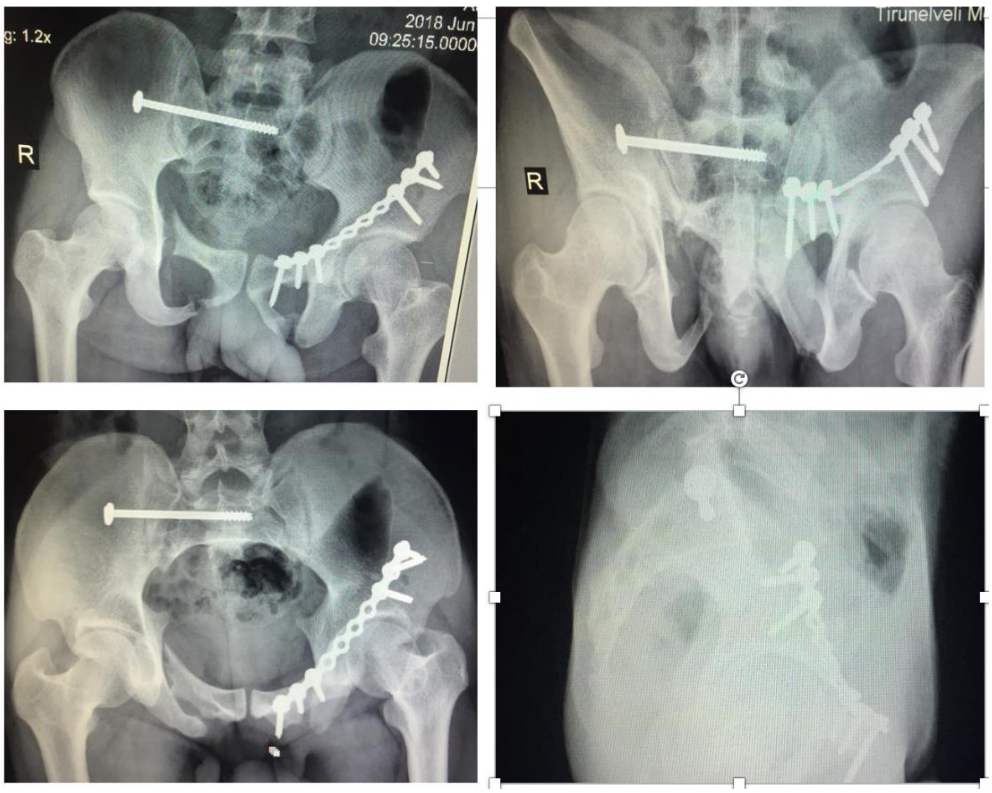
Case 2

Mr. Murugan a 25-year-old male met with RTA and sustained injury to left side anterior column acetabulum fracture and sacroiliac disruption on Right side.

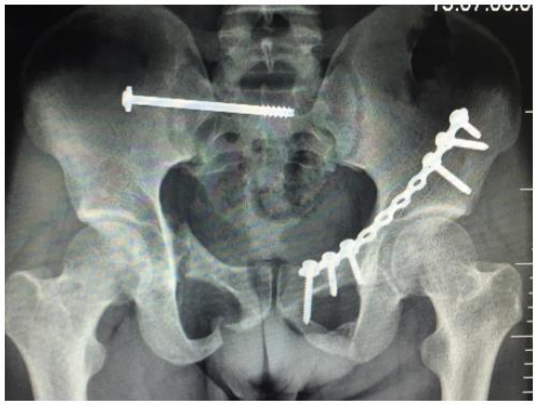
Preoperative:

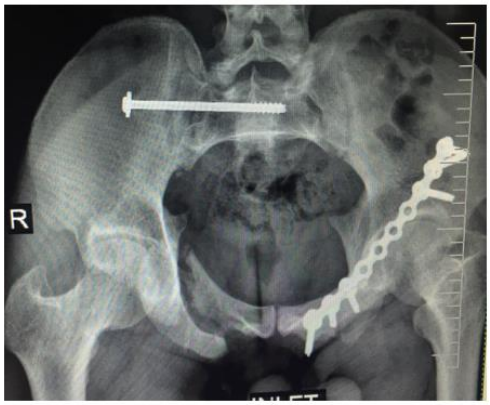


Postoperative:



Follow up

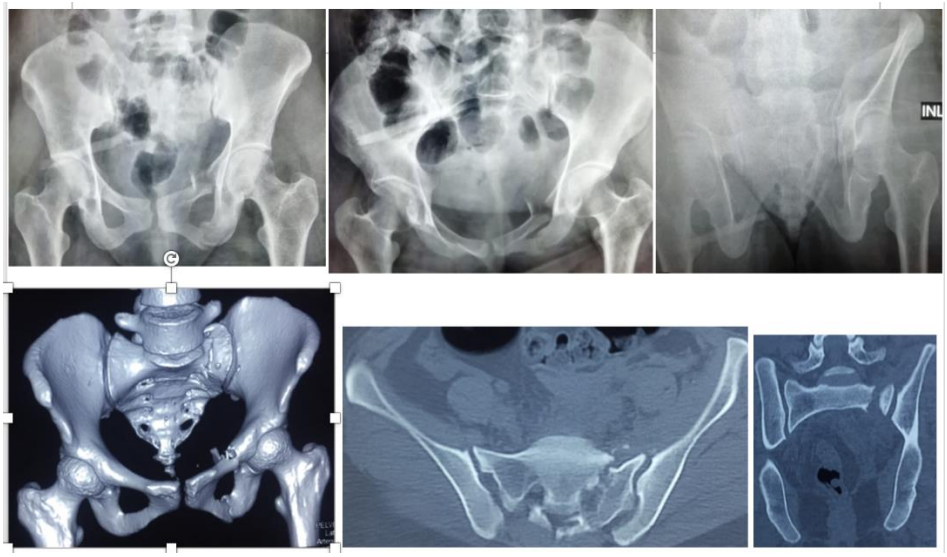




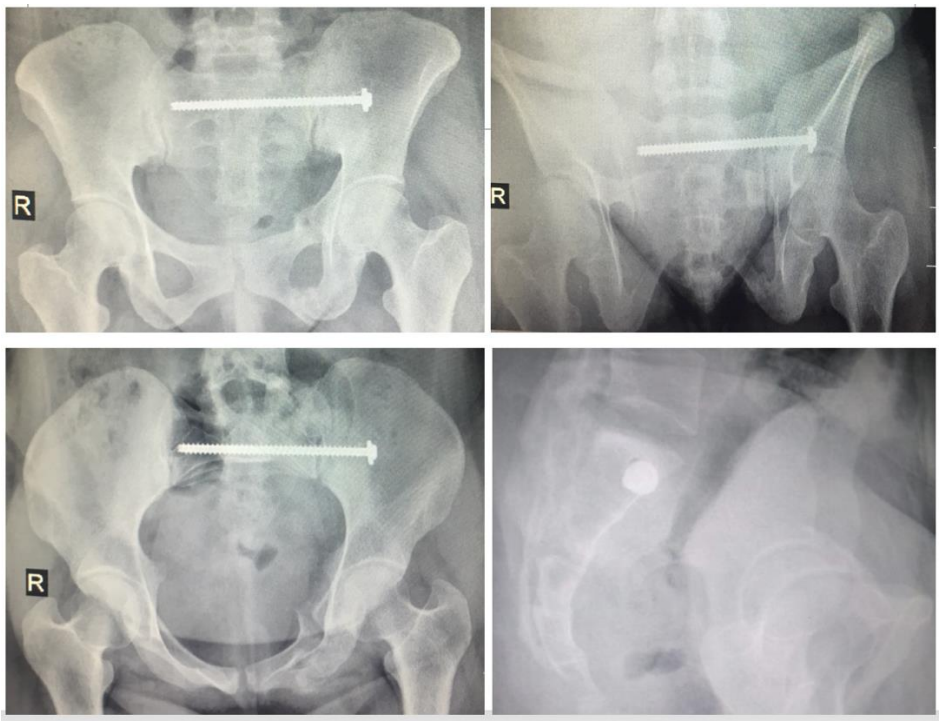
Case 3

A 26-year-old female sustained accidental fall from height and injury to the sacrum (Dennis Zone II)

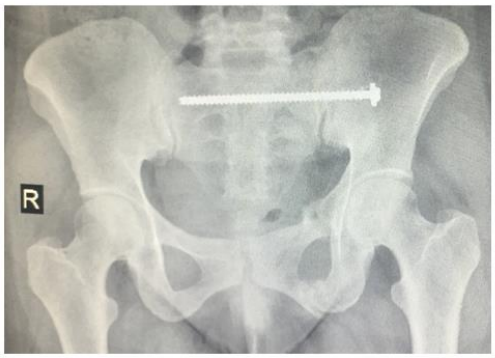
Preoperative



Postoperative



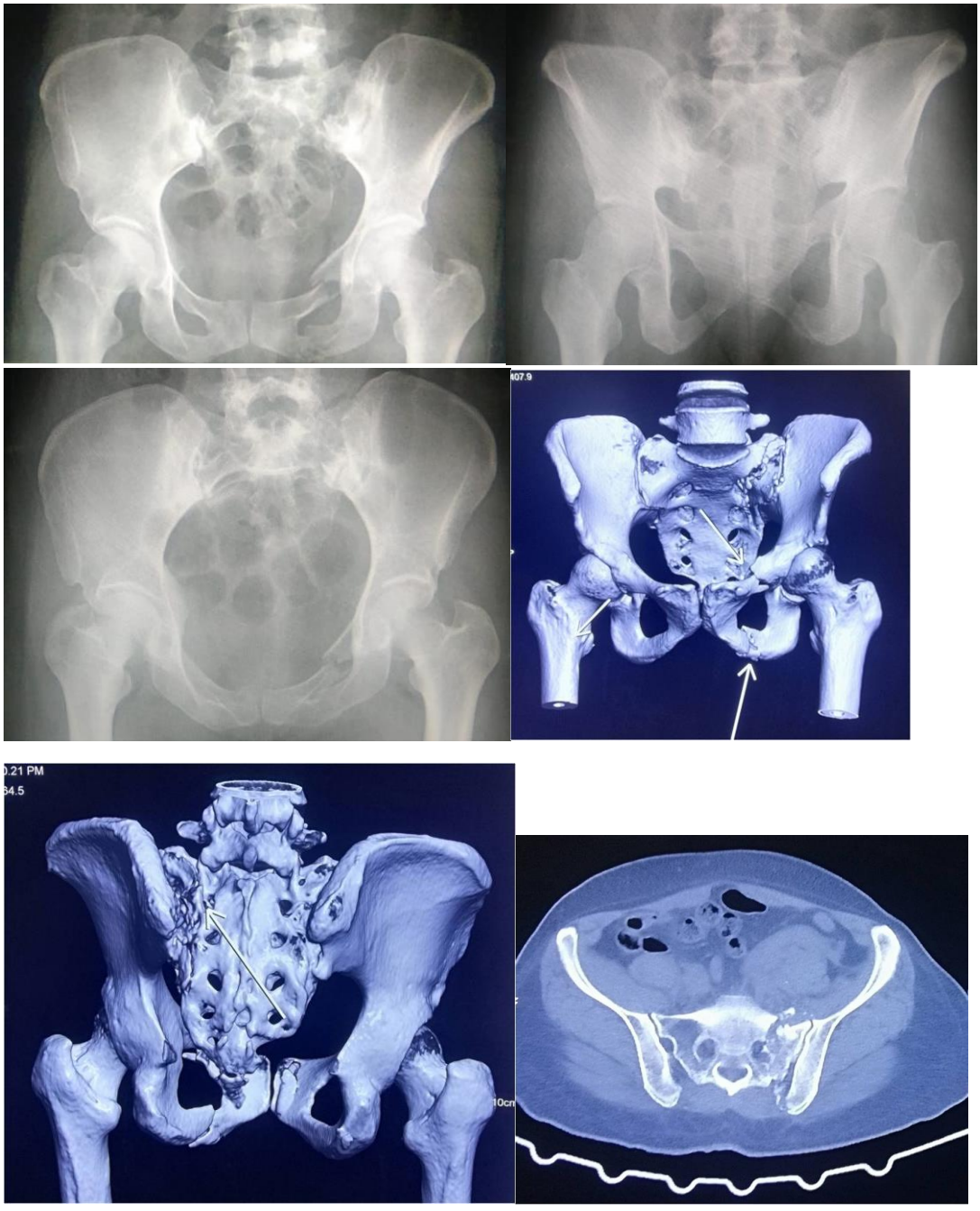
Follow up



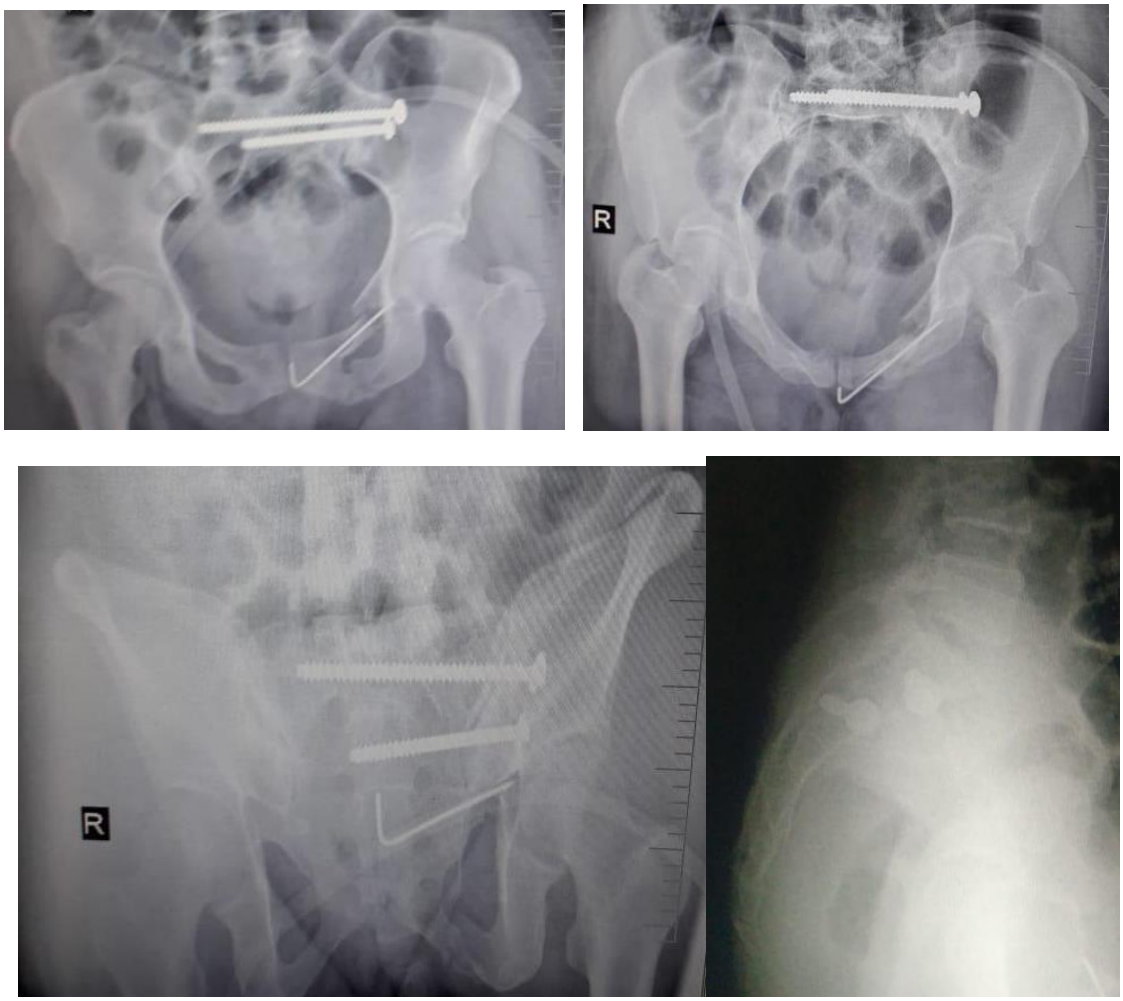
Case 4

A 45-year female sustained RTA and admitted with Denis zone 2 Sacral fracture with SPR and IPR fracture on left side

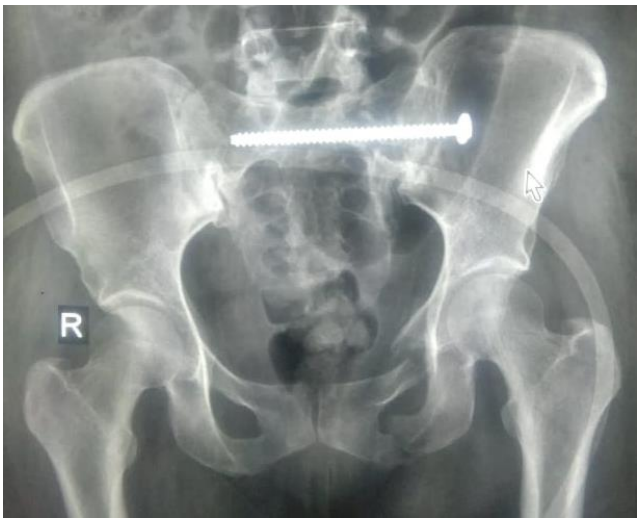
Pre-operative:



Post-operative



The S2 screw removed since it is directed posteriorly and patient had altered sensation in S1 dermatome.



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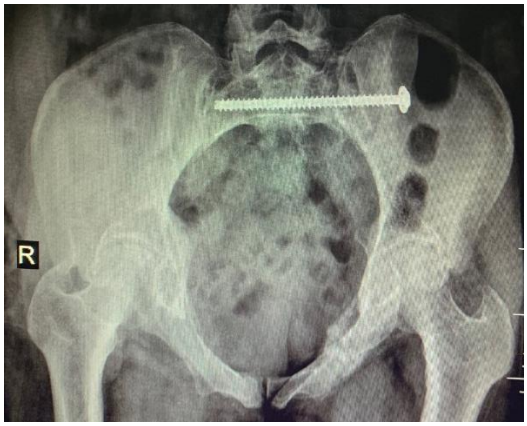
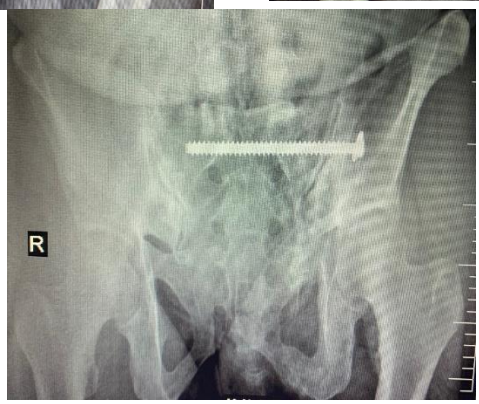
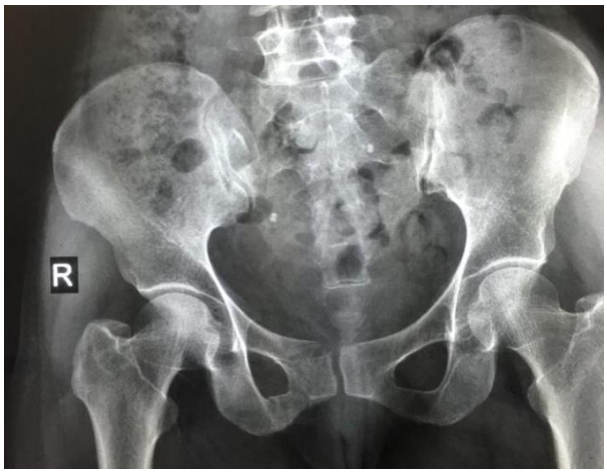


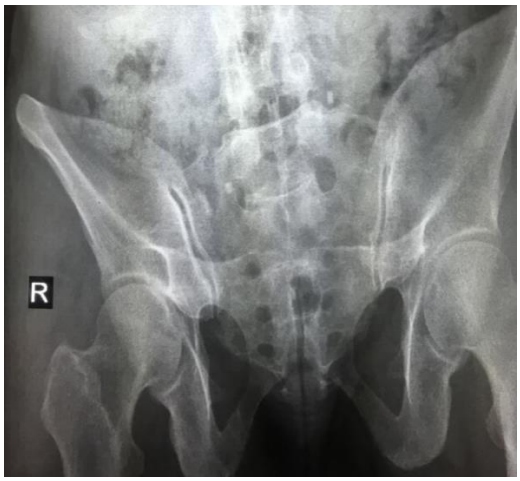


Case 5

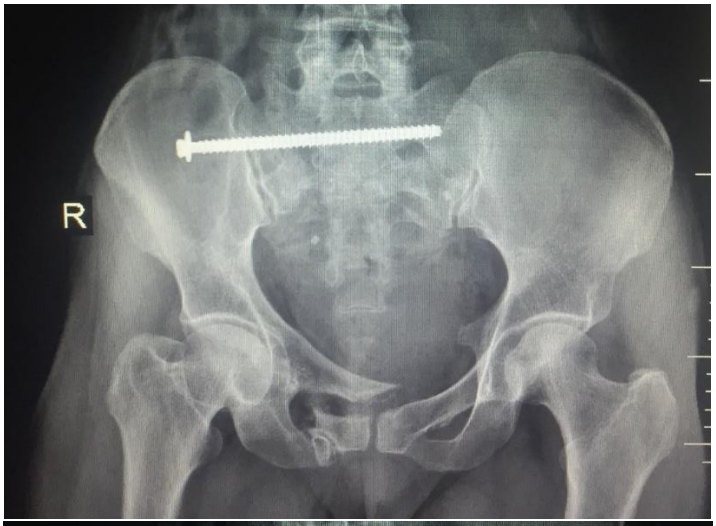
A 38-year-old female sustained RTA and admitted with Head injury with Dennis zone 2 Sacral fracture with SPR and IPR fracture on Right side, patient also had Distal radius fracture.

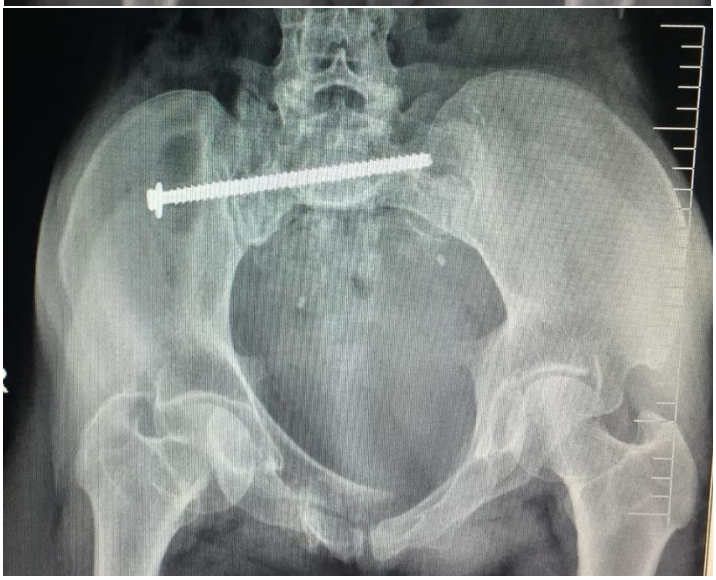
Preoperative:



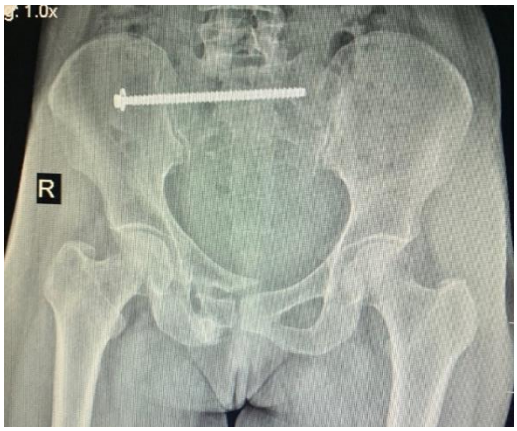


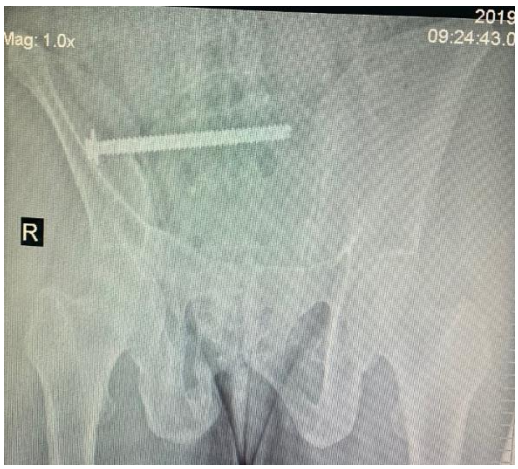
Post-operative:





Follow up;





DISCUSSION

Studies on the natural history of the pelvic fractures (sacroiliac joint disruptions and sacral fractures) proved that unstable pelvic fractures had high mortality in acute stage and chronic morbidity in the long term. Despite aggressive resuscitation which include application of external fixators, the mortality and morbidity remained high (10-20%). This led to clinical trials on internal fixation of pelvic fractures and several clinical studies have shown that early surgery and stable internal fixation enhances the chances of survival and more importantly, reduces the incidence of morbidity.

Males are most commonly injured with the male female ratio of 16:6. The most common mode of injury was road traffic accident (86.3%) in our study. Sunny Brook Medical Centre`s prospective study reported 81% of road traffic accidents.

Skeletal injuries were the major associated injury (50%), in which acetabular and extremities fracture are common in our series. Sunny Brook Medical Center study reported head injury as their major associated injury (38%). Cole et al reported skeletal injuries as the most frequently associated injury.

Tornetta et al reported associated skeletal injuries in 24 of 39 patients who suffered rotationally and vertically unstable pelvic injuries.

Radiological assessment was done with three standard views of x-ray (AP, inlet and outlet projections) and CT scan was taken. Out of 22 patients type C injury was 13 and type B was 9. Tile`s type C1 (unilateral vertical shear) comprised of the single most common of subtype (7 cases31.8%) followed by B2 and C2 (5 cases each). The remaining three cases of B1 and B2 and C3 (1 case each). Cole et al in their series of 64 vertically unstable injuries reported Tile`s type C1 in 75% of cases. Miranda et al in his series of 80 patients, reported 31 cases of Tile`s B type and 24 cases of C type injuries.

Out of 22 patients two patients had urethral injury and another patient had bladder injury in our study compared with Sunil et al reported 78 cases of pelvic fractures in which 17 patients had urogenital injuries, commonest being the urethral injury (8 cases). Miranda et al reported urological injury in 15 of 55 patients with Tile`s type B and C injuries. Cole et al reported on 64 cases of type C injury in which 18 patients associated with urethral injury.

We used DVT thromboprophylaxis in patients who needed prolonged bed rest and in patients with associated injuries which warrented immobilization.

In our study one patient had L5 root palsy on admission which improved to a motor power of 4 in 9 months. One patient developed post-operative paresthesia in S1 dermatome which improved after 2 months. However, Cole et al[5] reported 19 cases of neurological injury in his series. Torenetta et al reported 35% of significant neurological injury in their study of 48 unstable posterior pelvic ring disruptions.

In our study, patients are operated in both supine and prone positions. In patients with external fixator, who needs traction for reduction, those with unstable anterior pelvic ring, supine position is used. In Patients with isolated Posterior ring injuries, prone position is used. Most of the patients needed a single screw, and in 2 patients with Tile type C2 and C3, Bilateral sacroiliac screw fixation is done.

We preferred Supine position since it is more anatomical and the radiographic orientation is good. In prone position the inlet and the outlet images change. But prone position gives good access for the screw insertion.

In our study, 22 patients were treated with closed reduction and percutaneous sacroiliac screw fixation. 86.3% of patients had good results following internal fixation of sacroiliac joint disruptions analysed with pelvic outcome scale and Majeed scoring compared with Tornetta et al reported 48 patients of unstable posterior pelvic injuries treated with open reduction and internal fixation in which 67% of patients had good functional results.

CONCLUSION

Unstable pelvic injuries are in the rise and Early aggressive but thoughtful management of the patients is essential for maximizing the immediate survival and long term functional outcome. The role of team approach with various specialties cannot be over emphasized. Emergent external skeletal fixation alone is not sufficient to restore hemodynamic stability in all patients who fail to improve after initial resuscitation.

Anatomic reduction and Percutaneous iliosacral screw fixation of unstable sacroiliac joint injuries gives excellent stability, allows early mobility and good functional outcome. It gives good results similar to that of internal fixation. Delaying the fixation, however, increased the difficulty of obtaining anatomical reduction. Even in delayed fixation good functional outcome can be obtained if anatomical reduction was achieved.

Acute management of unstable Pelvic fractures is challenging and techniques of safe surgical fixation are demanding. Constant dedication to improvement is needed and should be the goal of pelvic surgeons.

Percutaneous ilio-sacral screw fixation for sacro-iliac joint injury and sacral fracture with C arm guidance is safe and minimally invasive technique. Clear images and accurate interpretation of X-rays, CT scans and per operative C arm images are important to avoid malpositioning of screws and iatrogenic neurovascular injuries.

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We are conducting a study on **" OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES"** among patients attending the Department of Orthopedics ,Tirunelveli Medical college Hospital and for that your specimen may be valuable to us.

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The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator Signature of Participant

Date :

Place :

ANNEXURE 2: PATIENT CONSENT FORM

Study Detail: "TO STUDY THE OUTCOME OF PERCUTANEOUS SACRO ILIAC SCREW FIXATION OF PELVIC INJURIES IN UNSTABLE FRACTURES"

Study Centre : Tirunelveli Medical College Hospital, Tirunelveli.
Patient's Name :

Patient's Age :

Identification Number:

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction.

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms.

e) I hereby consent to participate in this study.

f) I hereby give permission to undergo detailed clinical examination, Radiographs & blood investigations as required.

Signature/thumb impression Signature of Investigator

MASTER CHART

SlNo	Name & I.P.No.	Age / Sex	Date of admission	Mode of injury	X-ray feature	Classification (Tile)	Asso. injuries	Date of surgery	Time delay	Procedure	Surgcial time	Complications	Follow-up	Outcome Total=100 (Majeed scoring)
1	Arumugam	24/ M	21/10/17	RTA	Pubic Diastasis with sacroiliac joint disruption (L)	B1	Nil	26/10/17	5 Days	Pubic Symphysis plating with SI Screw fixation	130 minutes	Nil	24 months	89
2	Maharasi	35/ F	25/10/17	RTA	Zone II Sacral # with SPR/IPR # (L)	C1	Clavicl#, Tibia #	27/10/19	2 Days	SI Screw fixation	40 minutes	Nil	24 months	90
3	Murugan	35/ M	30/10/17	RTA	SI joint disruption with Acetabulum # (R) with B/L SPR/IPR #	C1	Nil	3/11/17	4 Days	Ant. column plating with SI Screw fixation	145 minutes	Nil	23 months	82
4	Sharmi	26/ F	01/12/17	Fall	Denis Zone II Sacral # (L)	B2	Nil	5/12/17	4 Days	SI Screw fixation	32 minutes	Nil	22 months	92
5	Ravi chandran	40/ M	07/12/17	RTA	Pubic Diastasis with sacroiliac joint disruption (R)	B1	Distal radius #	14/12/17	7 Days	Pubic Symphysis plating with SI Screw fixation	115 minutes	Nil	22 months	89
6	Karuppa samy	23/ M	19/01/18	RTA	Denis Zone I Sacral # (L)	B2	Tibia # Urethral injury	28/01/18	9 Days	SI Screw fixation Nailing for tibia	105 minutes	Nil	21 months	87
7	Murugeswari	50/ F	19/01/18	Fall	Denis Zone II Sacral # (R)	B2	Head Injury	27/01/17	8 Days	SI Screw fixation	45 minutes	Nil	21 months	88
8	Sankar	35/ M	27/03/18	RTA	Zone II Sacral # (L) with SPR/IPR # Lt	C1	Nil	29/03/18	2 Days	SI Screw fixation	32 minutes	Nil	19 months	86
9	Pandiaraj	34/ M	11/04/18	RTA	Denis Zone II Sacral # with SPR/IPR # (L)	C1	Head injury	19/04/18	8 Days	SI Screw fixation	28 minutes	Nil	18 months	90
10	Krithiga	16/ Fch	11/05/18	RTA	Sacroiliac disruption (R) with pubic diastasis	C1	Spine injury	12/05/18	1 day	SI screw fixation	125 minutes	Nil	17 months	94
11	Gnana muthu	65/ M	20/07/18	RTA	B/L SI Joint disruption SPR/IPR # (R) Iliac wing # (L)	C2	Nil	27/07/18	6 Days	B/L SI Screw fixation	95 minutes	Nil	15 months	67
12	Eswari	70/ F	21/09/18	RTA	Denis Zone II Sacral # with SPR/IPR # (L)	C1	Nil	29/09/18	8 Days	SI Screw fixation	35 minutes	Nil	13 months	82

13	Suruttu lingam	31/ M	28/10/18	RTA	Denis Zone II Sacral # with SI Joint disruption (L)	C2	Chest , Head injury	09/11/18	12 Days	Pelvic external fixator with SI screw fixation	55 minutes	Infec tion	11 months	86
14	Kesava nathan	35/ M	5/11/18	RTA	Zone II Sacral # with acetabulum # with IPR # (L) SPR/IPR (R)	C2	Bladder injury Chest injury	11/11/18	6 Days	SI Screw fixation	60 minutes	Nil	11 months	89
15	Paulraj	35/ M	02/01/19	RTA	Zone II Sacral # with SPR/IPR (R) Ant. Column with post hemitransverse # (L)	C2	Nil	05/01/19	3 Days	SI Screw fixation with Acetabulum post. Column plating	155 minutes	Nil	9 months	76
16	Mariya Anthony	67/ M	05/02/19	RTA	Denis Zone I Sacral #(R) with Pubic Diastasis	B1	Nil	15/02/19	10 Days	Pubis diastasis plating with SI screw fixation	105 minutes	Nil	8 months	86
17	Pitchumani	49/ M	07/03/19	RTA	Zone II Sacral # With anterior column # (R)with B/L SPR/IPR # with pubic Diastasis	C2	Nil	13/03/19	6 Days	SI Screw fixation, Anterior column plating with Pubic diastasis plating	160 minutes	Nil	7 months	65
18	Vignesh	29/ M	10/03/19	RTA	Pubic Diastasis with SI joint disruption (L)	C1	Shaft of Femur# Clavicl#	12/03/19	2 Days	Pubic Symphysis plating with SI Screw fixation	105 minutes	Nil	7 months	90
19	Ajitha	43/ F	16/05/19	RTA	Denis Zone II Sacral # with SPR/IPR # (L)	B1	S1 nerve root injury	19/05/19	3 Days	SI Screw fixation	85 minutes	S1 root pares is	5 months	92
20	Moorty	24/ M	26/05/19	RTA	Denis Zone II Sacral # (R)	B1	Humerus#	28/05/19	2 Days	SI Screw fixation	35 minutes	Nil	5 months	90
21	Muruagn	45/ M	29/05/19	RTA	Zone II Sacral # Rt. With B/L SPR/IPR #	C2	Urethral injury	05/06/19	7 Days	SI Screw fixation	40 minutes	Nil	4 months	89
22	Vannathai	22/ F	03/06/19	RTA	Denis Zone II Sacral # (L) with SI Joint (R) with B/L SPR/IPR #	C3	Rectal injury	06/06/19	3 Days	B/L SI Screw fixation	75 minutes	Nil	4 months	87

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