Acute Management of Pelvic Fractures and Basic Understanding of Acetabular Anatomy

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Original Author: Kyle F. Dickson, MD; Created March 2004

New Author, : Vince Lands MD; Revised October 2021

Objectives:

- Pelvic ring instability can be a major contributing factor to hemorrhagic shock and death.

- Understand which pelvic ring injuries need emergent intervention
- How to apply emergency management strategies for the injuries
- Basic Understanding Acetabular Fractures

The unstable patient

- 3 Peak times of death following trauma:

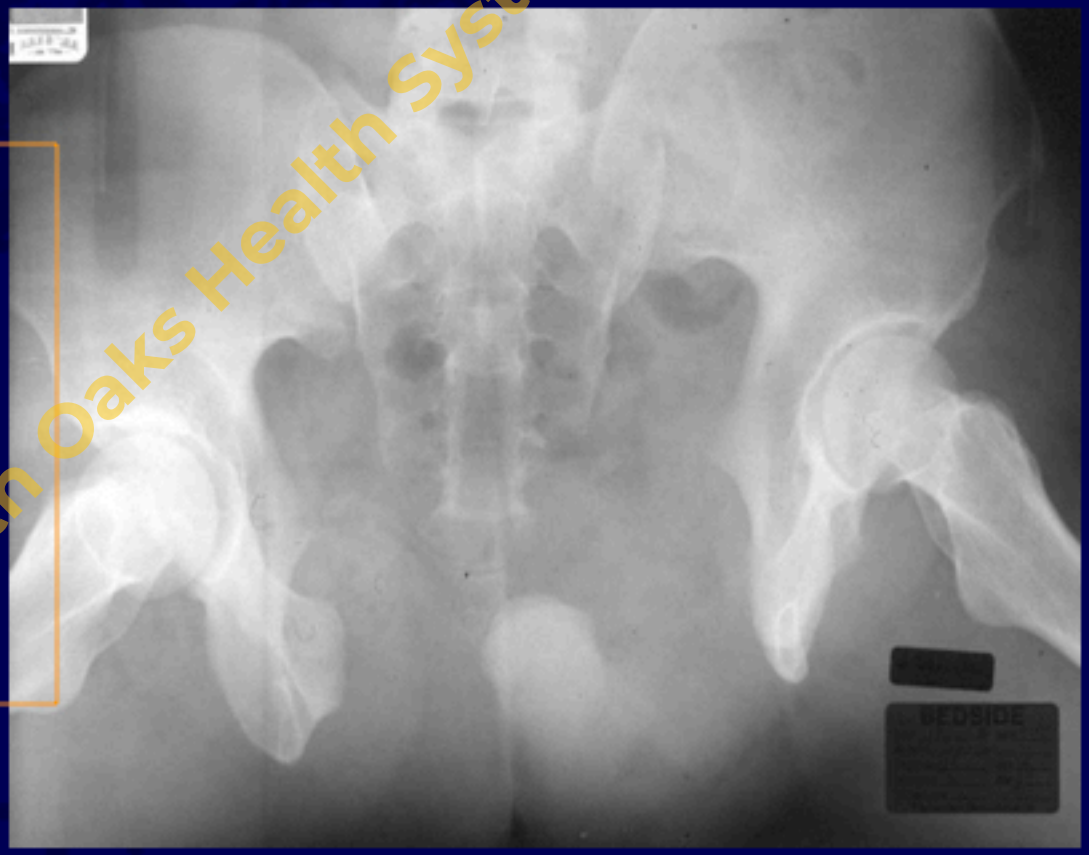
- 1. 50%(minutes)-CNS, massive hemorrhage
- 2. 30%(hours to days)- Neurologic Injury/prolonged blood loss/severe abdominal injury
- 3. 20%(weeks)-infection/multi-organ failure

Pelvic Ring Injuries

High energy

Morbidity/Mortality

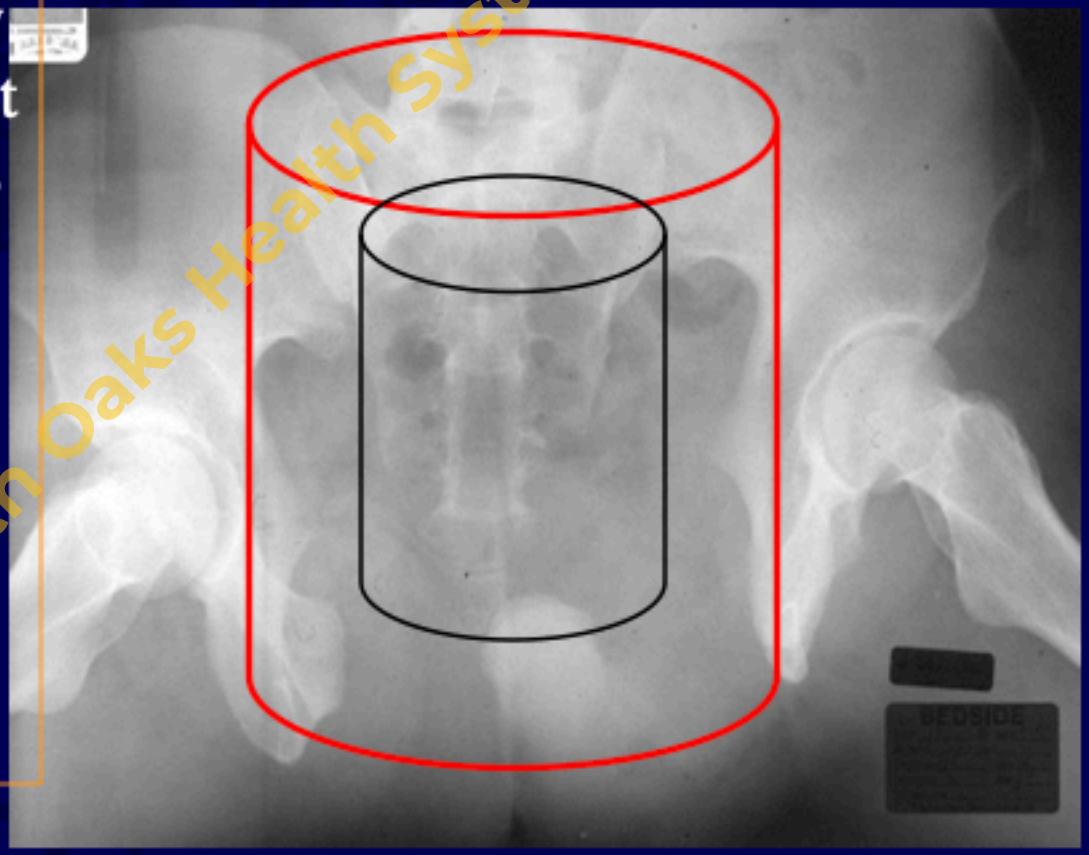
Hemorrhage



Pelvic Ring Injuries

An unstable pelvic injury may allow hemorrhage to collect in the true pelvis as there is no longer a constraint which allows tamponade.

The volume was traditionally assume to be a cylinder with a volume of $4/3\pi r^3$. However…



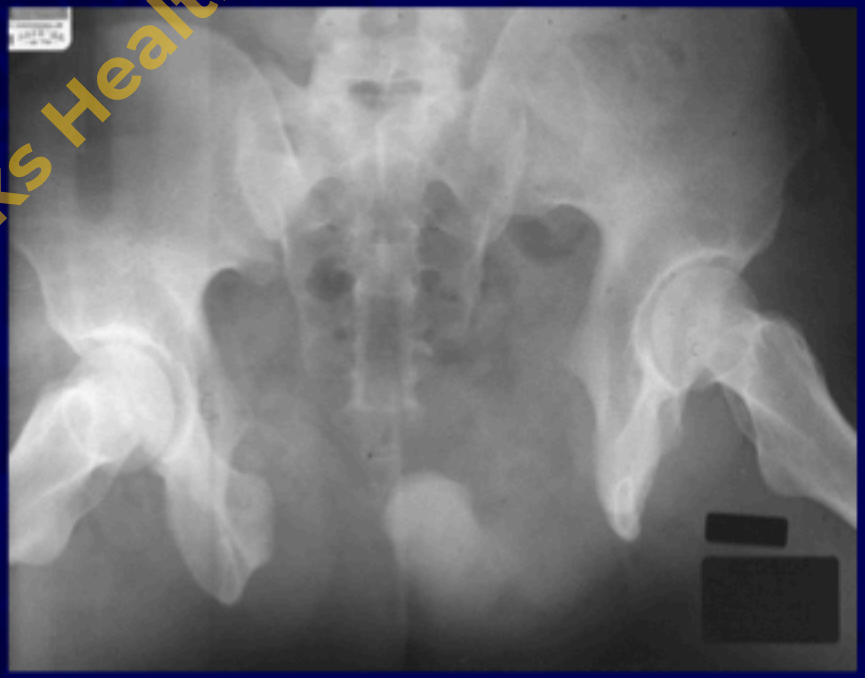
Best estimated by a hemi-elliptical sphere

(Stover et al, J Trauma, 2006)

The unstable pelvis

- Sources of blood loss
  - Pre sacral venous plexus
  - Exposed cancellous bone
  - Arterial extravasation*

  - Least common, most difficult to control



The unstable pelvis

Open book and vertical shear patterns increase pelvic volume and are frequently associated with hemodynamic instability.

Emergent management = reduce pelvic volume

Primary survey: ABC's

Airway maintenance with cervical spine protection

Breathing and ventilation

Circulation with hemorrhage control

Disability: Neurologic status

Exposure/environment control: undress patient but prevent hypothemia

Considerations for Transfer or Care at a Specialized Center: Pelvic Fractures

- Significant posterior pelvis instability/displacement on the initial AP X-ray (indicates potential need for ORIF)
- Bladder/urethra injury
- Open pelvic fractures
- Lateral directed force with fractures through iliac wing, sacral ala or foramina
- Open book with anterior displacement > 2.5 cm (value of 2.5 centimeters somewhat arbitrary and controversial with regards to reliability)

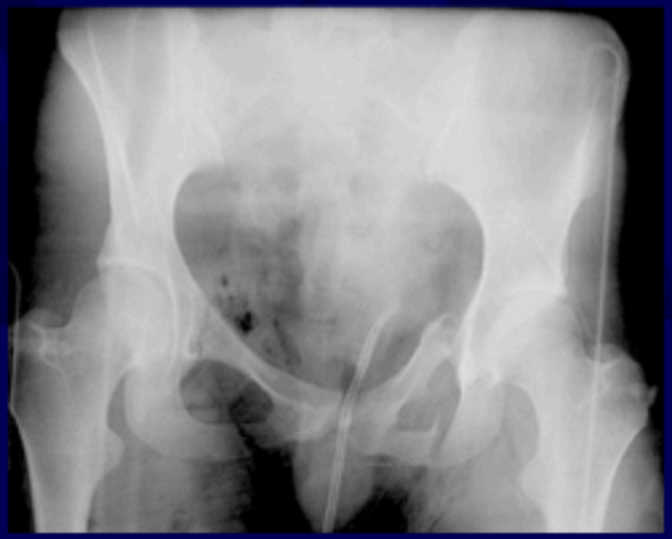
Physical Exam

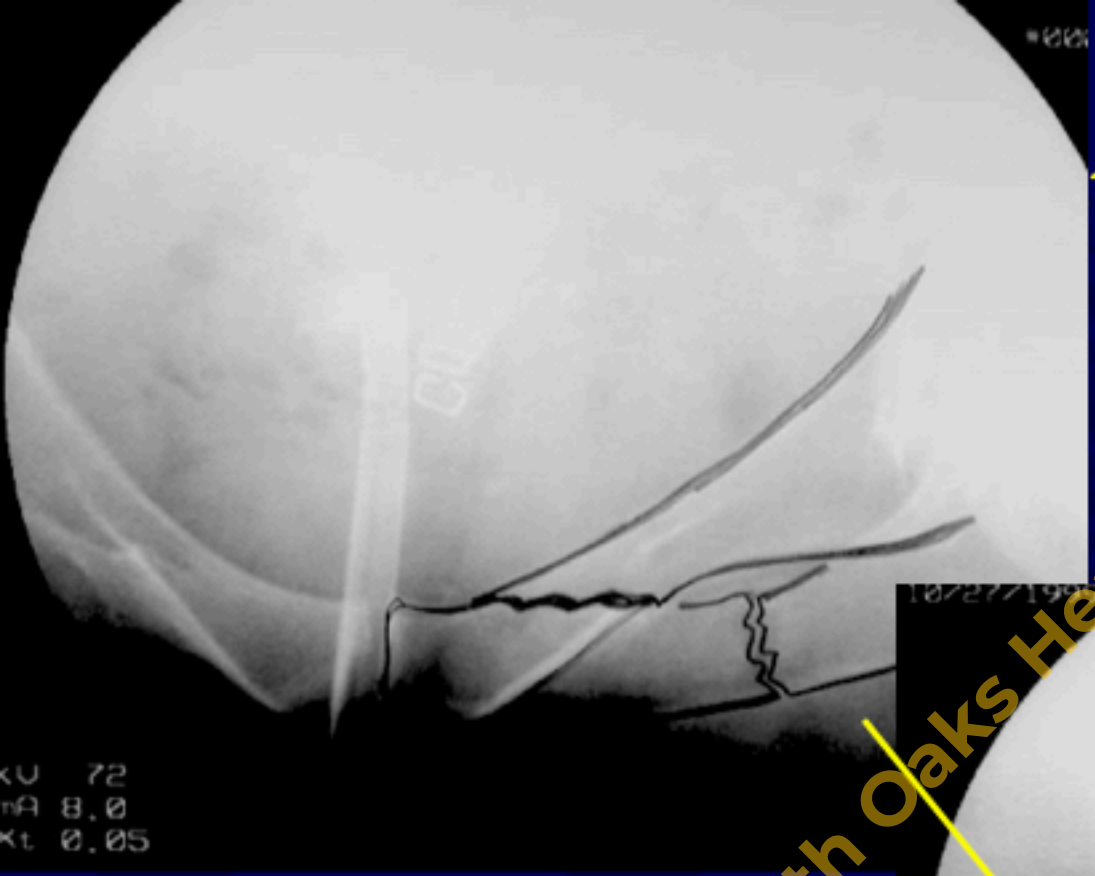
- Degloving injuries
- Limb shortening
- Limb rotation
- Open wounds
- Swelling hematoma

Defining Pelvic Stability???

- Radiographic
- Hemodynamic
- Biomechanical (Tile & Hearn)
- Mechanical

"Able to withstand normal physiological forces without abnormal deformation"





table?

- Single examiner
- Use fluoro if available
- Best in experienced hands

Radiographic Signs of Instability

- Sacroiliac displacement of 5 mm in any plane
- Posterior fracture gap (rather than impaction)
- Avulsion of fifth lumbar transverse process, lateral border of sacrum (sacrotuberous ligament), or ischial spine (sacrospinous ligament)

Open Pelvic Injuries

- Open wounds extending to the colon, rectum, or perineum: strongly consider early diverting colostomy
- Soft-tissue wounds should be aggressively debrided
- Early repair of vaginal lacerations to minimize subsequent pelvic abscess

Urologic Injuries

- 15% incidence
- Blood at meatus or high riding prostate
- Eventual swelling of scrotum and labia (occasional arterial bleeder requiring surgery)
- Retrograde urethrogram indicated in pelvic injured patients

Urologic Injuries

- Intraperitoneal & extraperitoneal bladder ruptures are usually repaired
- A foley catheter is preferred
- If a supra-pubic catheter it used, it should be tunneled to prevent anterior wound contamination
- Urethral injuries are usually repaired on a delayed basis

Sources of Hemorrhage

- External (open wounds)
- Internal: Chest
- Long bones
- Abdominal
- Retroperitoneal

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→	**Chest x-ray**
→	**Physical exam, swelling**
→	**DPL, ultrasound, FAST**
→	**CT scan, direct look**

Shock vs Hemodynamic Instability

- Definitions Confusing
- Potentially based on multiple factors & measures
- Lactate
- Base Deficit
- SBP < 90 mmHg
- Ongoing drop in Hematrocrit
- Response to fluid challenge

Pelvic Fractures & Hemorrhage

- Fracture pattern associated with risk of vascular injury (Young & Burgess)
- External rotation and vertical shear injury patterns at higher risk for a vascular injury that internal rotation patterns
- APC & VS (antero-posterior compression and vertical shear) at increased risk of hemorrhage
- Injury patterns that are tensile to N-V structures at increased risk
- (eg iliac wing fractures with GSN extension

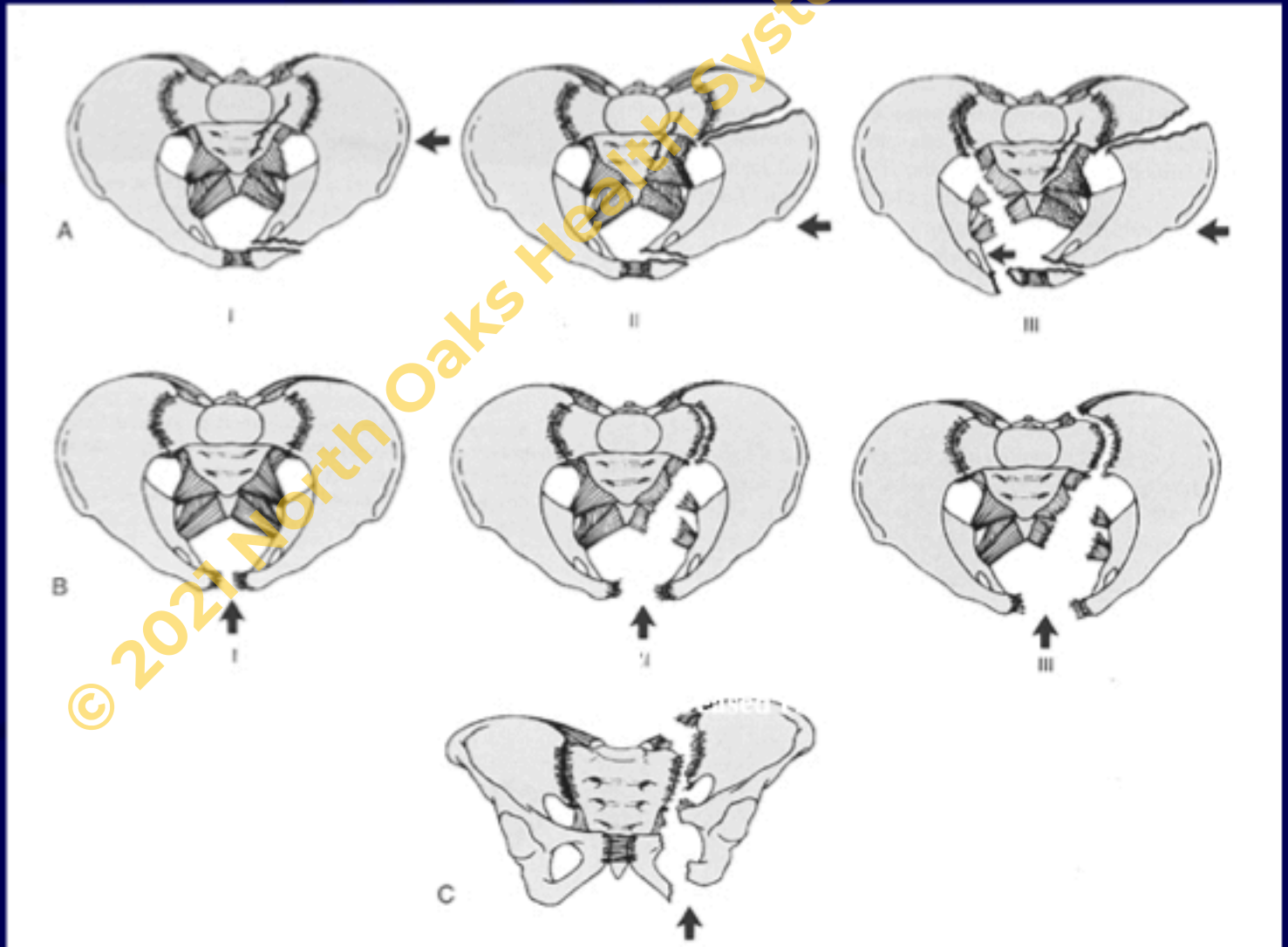
Dalal et al, JT, 1989
Burgess et al, JT, 1990
Whitbeck et al, JOT, 1997
Switzer et al, JOT, 2000
Eastridge et al, JT, 2002

Pelvic Fractures & Hemorrhage: Young and Burgess Classification

Lateral Compression (LC)

Anteroposterior Compression (APC)

Vertical Shear (VS)



Hemorrhage Control: Methods

- Pelvic Containment
  - *Sheet/Skeletal traction*
  - *Pelvic Binder*
  - *External Fixation*
- Angiography
- Laparotomy
- Pelvic Packing

Circumferential pelvic antishock sheeting: a temporary resuscitation aid

M L Chip Routt Jr [1], Alexis Falicov, Emma Woodhouse, Thomas A Schildhauer

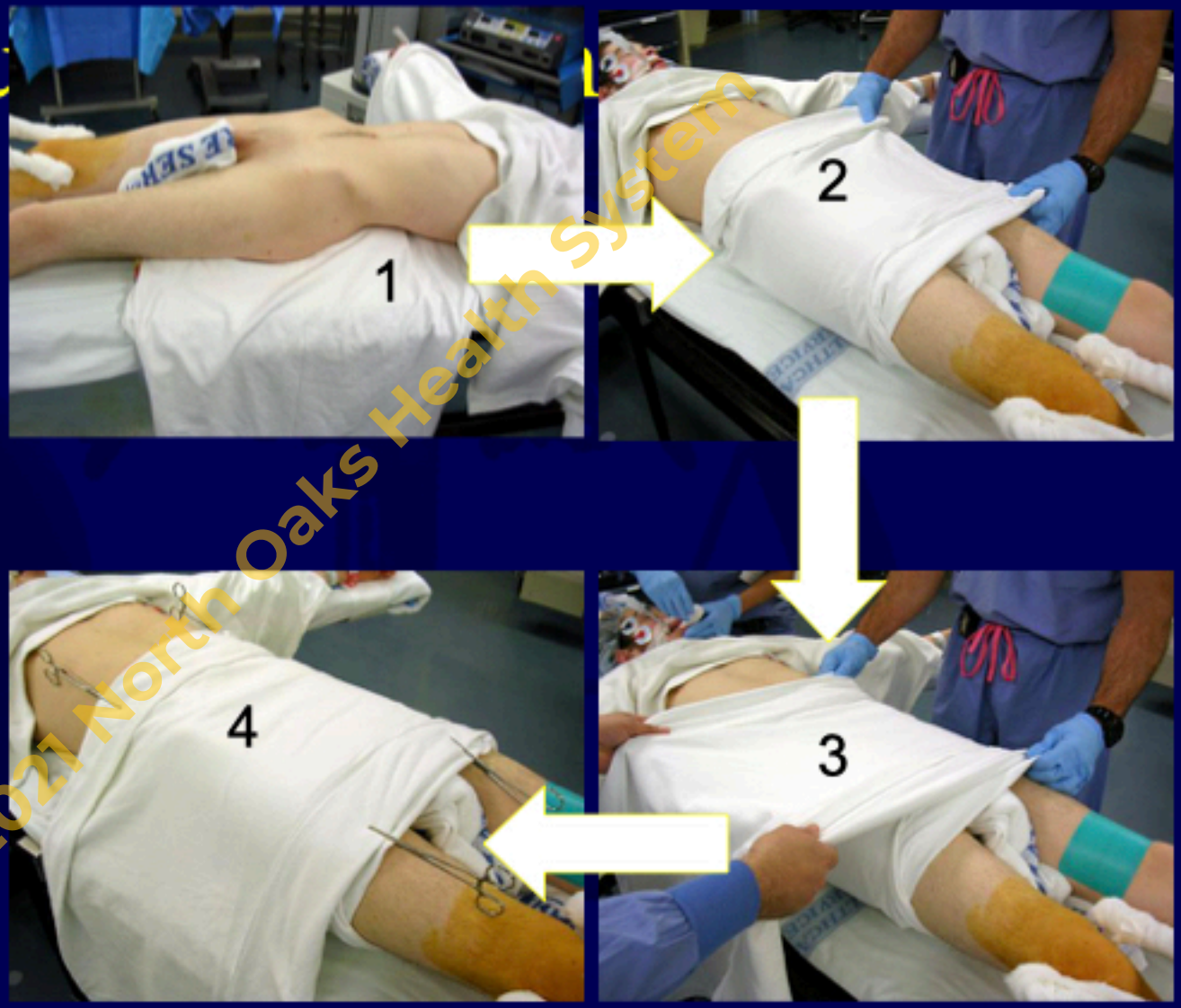
Affiliations + expand

PMID: 11782633 DOI: 10.1097/00005131-200201000-00010

- First intervention for volume expanding pelvic ring injury
- Simple, effective, universally available equipment
- Caution: skin problems

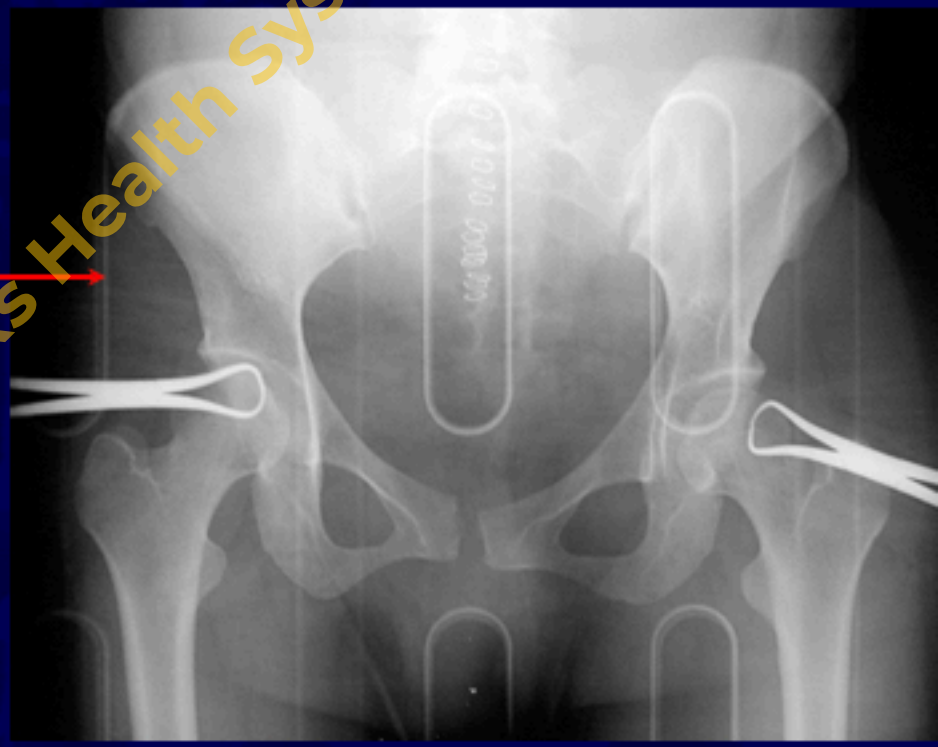
Circu

- Supine
- 2 “Wrappers”
- Placement
- Apply
- “Clamper”
- 30 Seconds



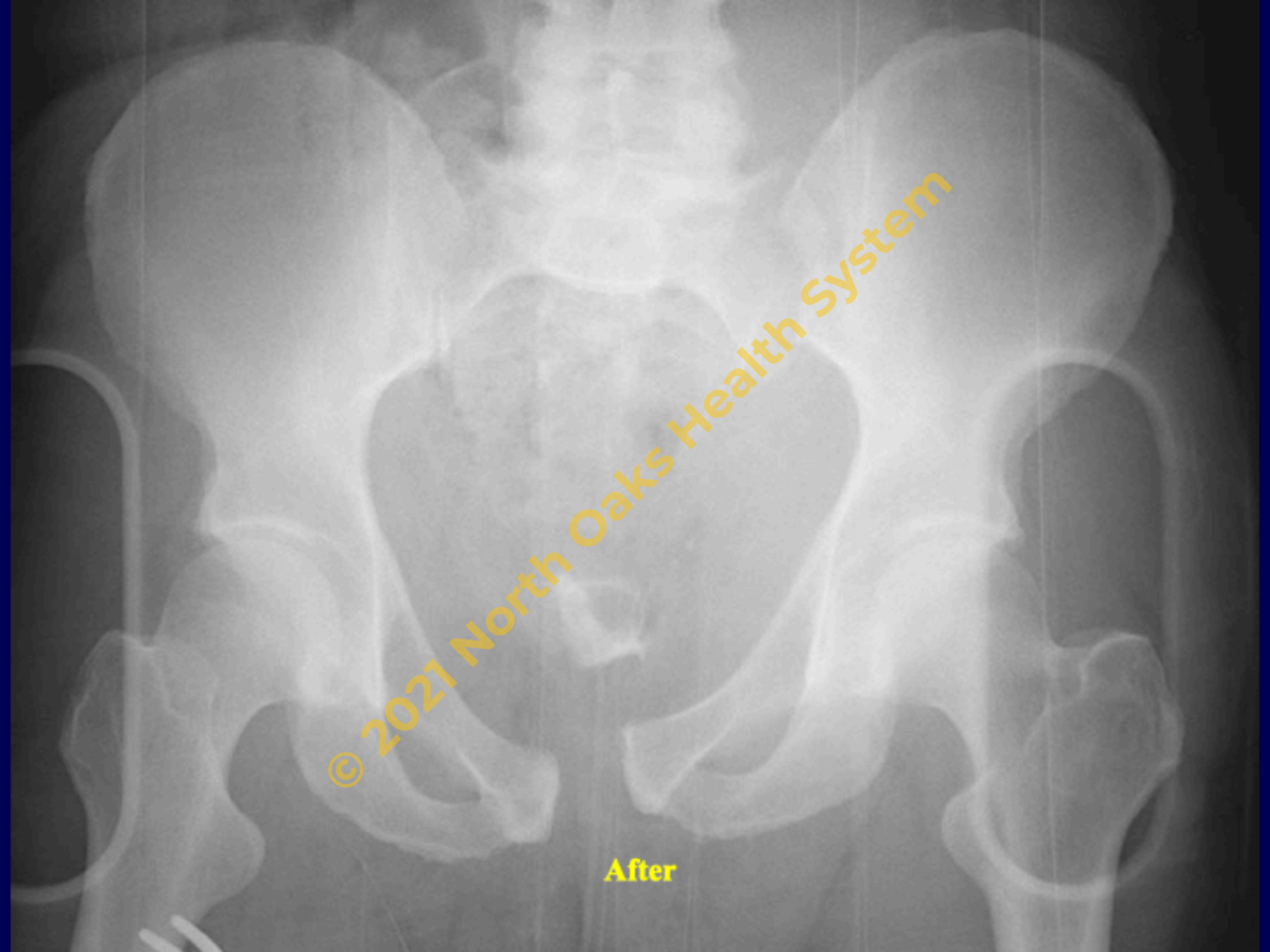
Routt et al, JOT, 2002

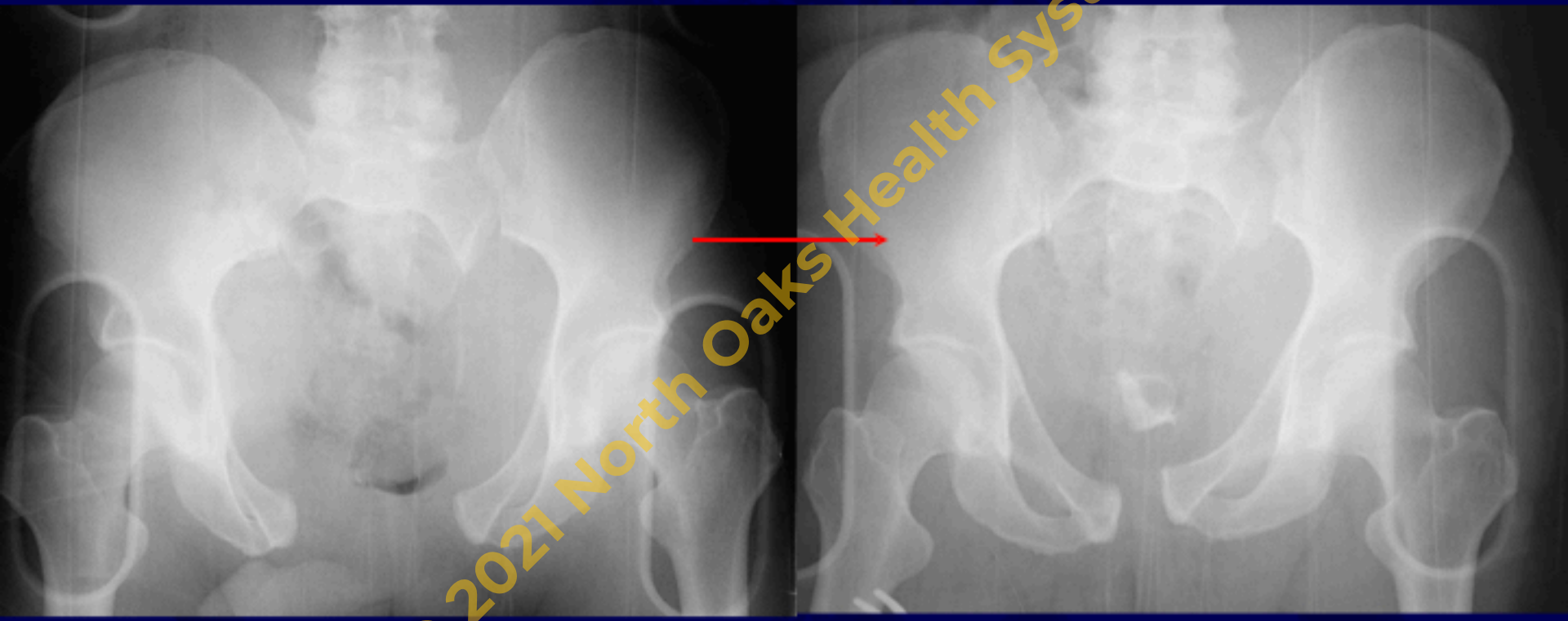
Sheet Application



Sheet Application

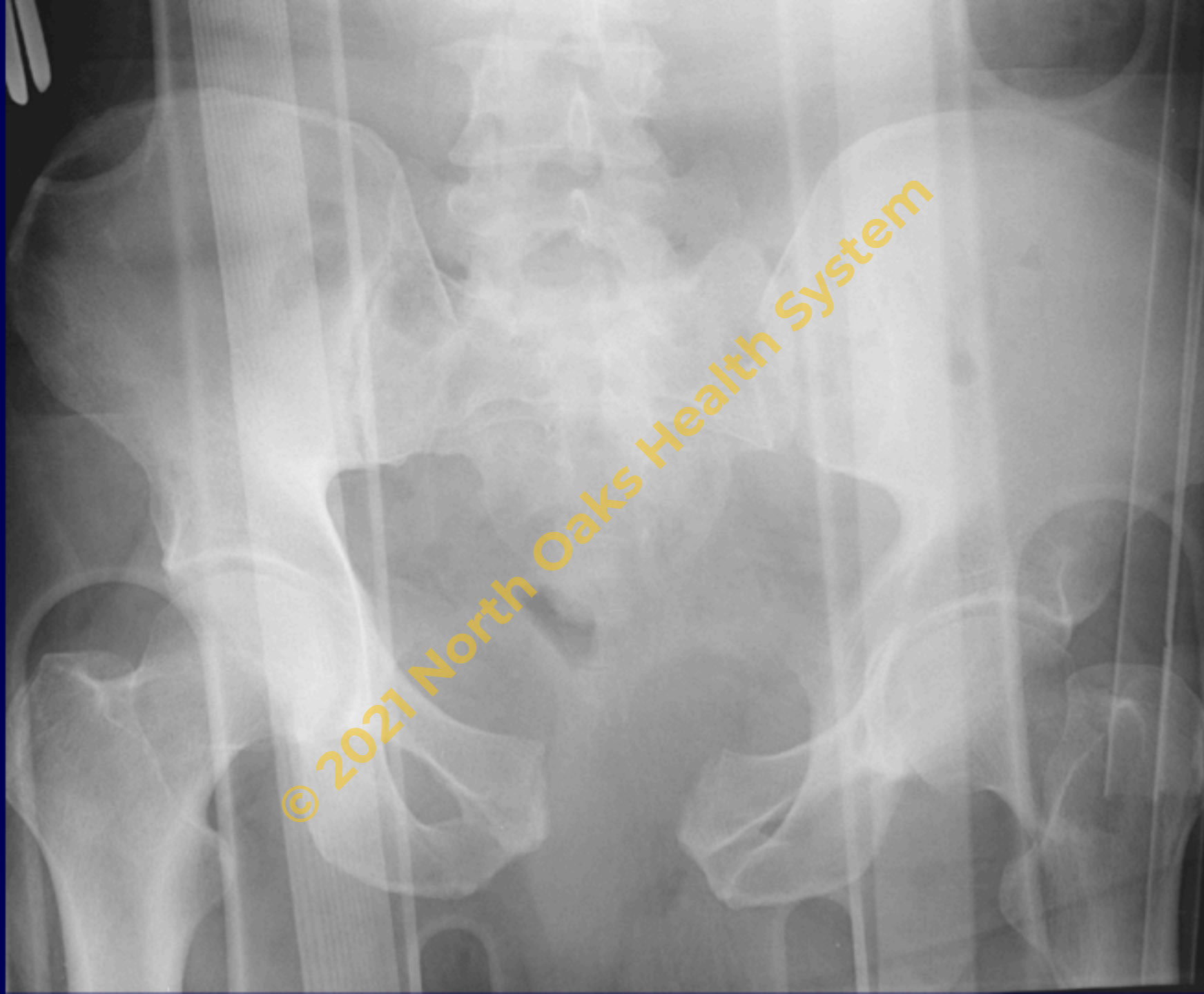
Before

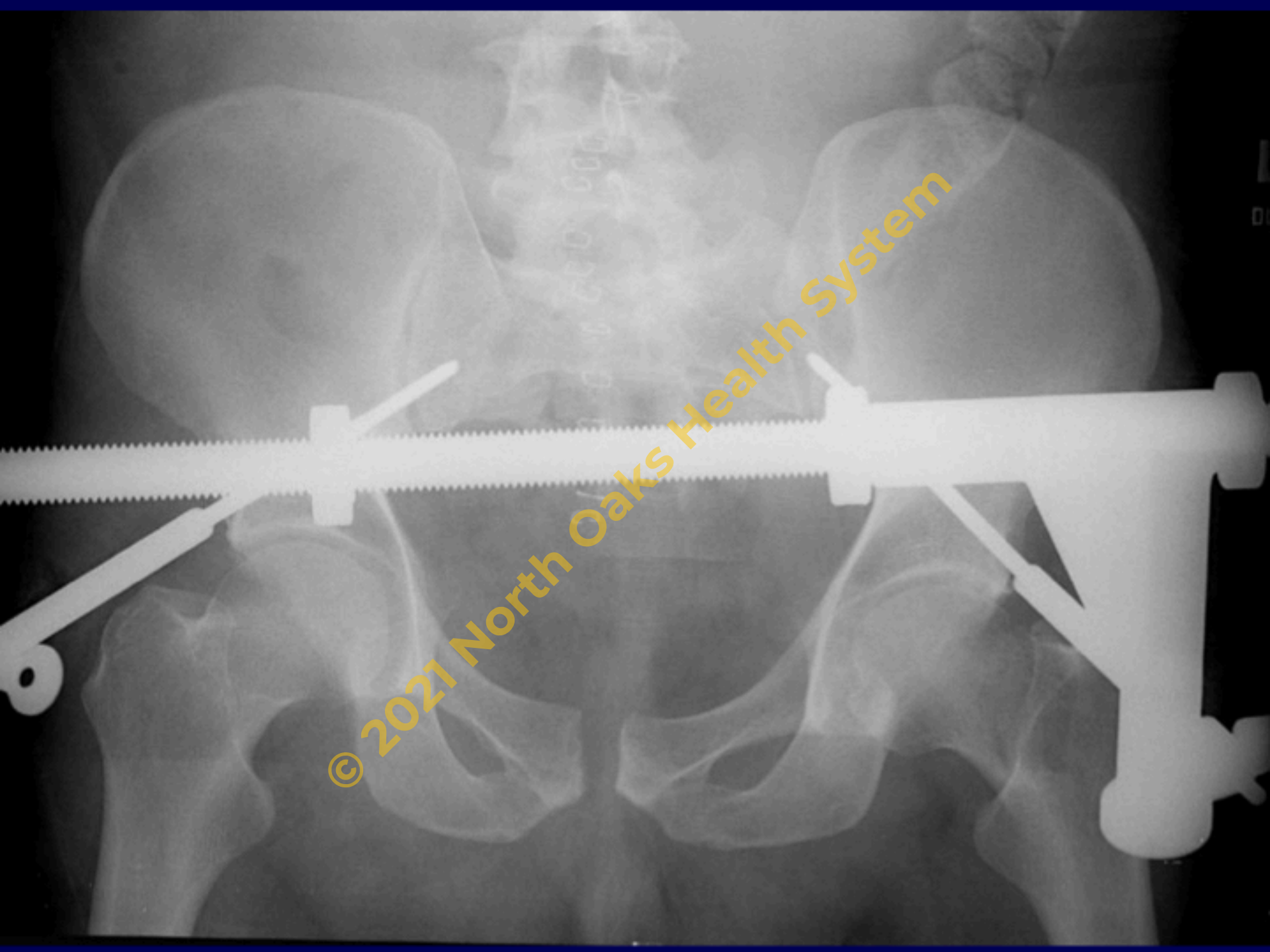


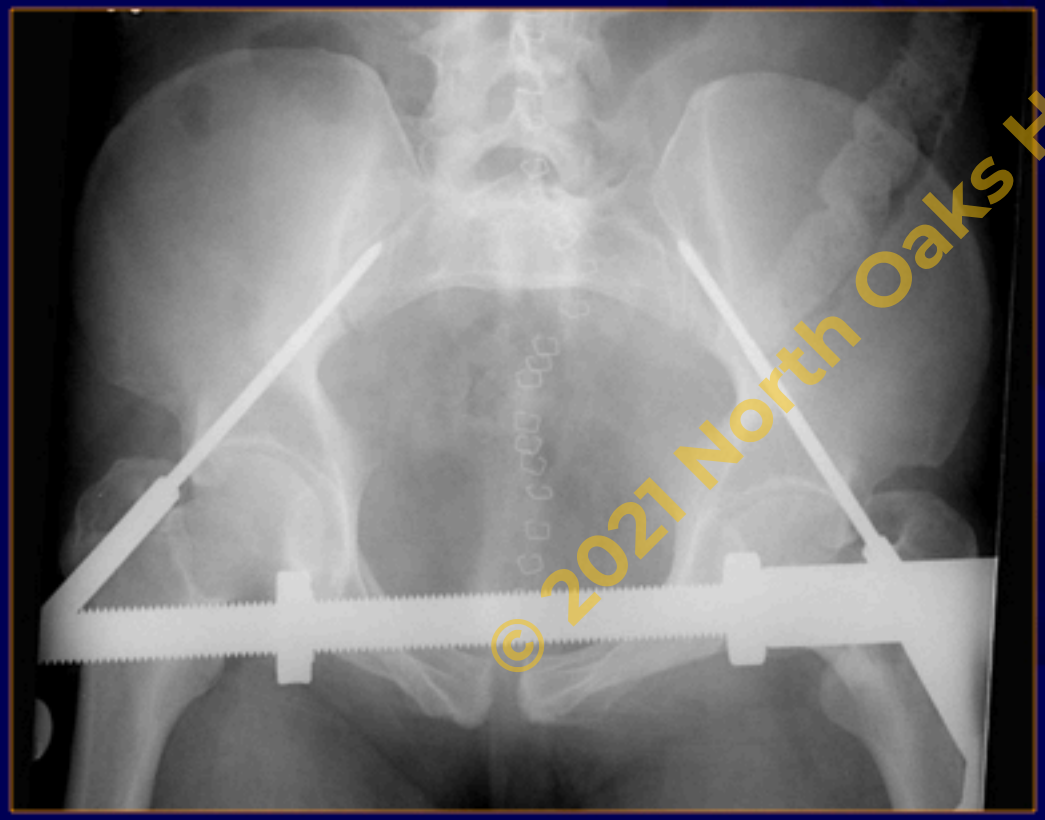


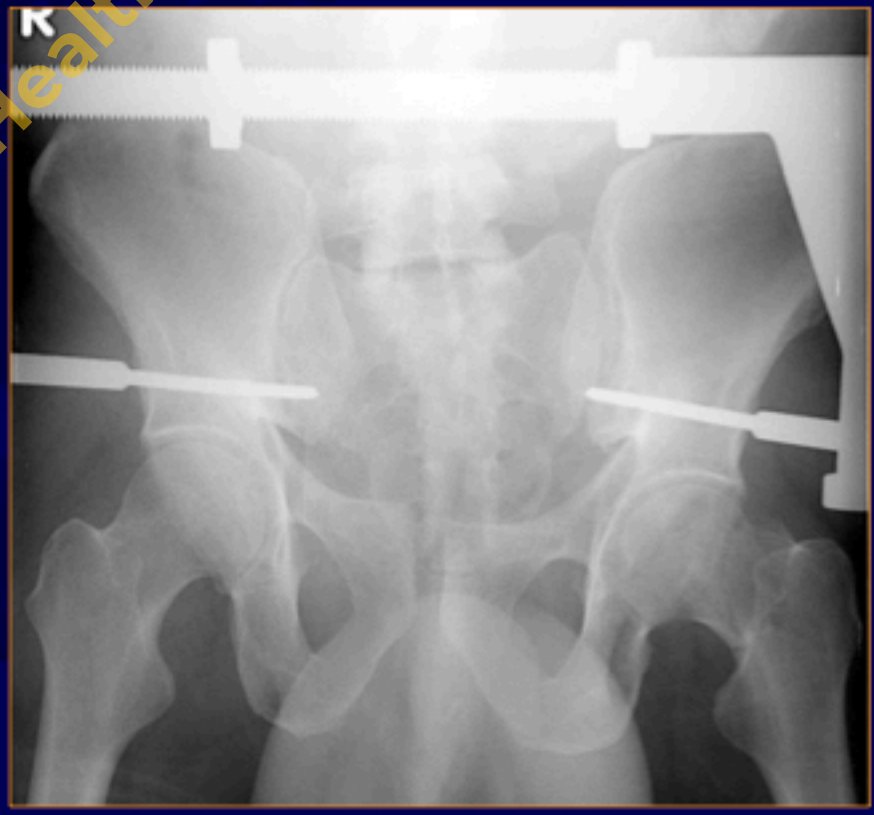
Sheeting Benefits

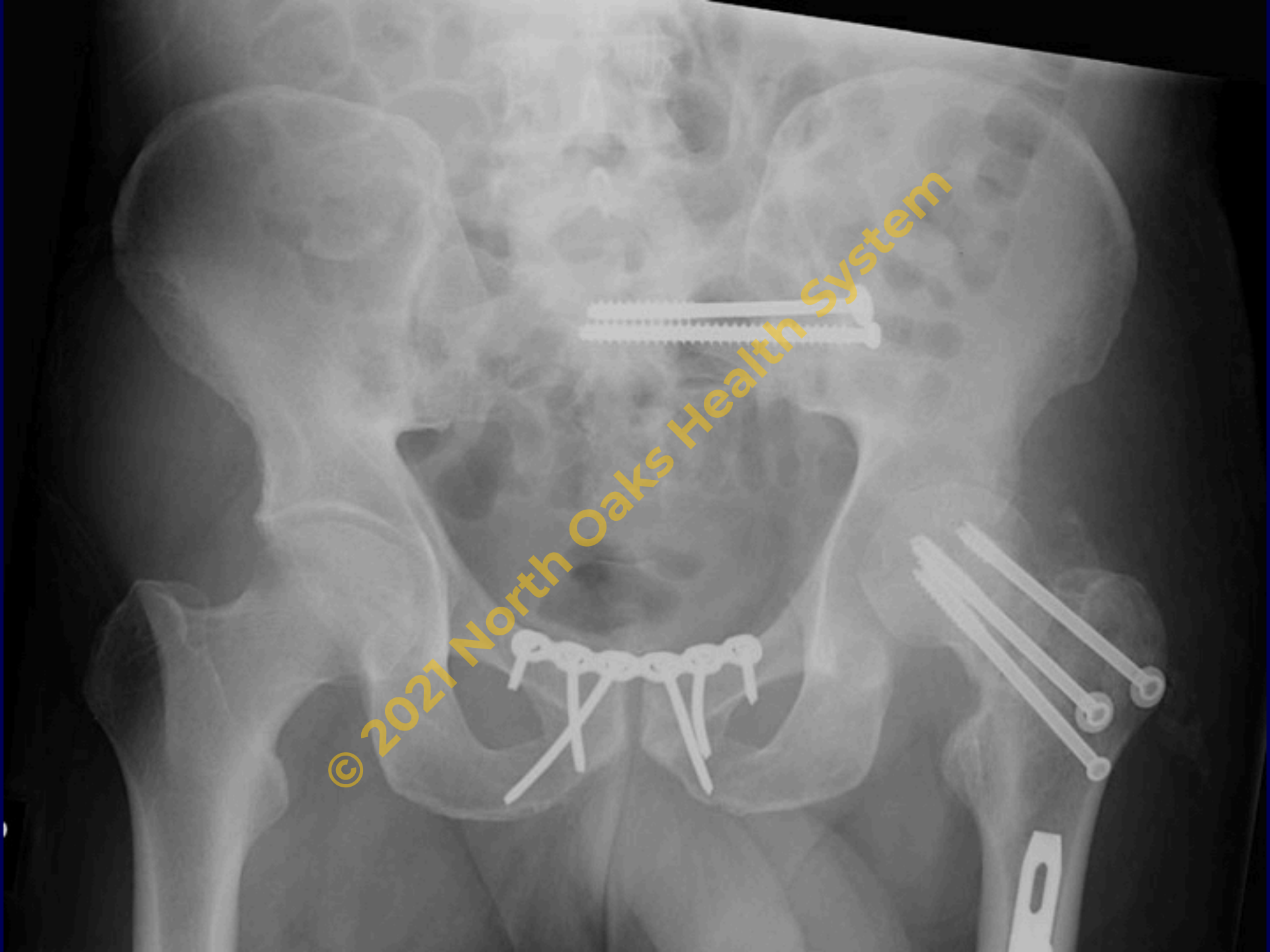
- Allows vascular access
- Can be maintained during external fixation and SI screw placement
- Wrinkle free
- Clamps checks and skin checks











Indications for External Fixation

- **Resuscitative** (hemorrhage control, stability)
- To decrease pain in polytraumatized patients?
- As an adjunct to ORIF
- Definitive treatment (Rare!)
  - Distraction frame
  - Can't ORIF the pelvis

Theoretical and a marginal indication, but there is literature support

Barei, D. P.; Shafer, B. L.; Beingessner, D. M.; Gardner, M. J.; Nork, S. E.; and Routt, M. L.: The impact of open reduction internal fixation on acute pain management in unstable pelvic ring injuries. *J Trauma,* 68(4): 949-53, 2010.

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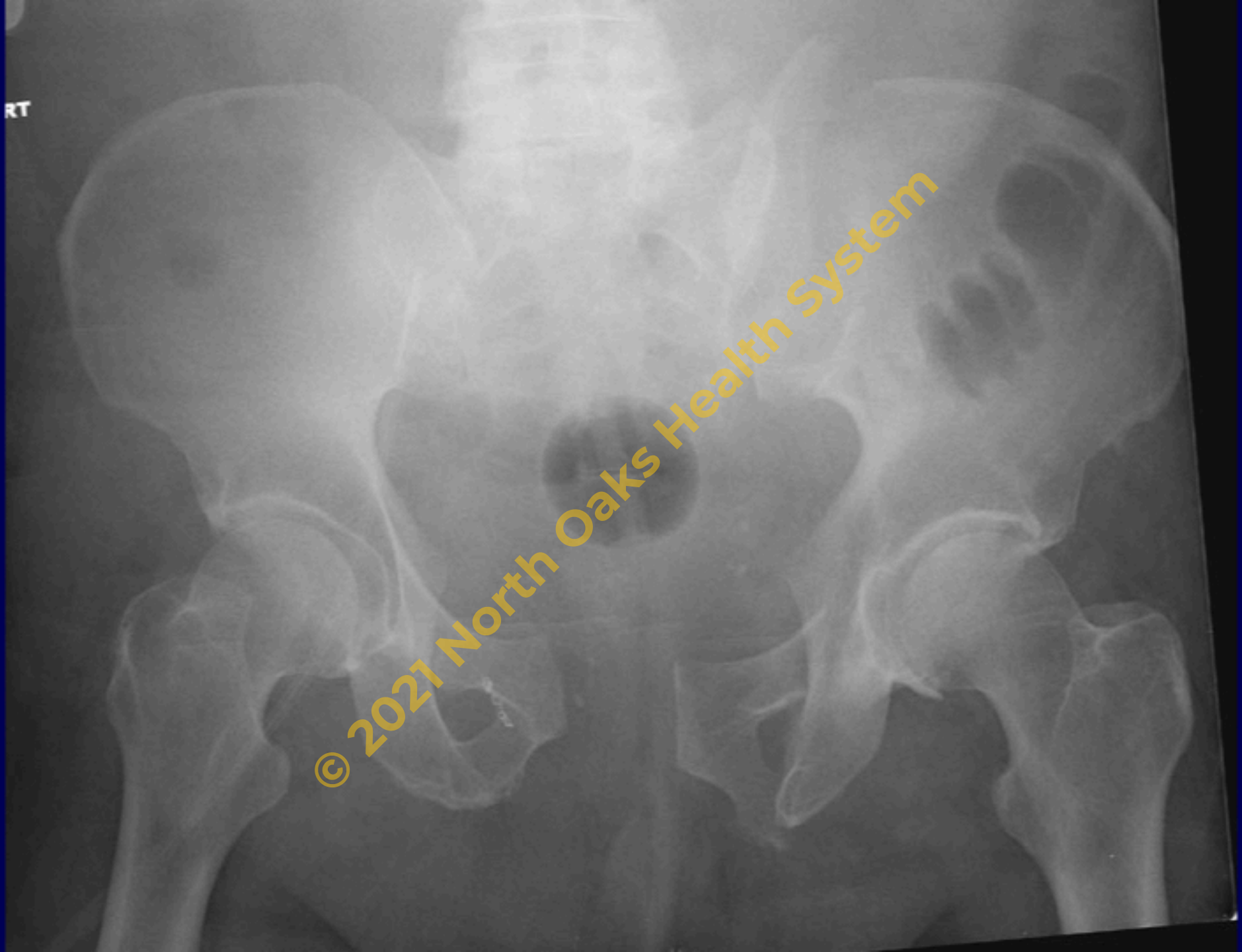

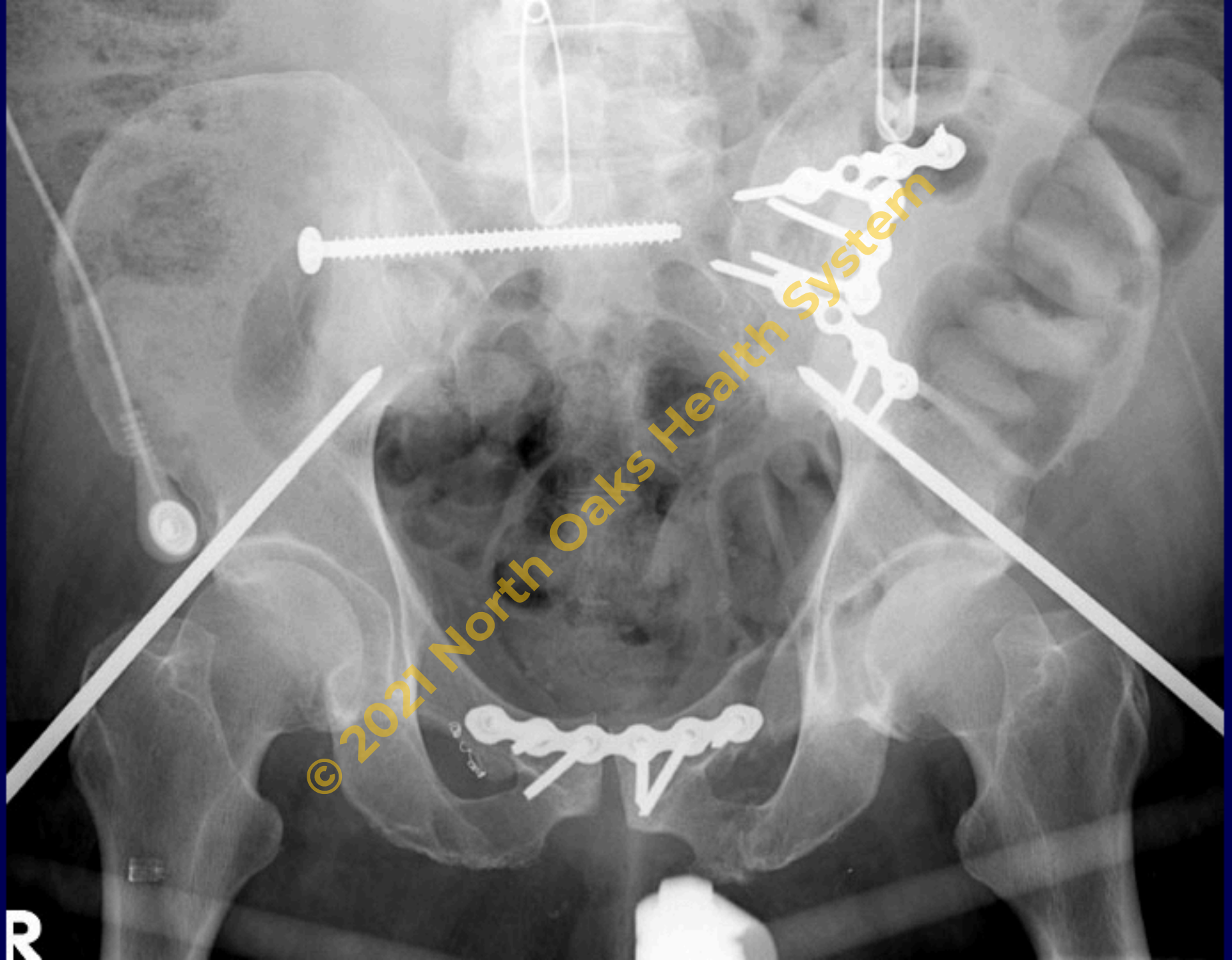

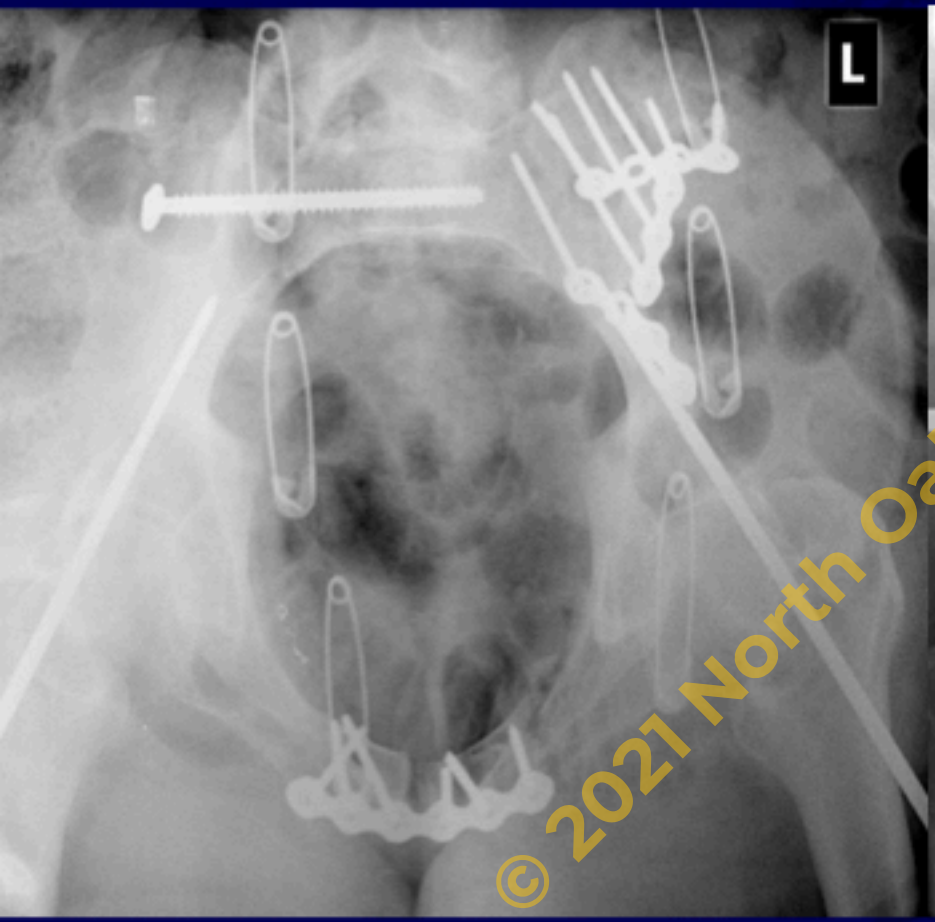

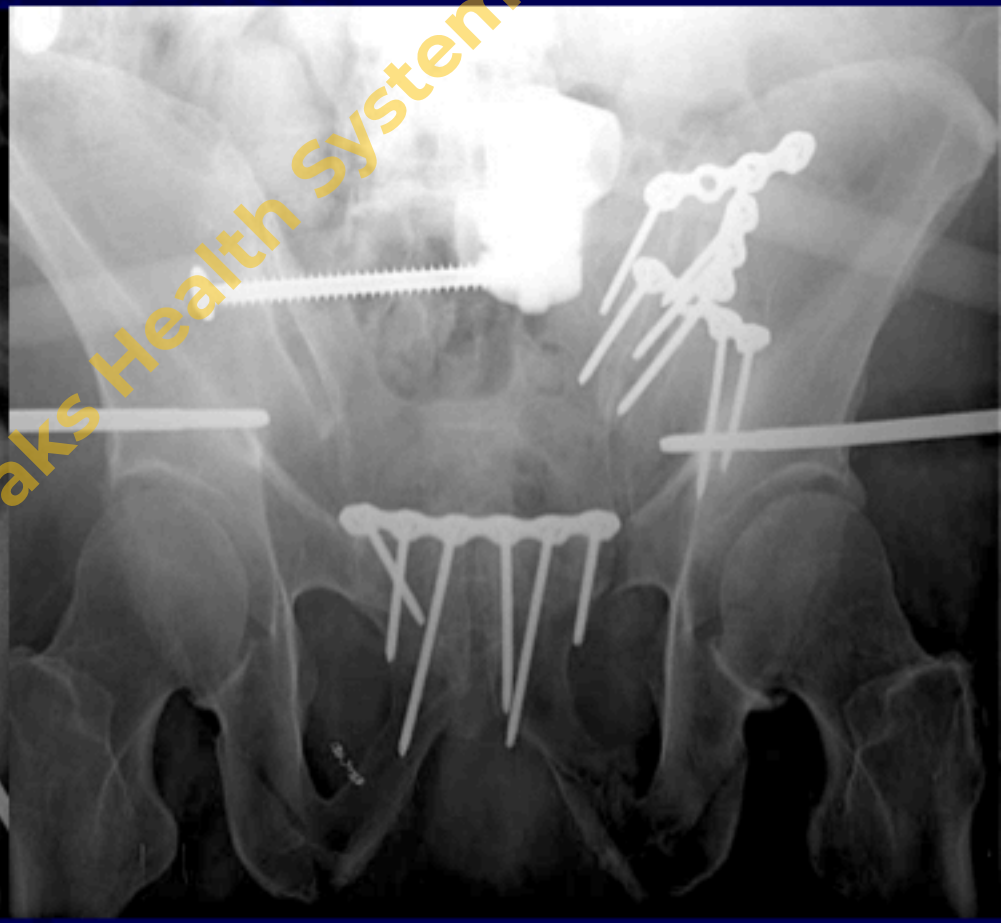

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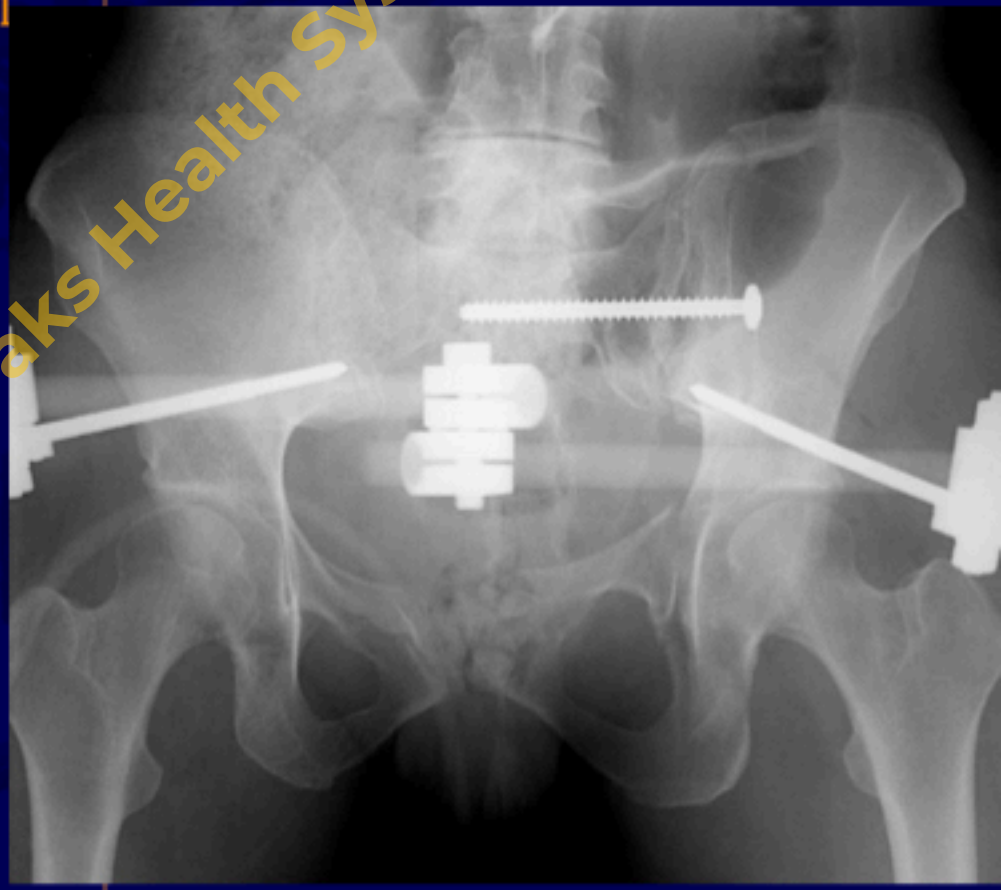
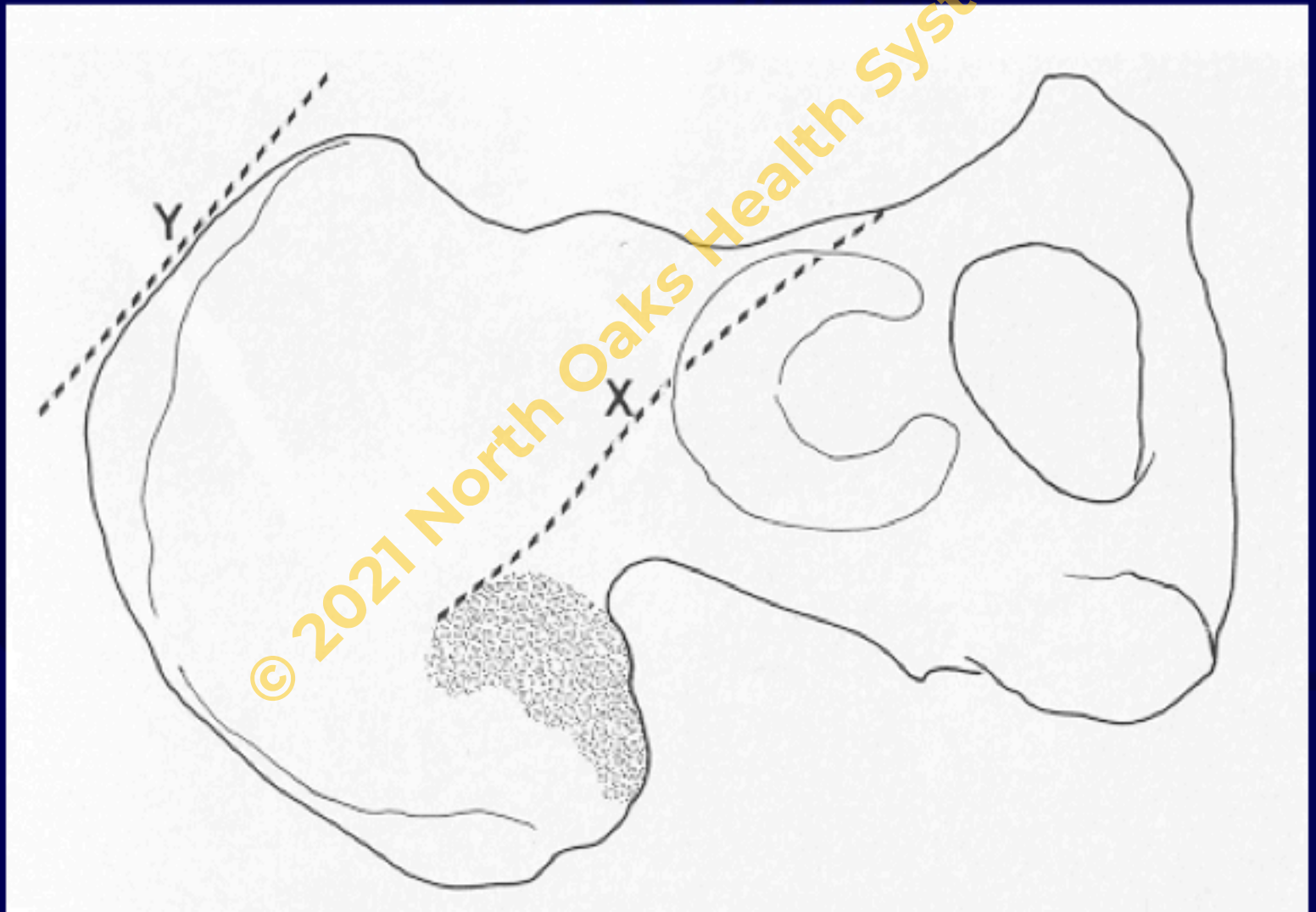
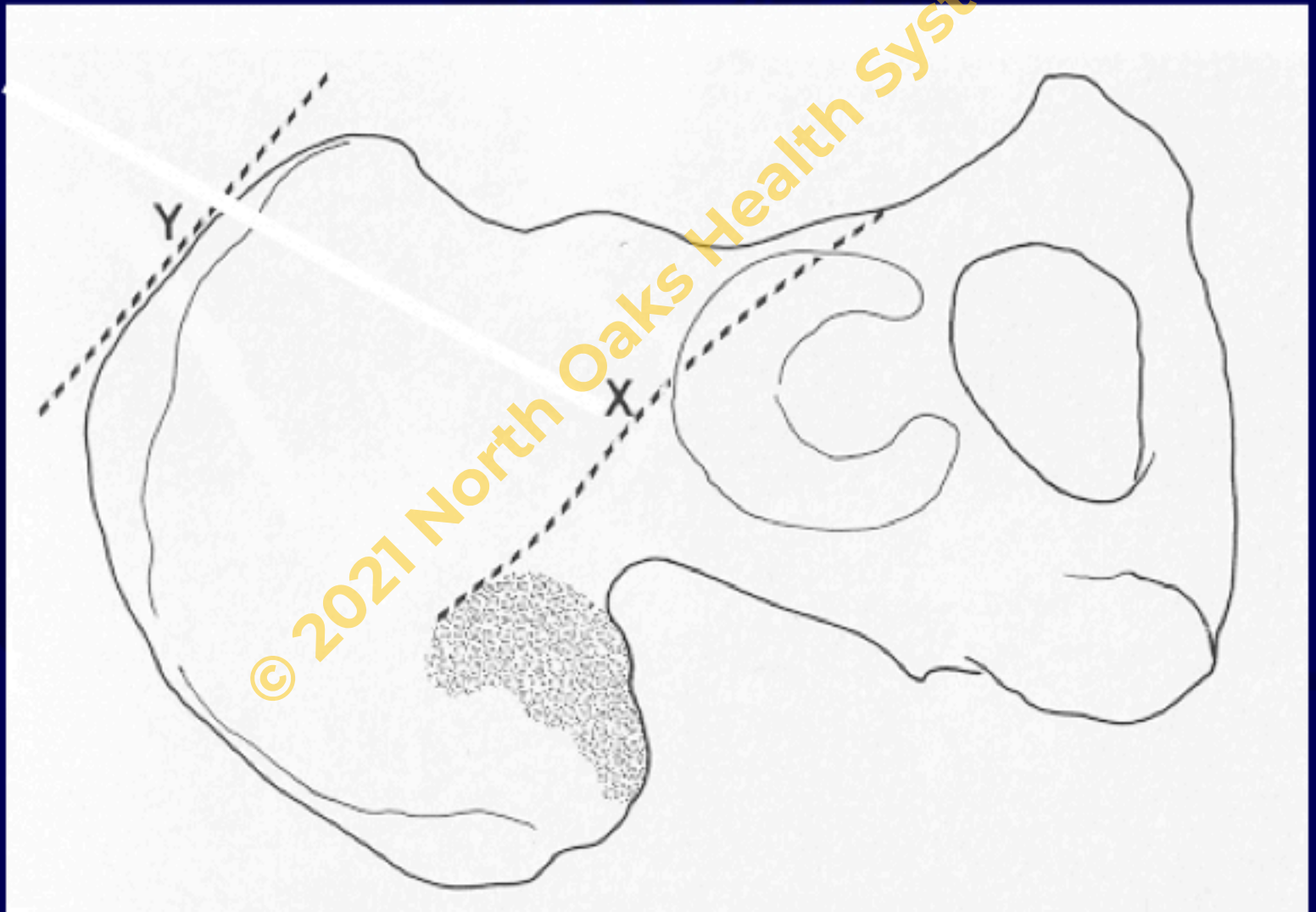


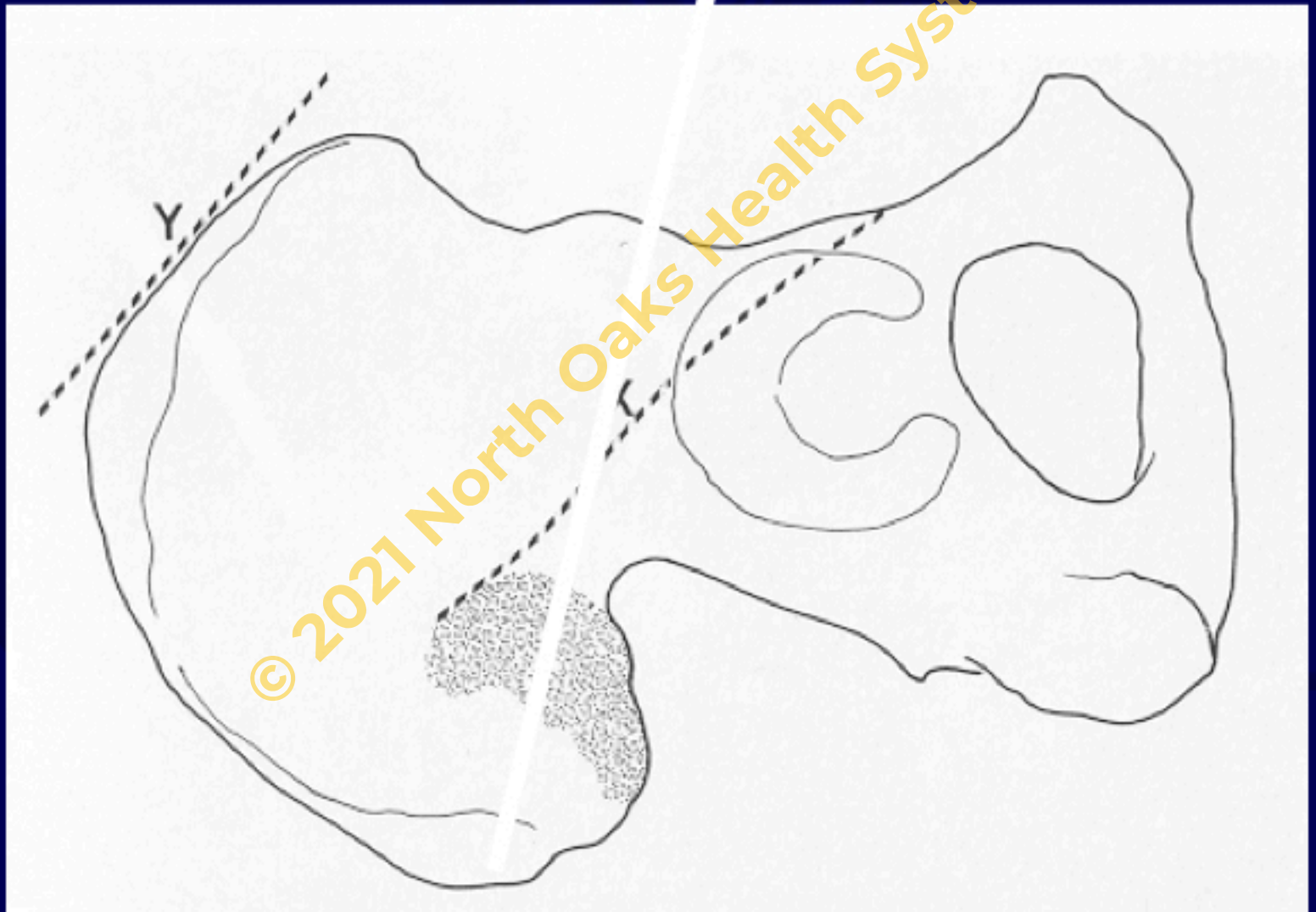
Technical Details: ASIS & AIIS Frames



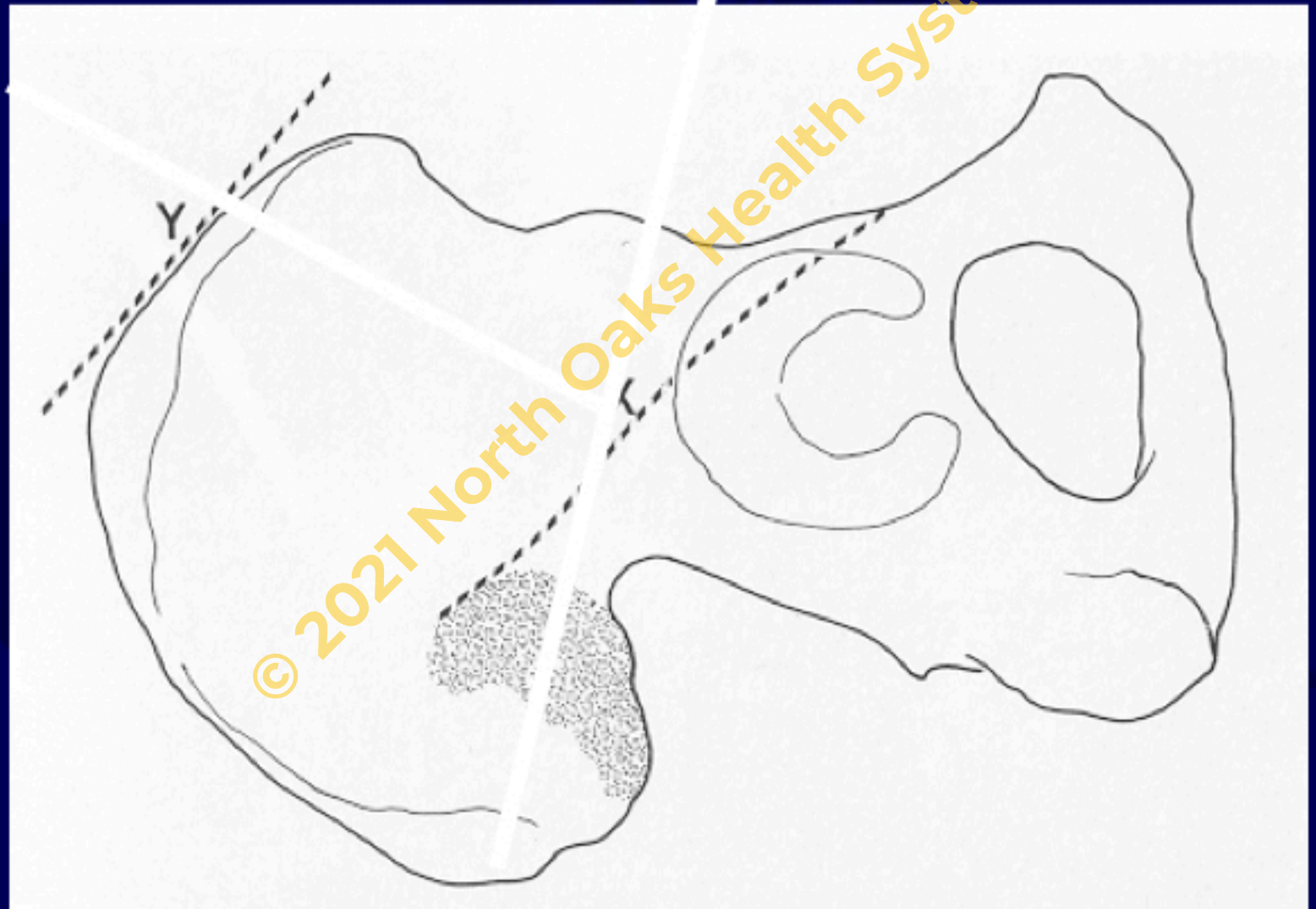
Pin Orientation: ASIS



Pin Orientation: AIIS

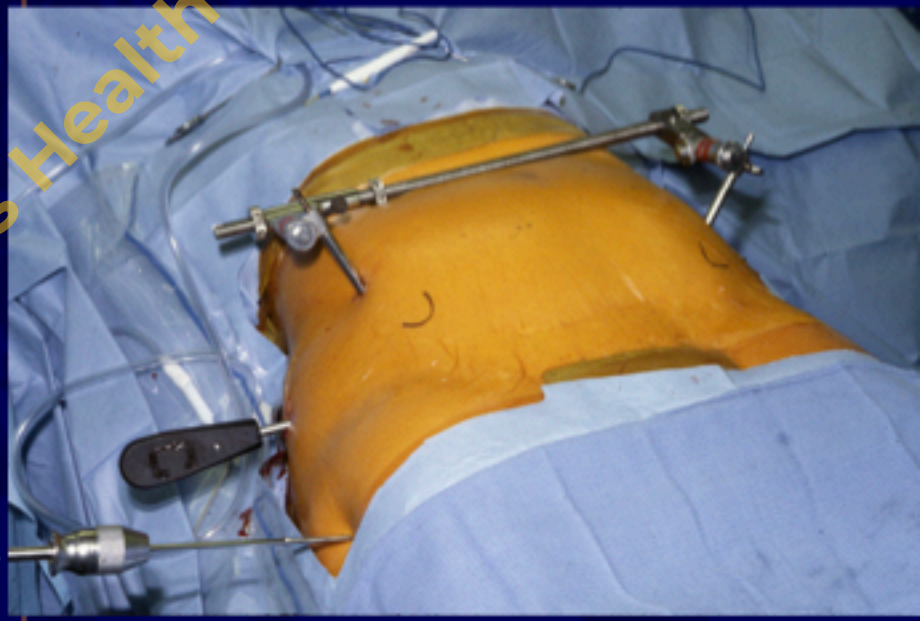


Pin Orientations



Technical Details: ASIS frames…

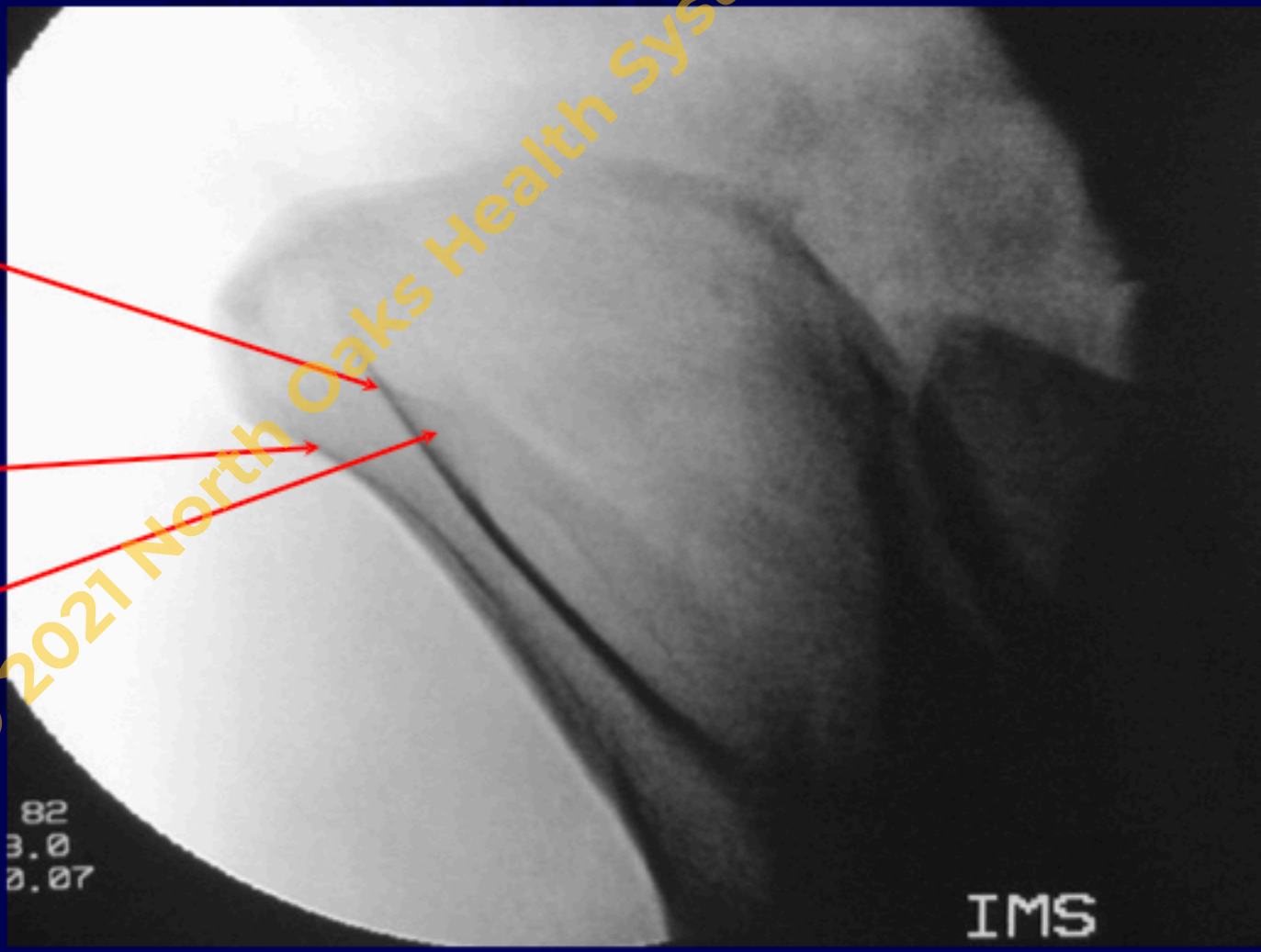
- Fluoro dependent
- 3 to 5 cm posterior to the ASIS
- Along the gluteus medius pillar
- Incisions directed toward the anticipated final pin location
- Pin entry at the junction of the lateral 2/3 and medial 1/3 of the iliac crest (lateral overhang of the crest)
- Aim: 30 to 45 degrees (from lateral to medial)
- Toward the hip joint



Consider partial closed reduction first!

Outlet Oblique Image

- Inner Table
- Outer Table
- ASIS



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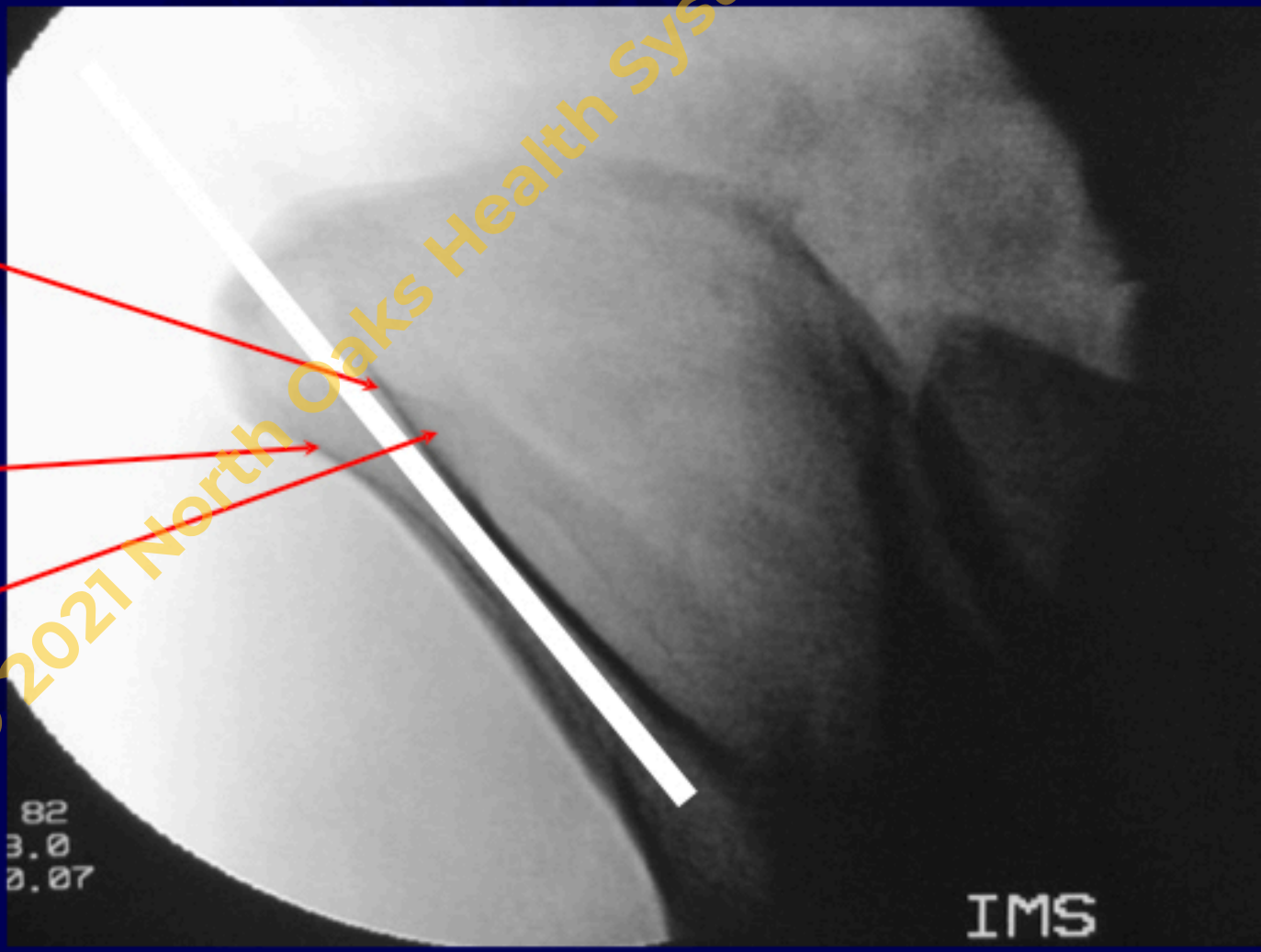

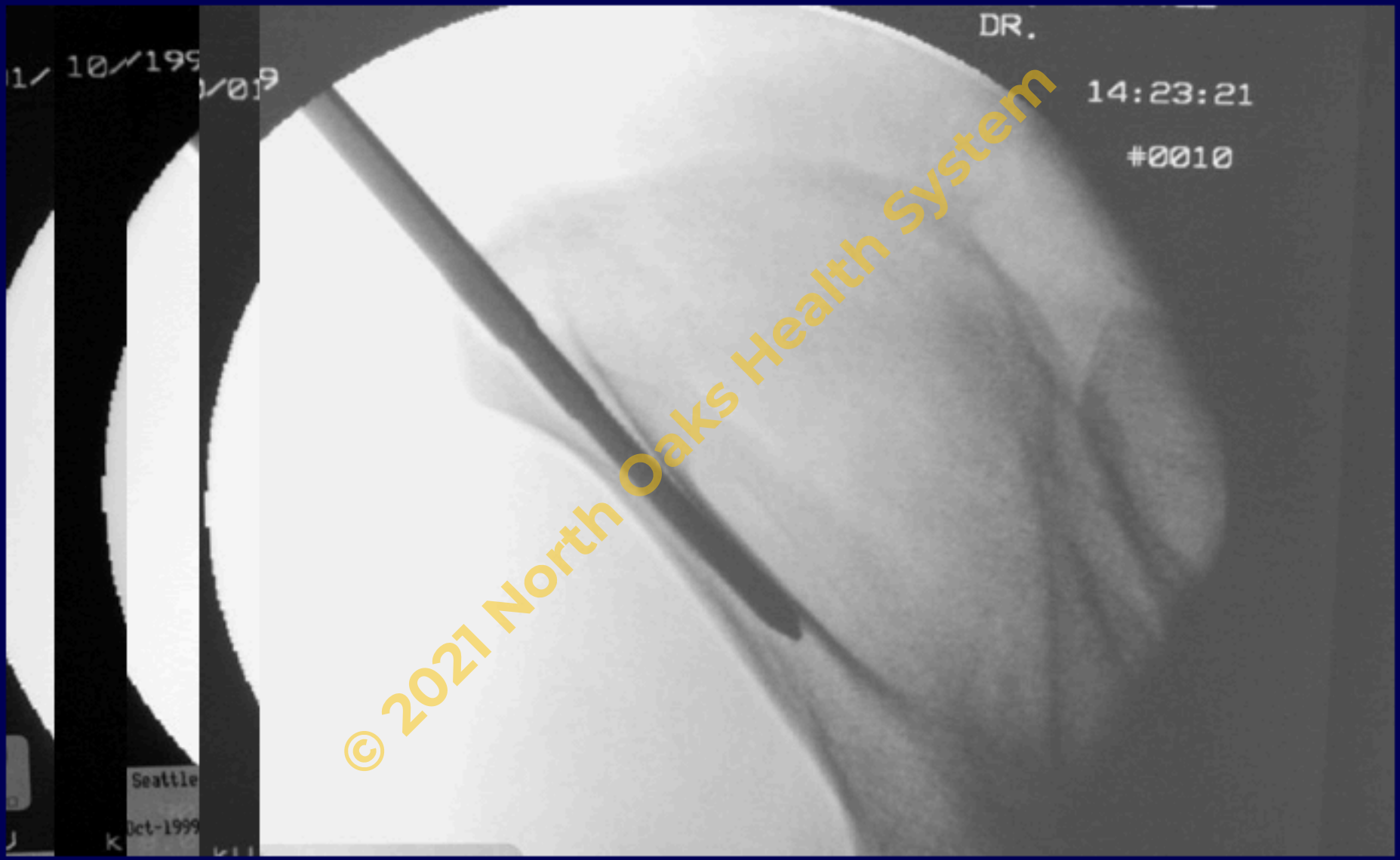
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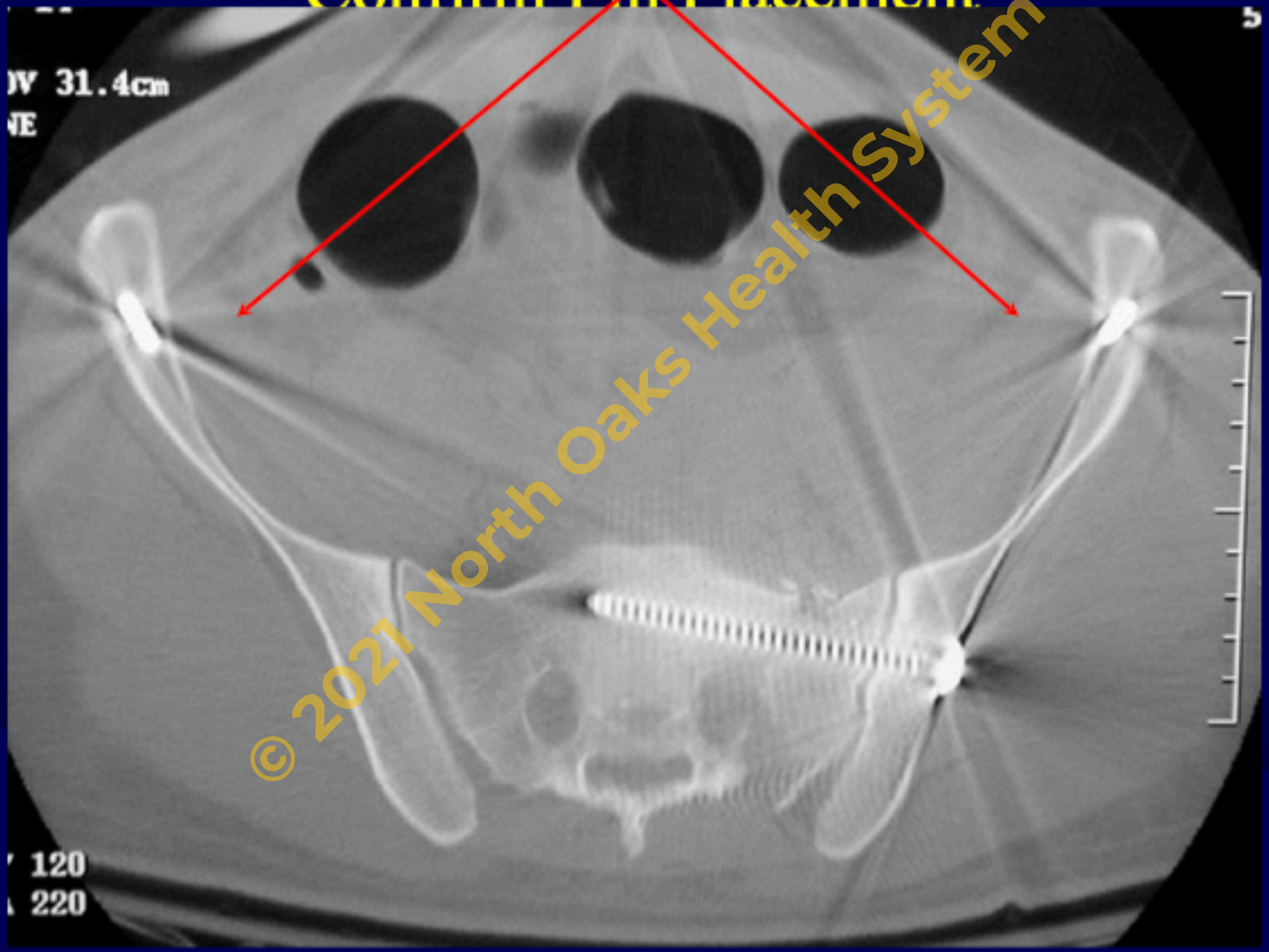
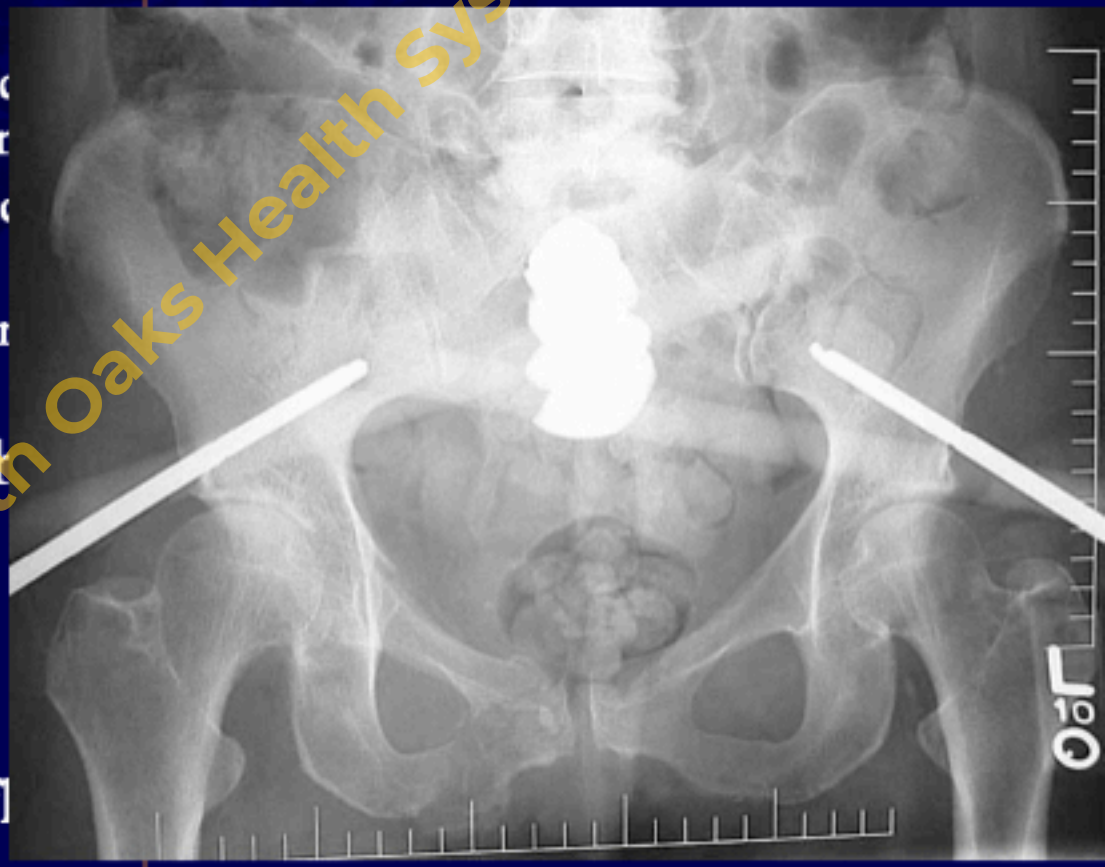
Confirm Pin Placement

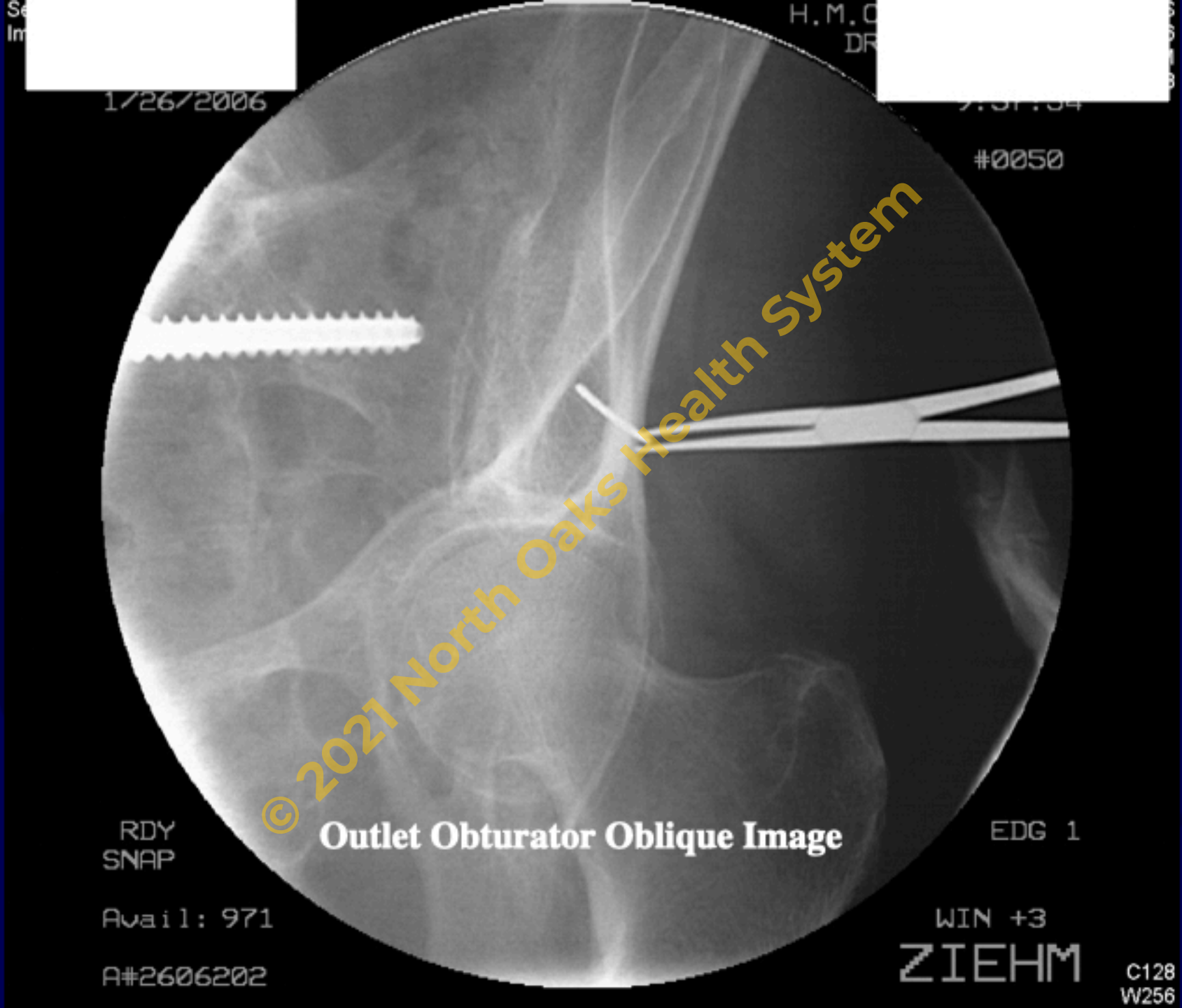


Technical Details: AIIS frames…

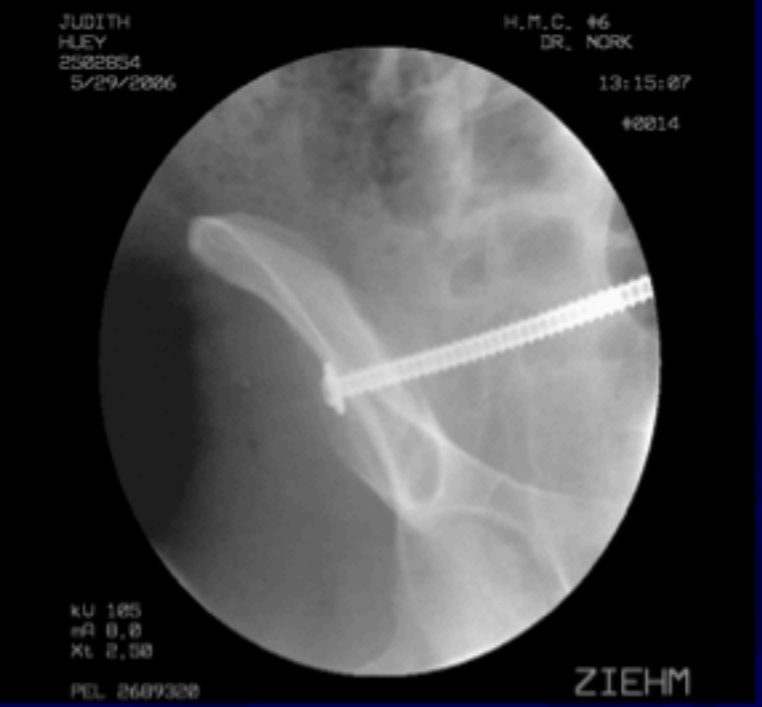
- Fluoro dependent:
- 1. 30/30 outlet/obturator oblic
(confirm entry location and direction
- 2. Iliac oblique (confirm direc
above sciatic notch)
- 3. Inlet/obturator oblique (cor
depth)
- Incisions directed toward th
anticipated final location
- Blunt dissection
- Aim: According to fl

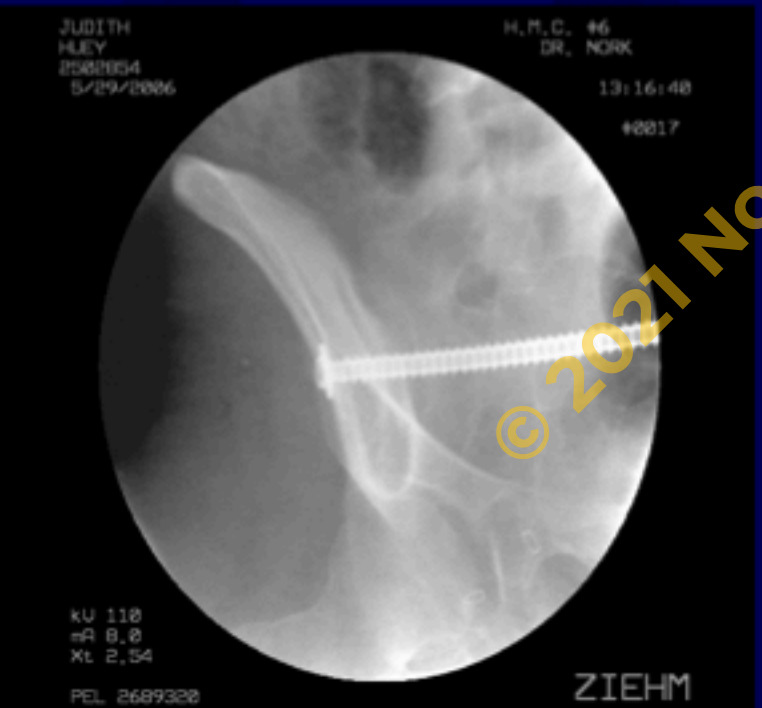


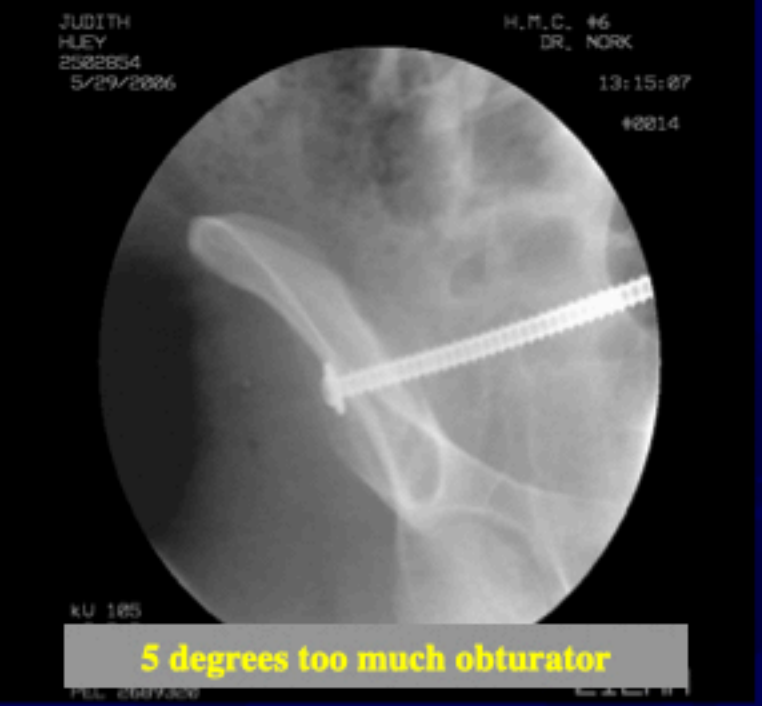
Consider partial closed reduction first!



Outlet Obturator Oblique Image





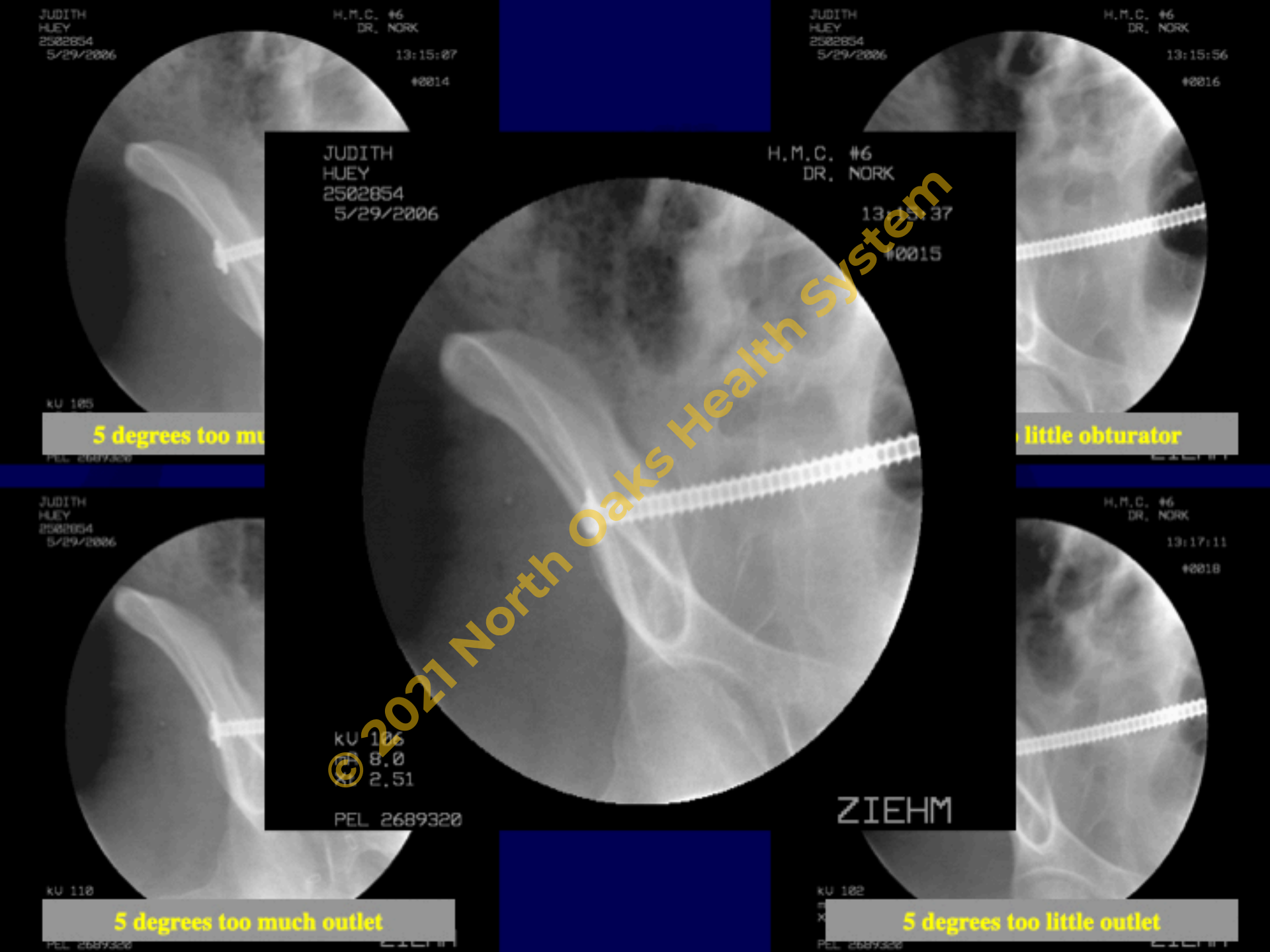


5 degrees too much obturator

5 degrees too little obturator

5 degrees too much outlet

5 degrees too little outlet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ZIEHM
5 degrees too much outlet
5 degrees too little outlet
little obturator
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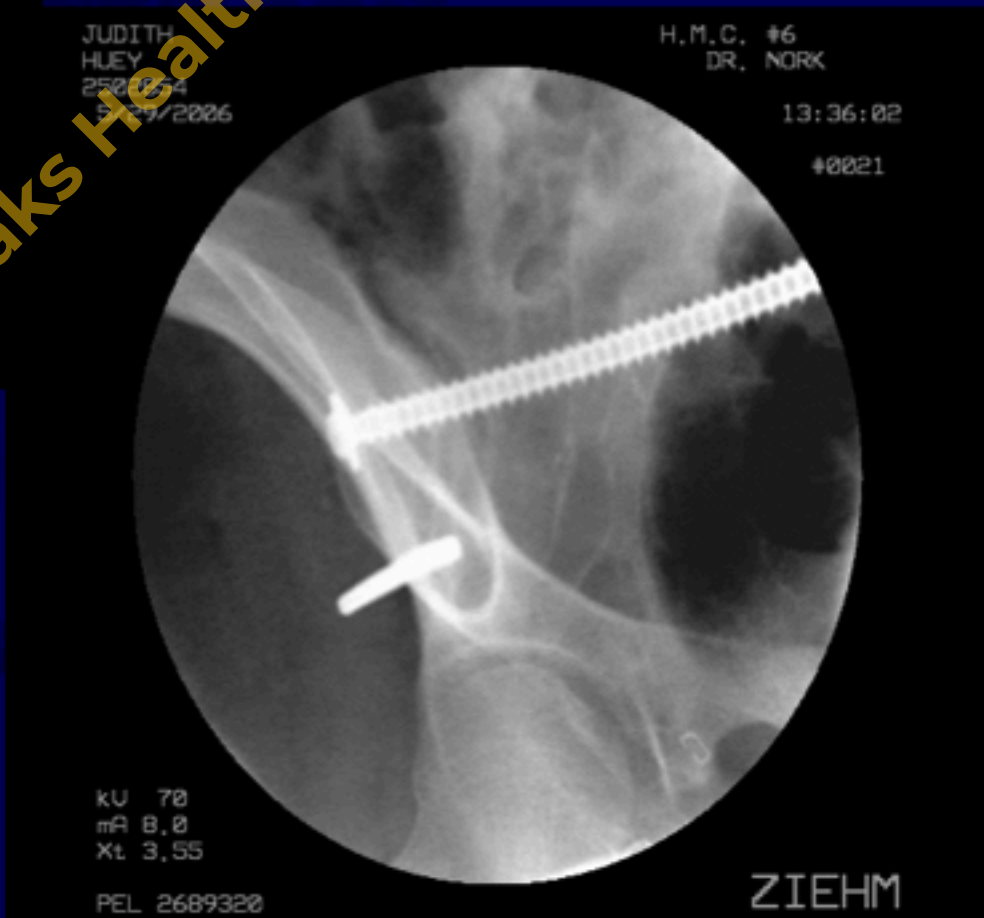
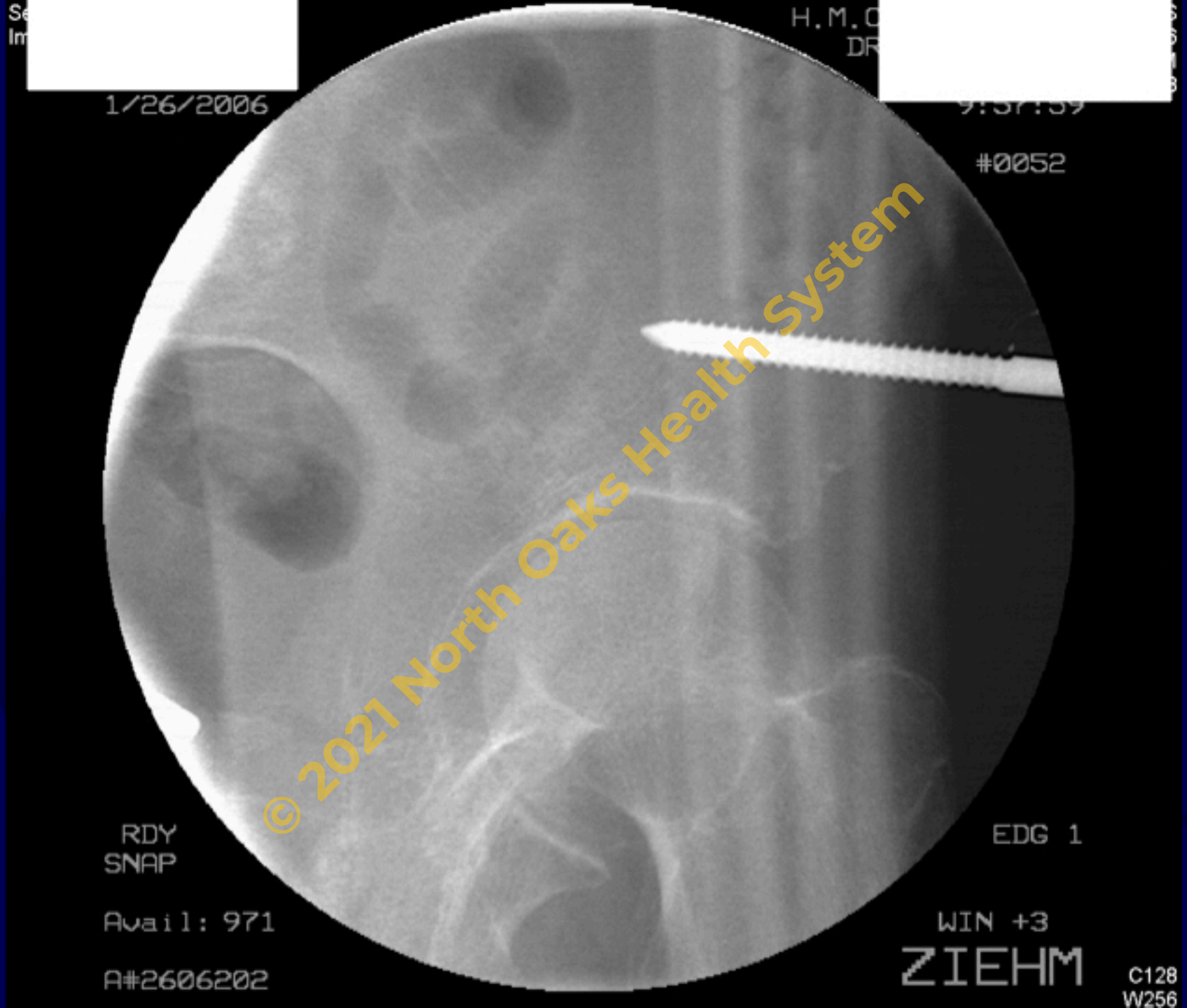
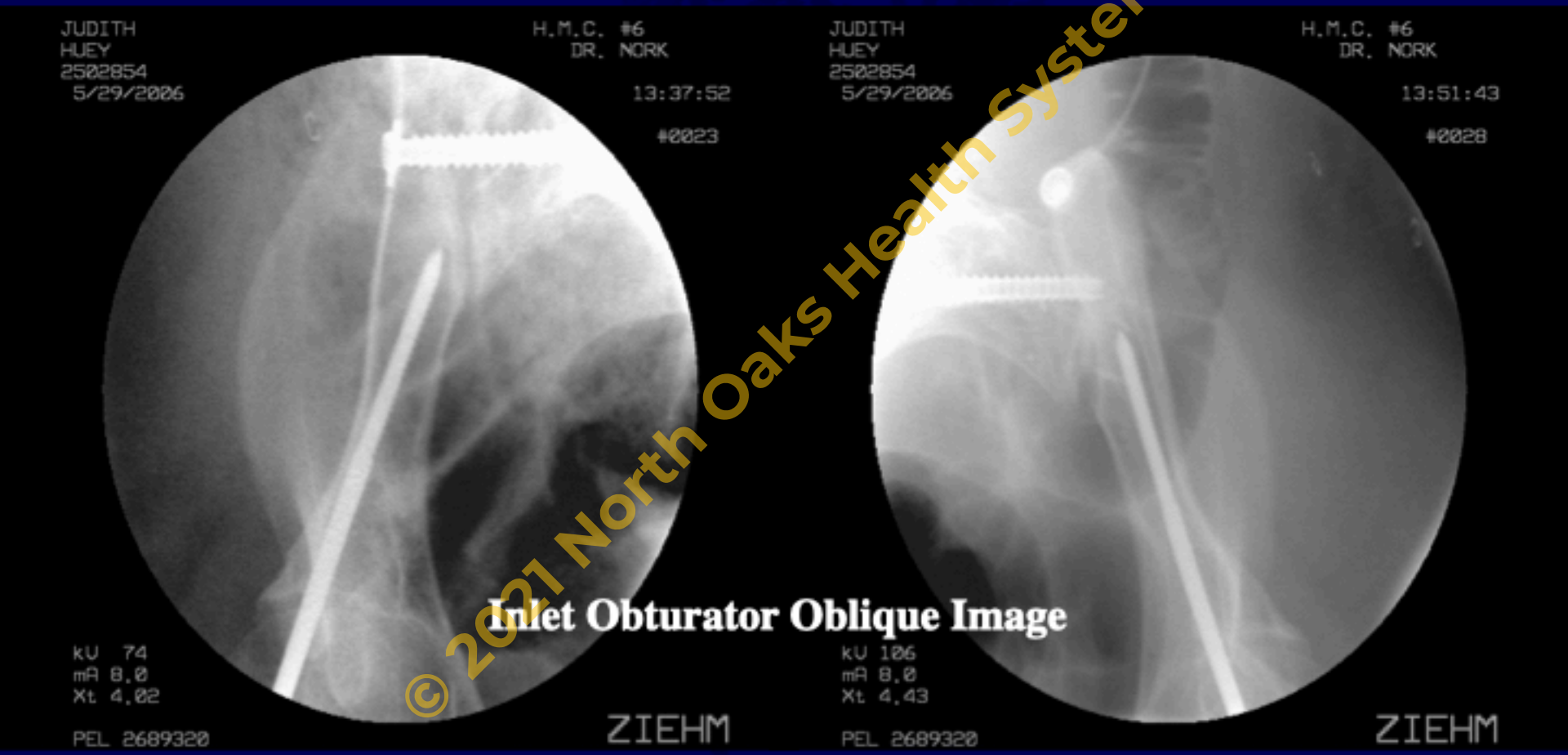
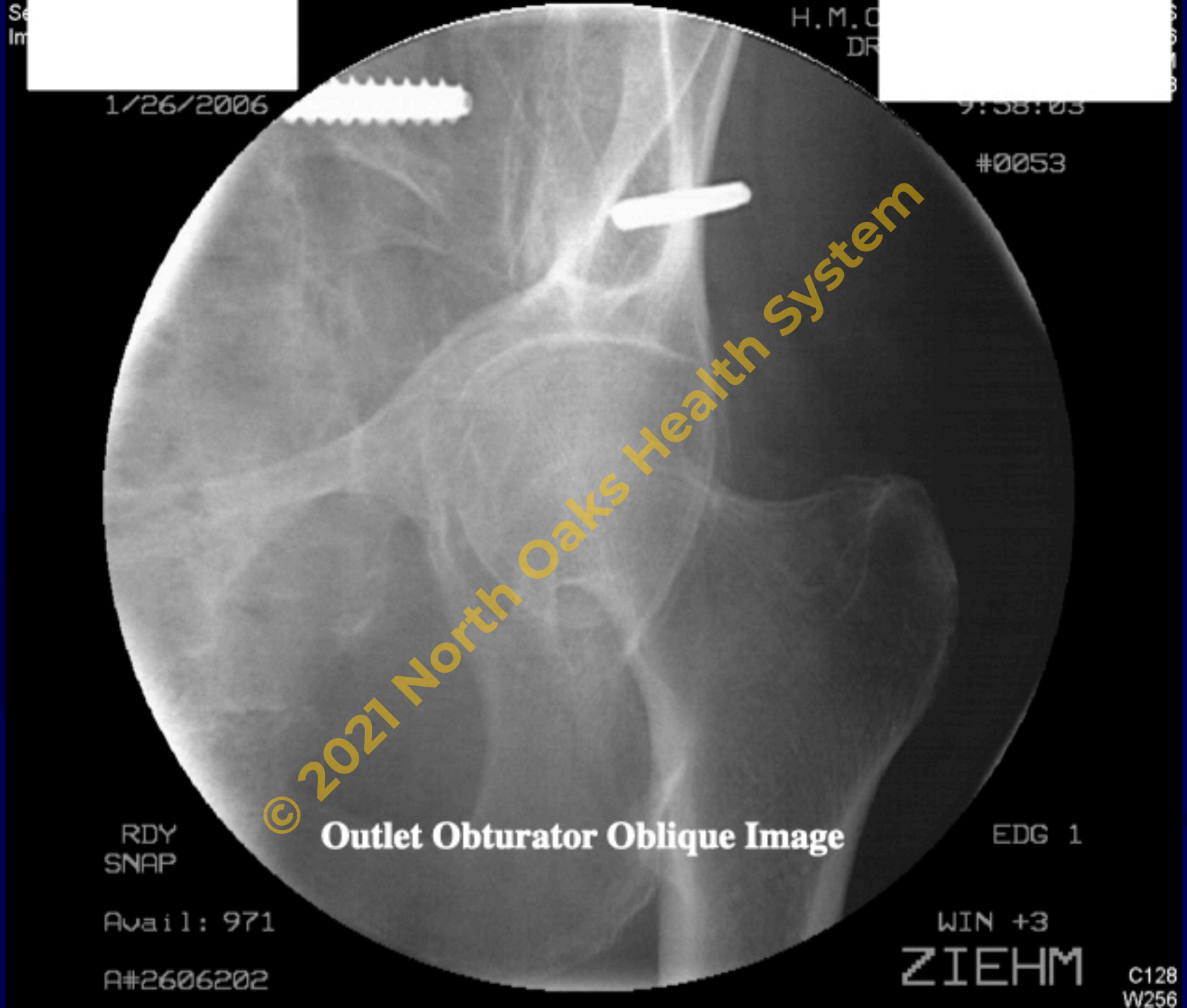






Inlet Obturator Oblique Image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Outlet Obturator Oblique Image
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SNAP
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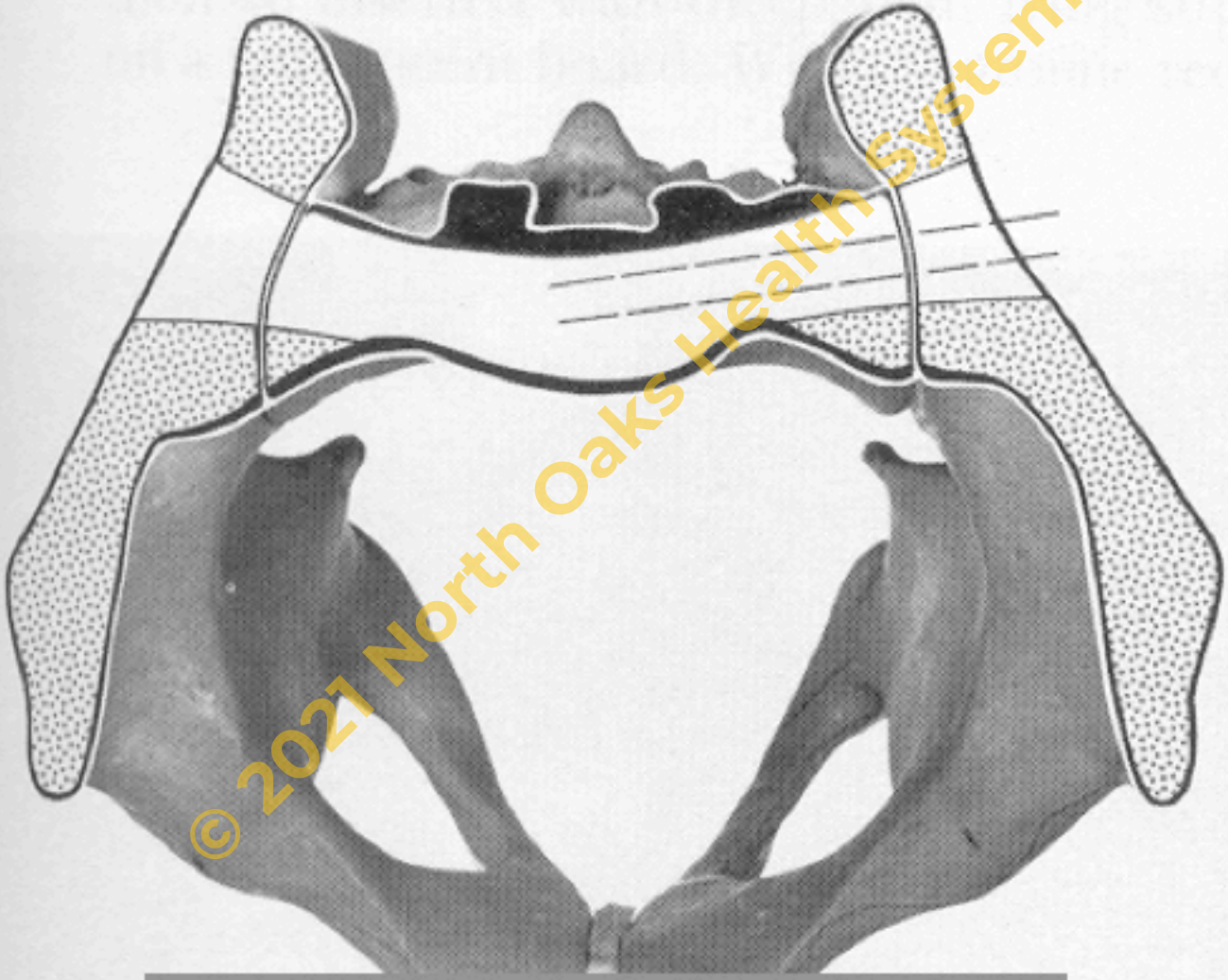
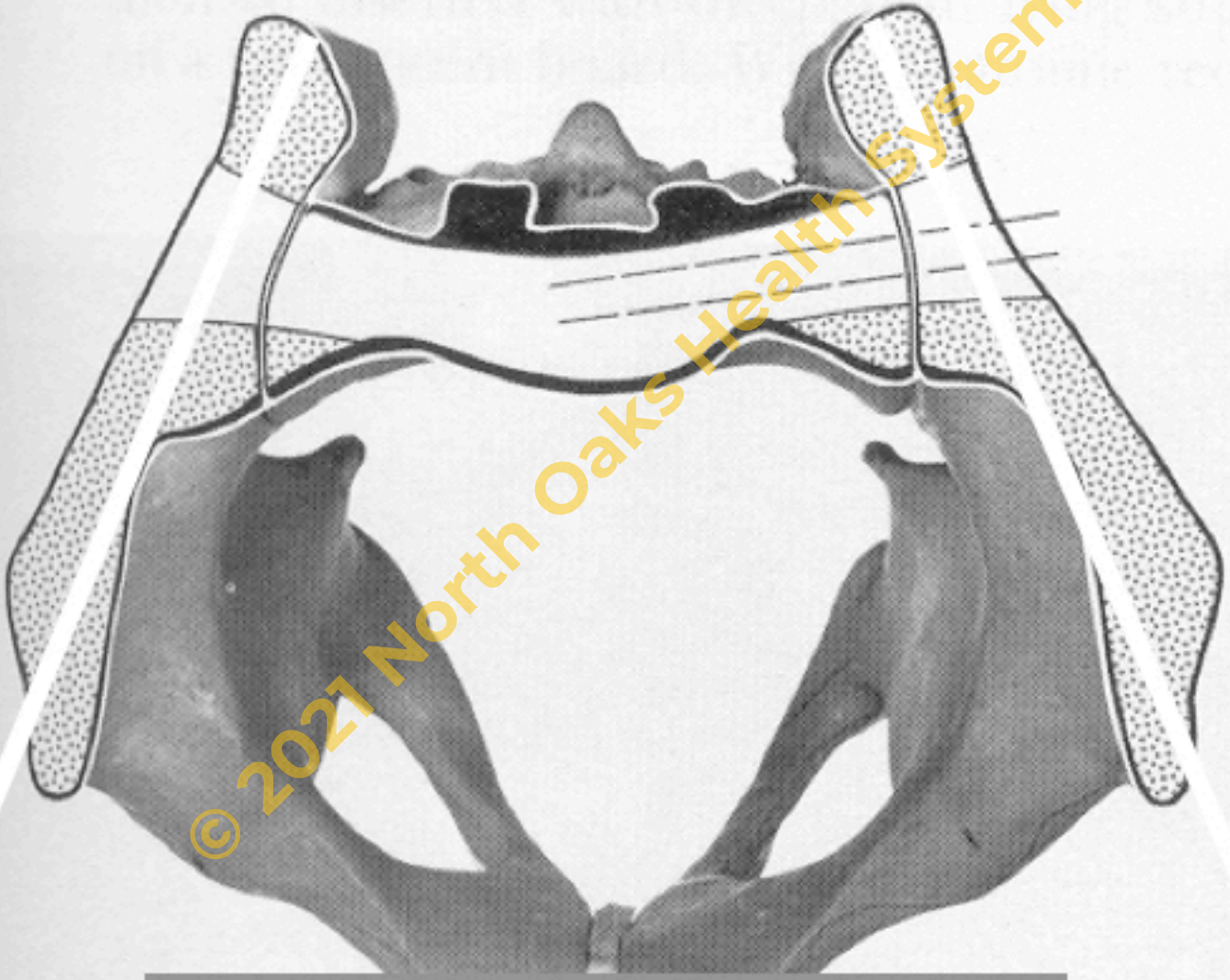
EDG 1
WIN +3
ZIEHM
C128
W256

Pin Orientation

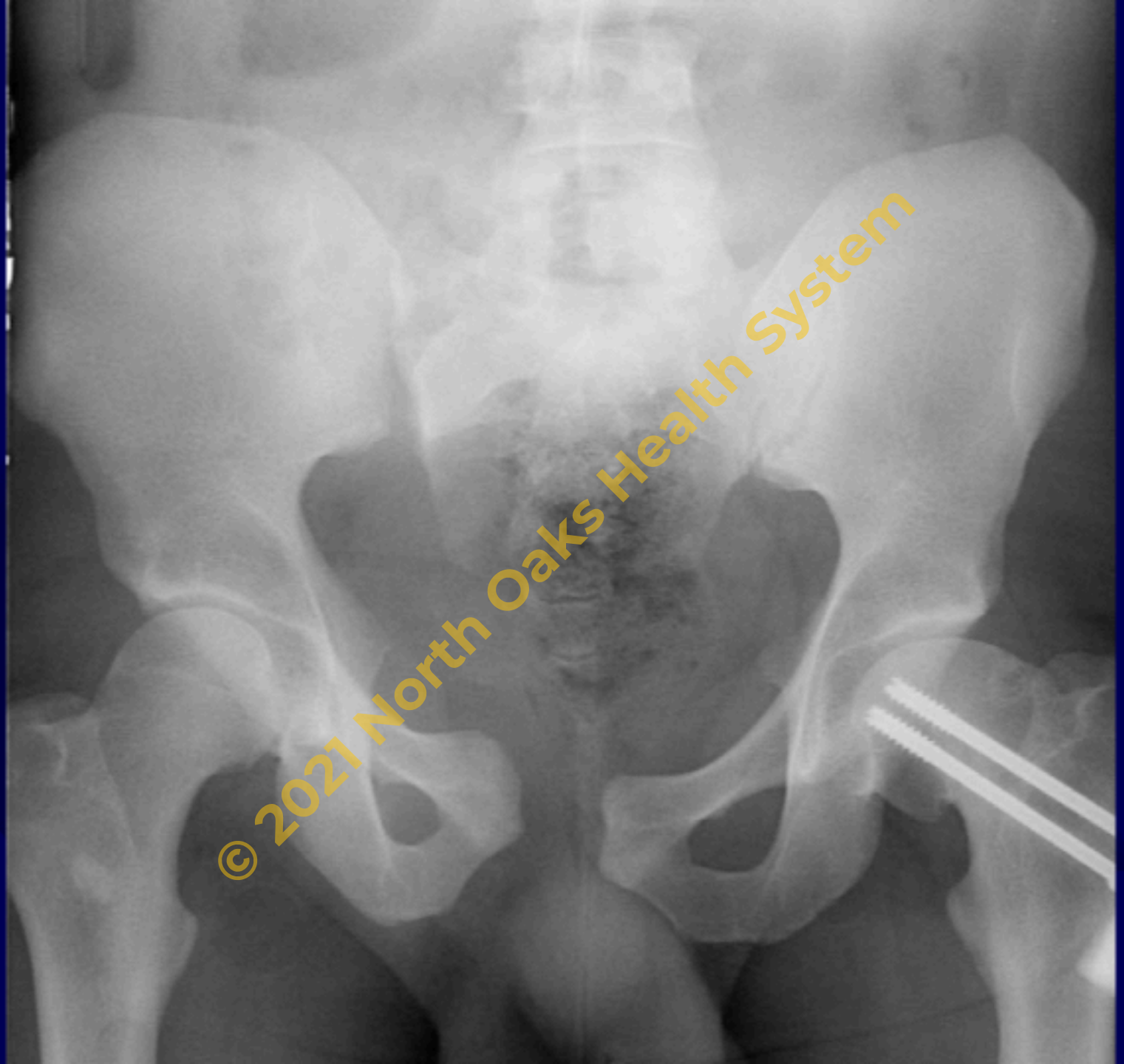


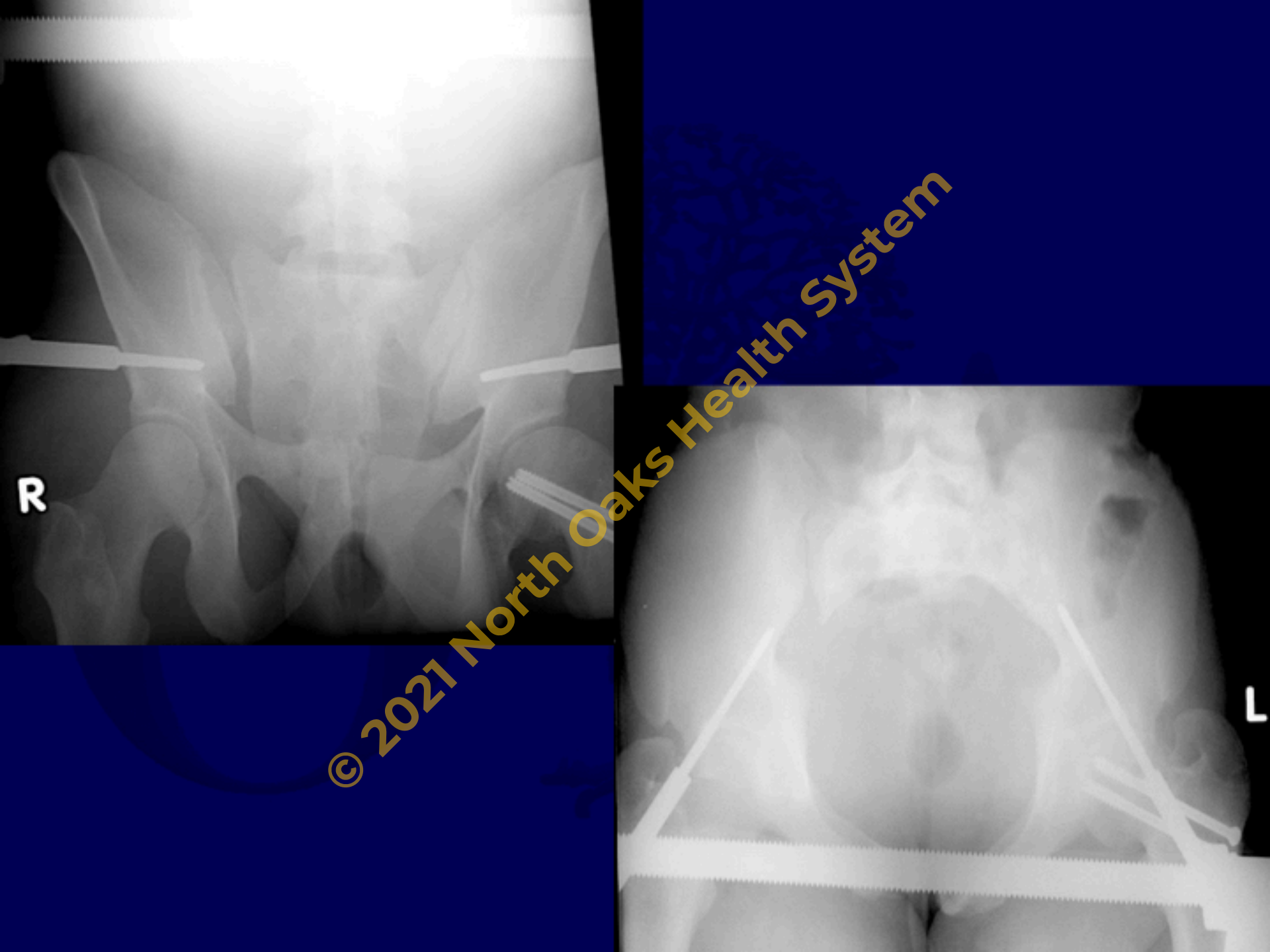
Inlet (with obturator oblique)

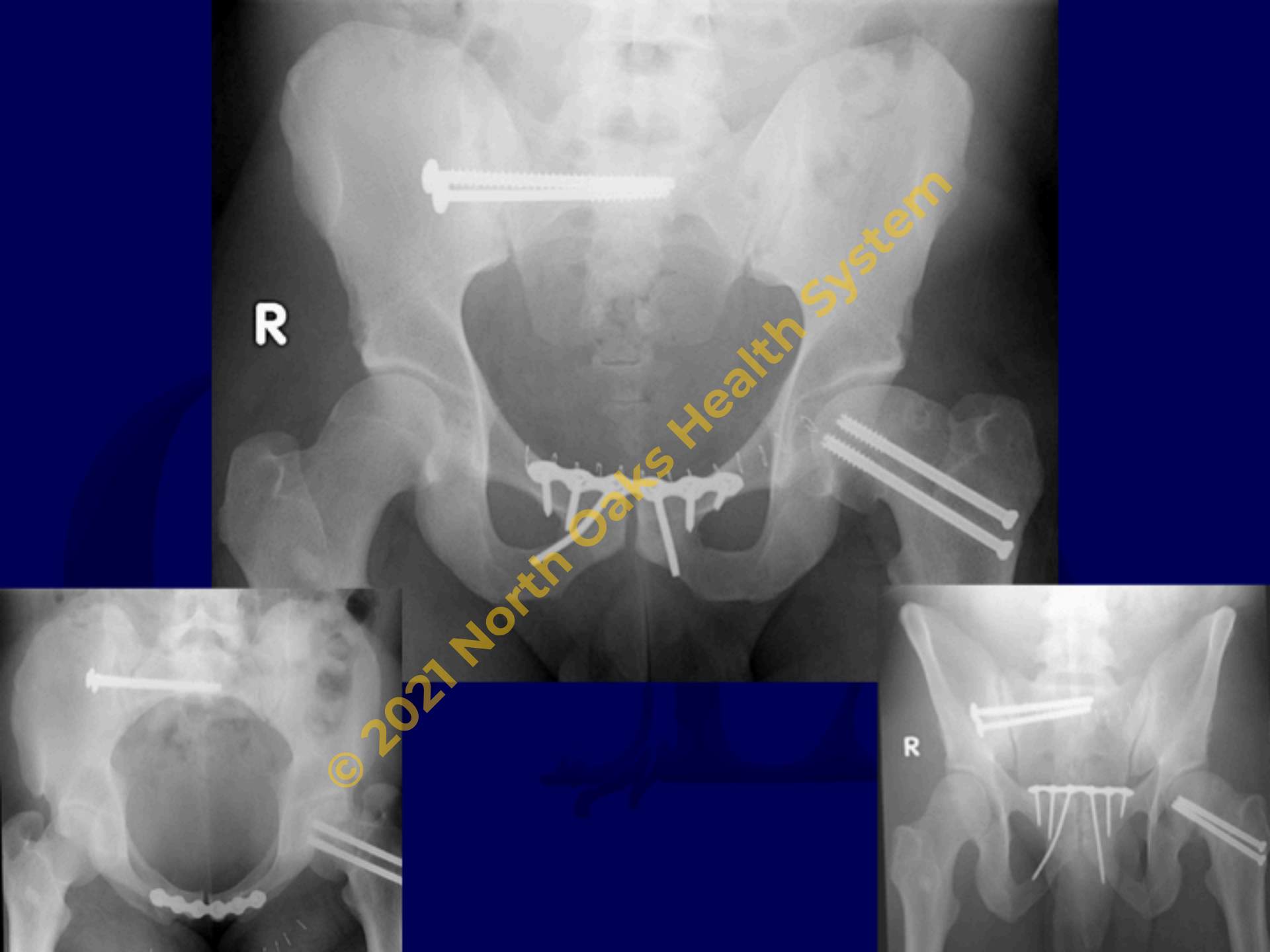
Pin Orientation



Inlet (with obturator oblique)

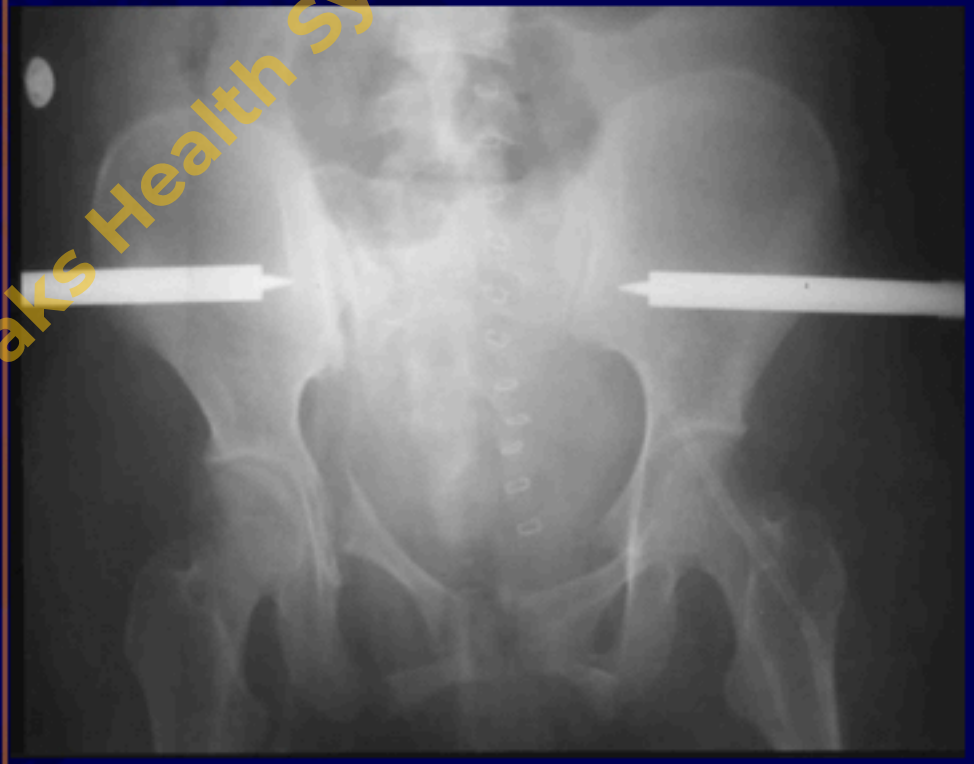






Anti-shock Clamp (C-clamp)

- Better posterior pelvis stabilization
- Allows abdominal access
- Consider application with fluoro or in the OR to prevent poor pin placement
- Can be combined with pelvic packing



Ertel, W et al, JOT, 2001

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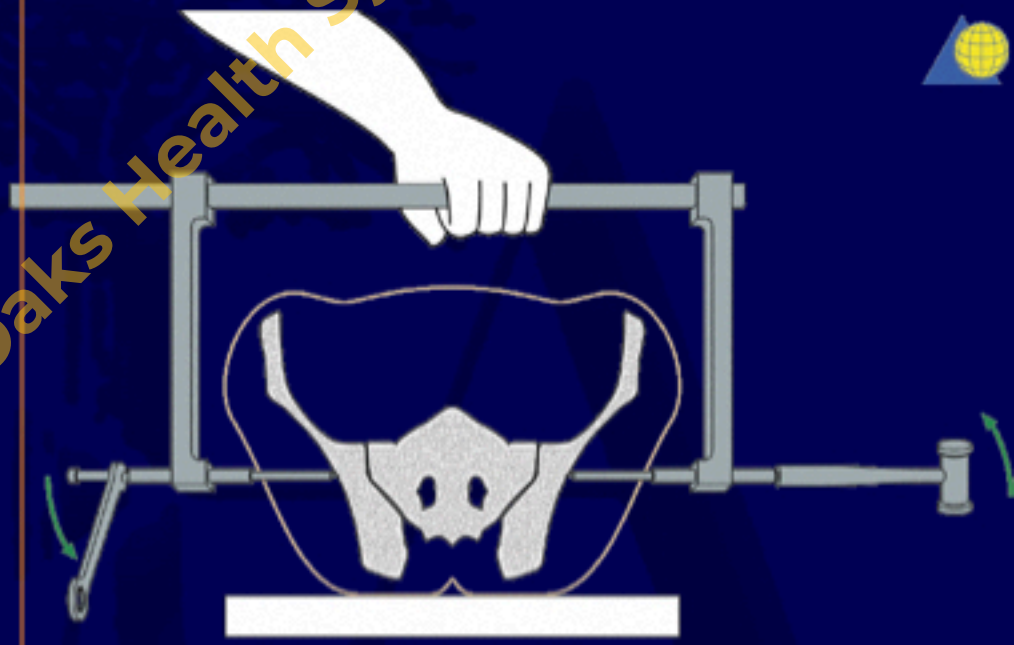

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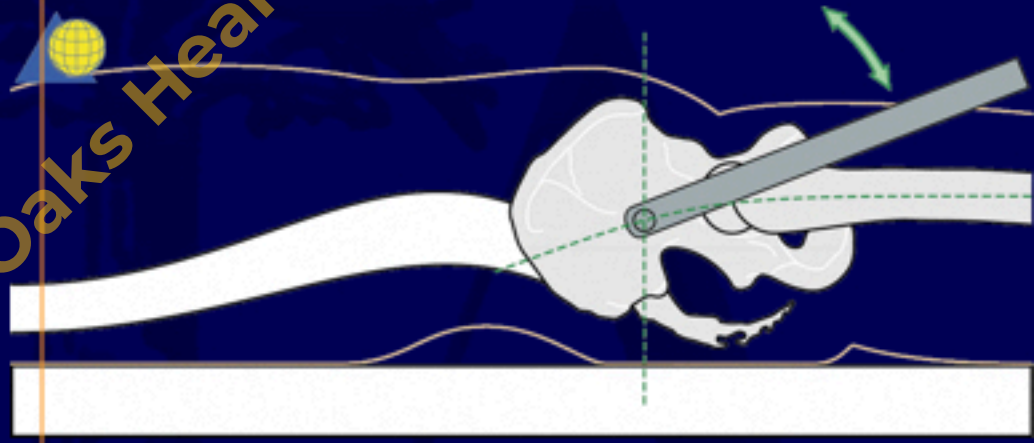
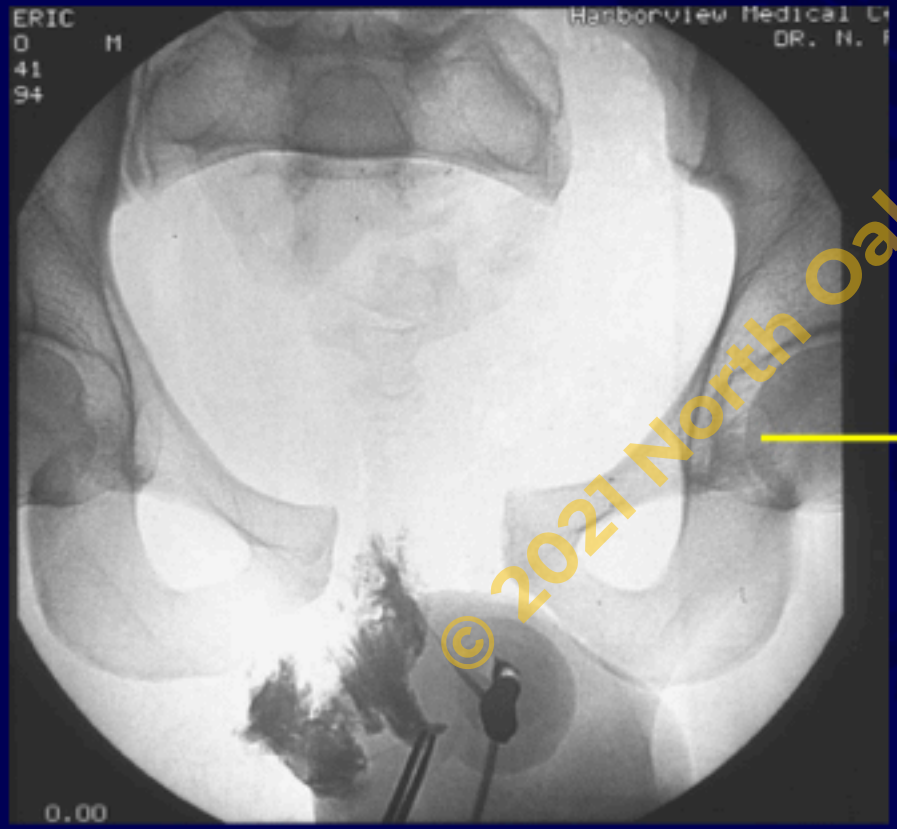
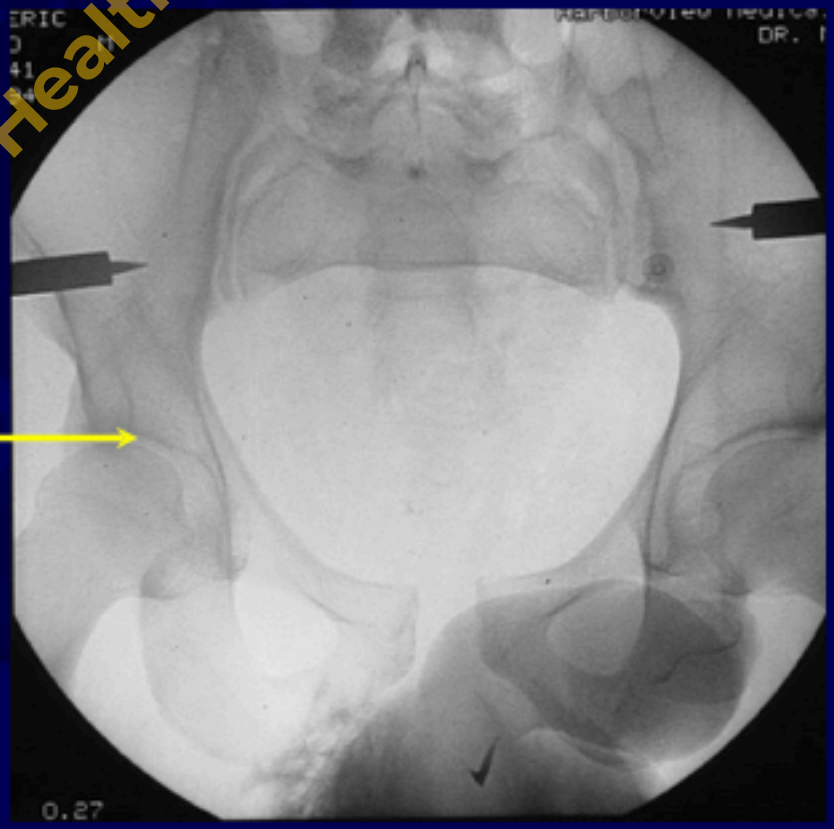


Emergent Application



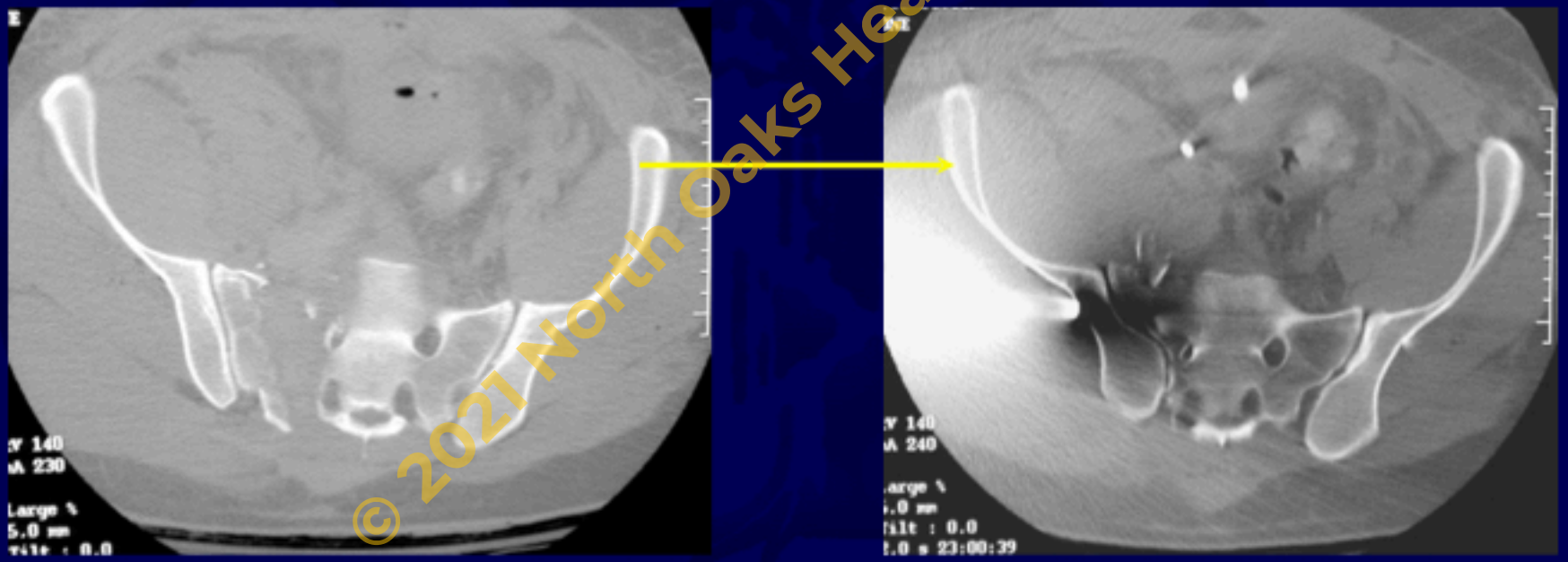


C-clamp: Anatomical Landmarks

- Same (similar location) as the starting point for an iliosacral screw
- "Groove" located on the lateral ilium as the wing becomes the posterior pelvis
- Allows for maximum compression
- Can be identified without fluoro in *experienced* hands

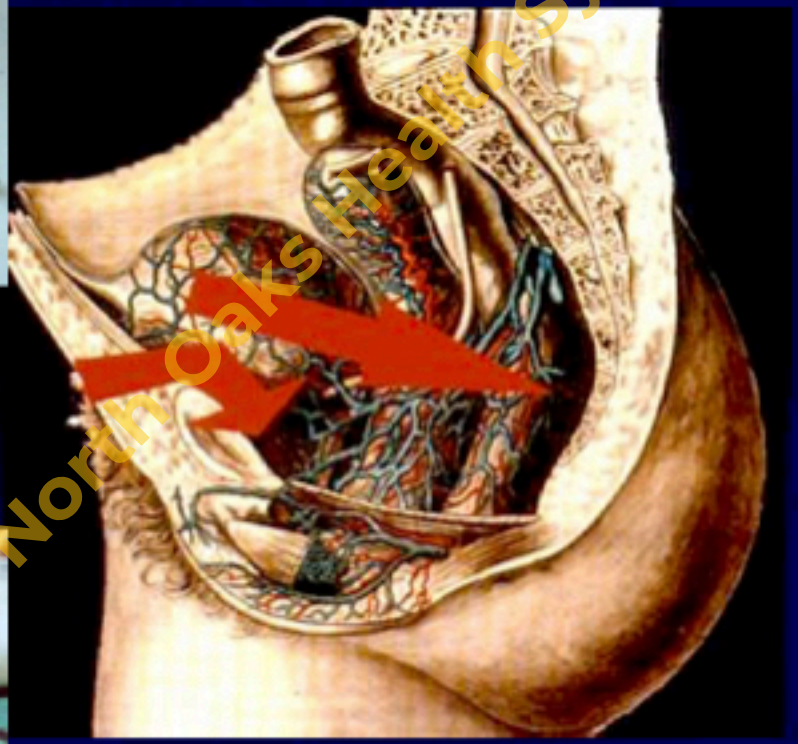
Pohlemann et al, JOT, 2004

Caution…



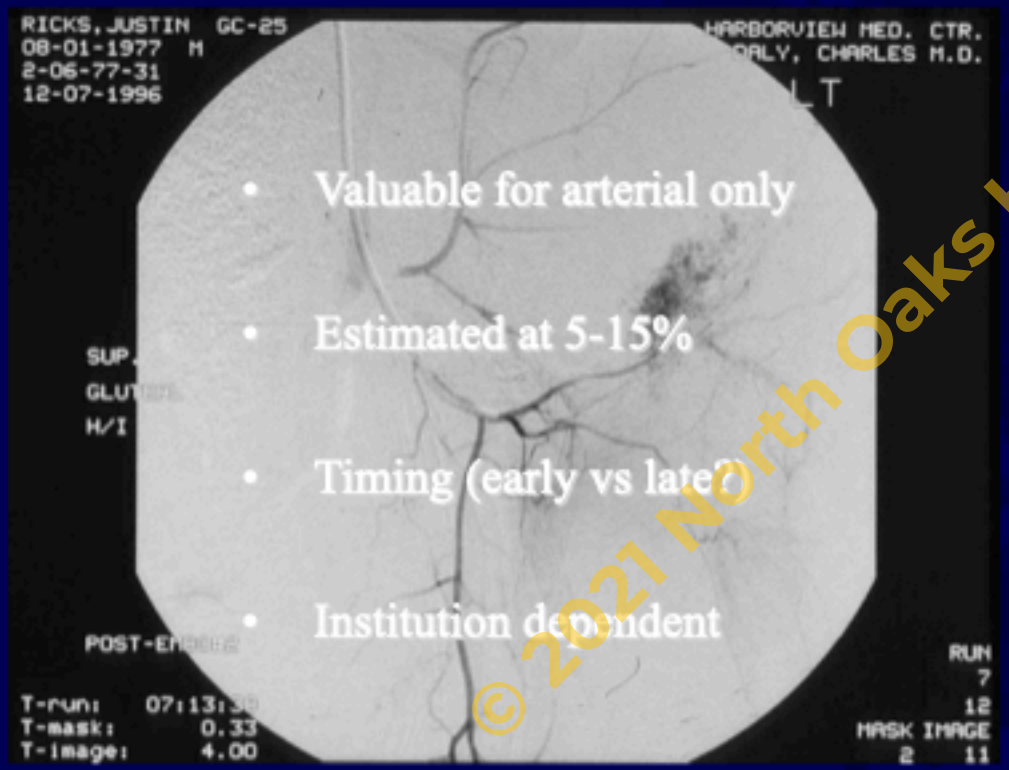
Avoid Over-compression in Sacral Fractures!

Pelvic Packing

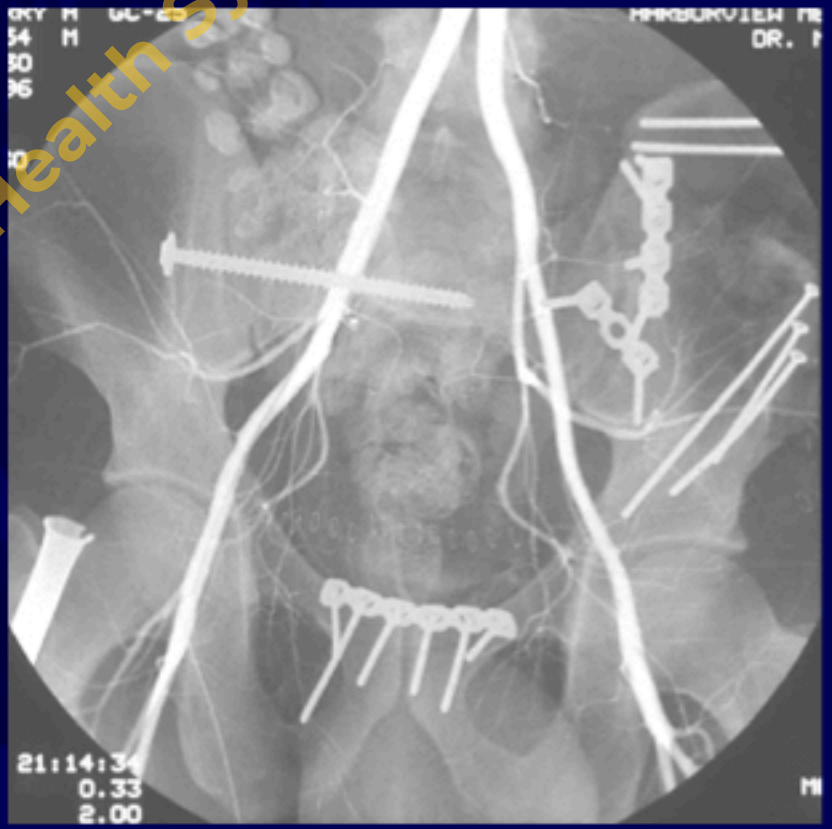


- Ertel, W et al, JOT, 2001
- Pohlemann et al, Giannoudis et al,

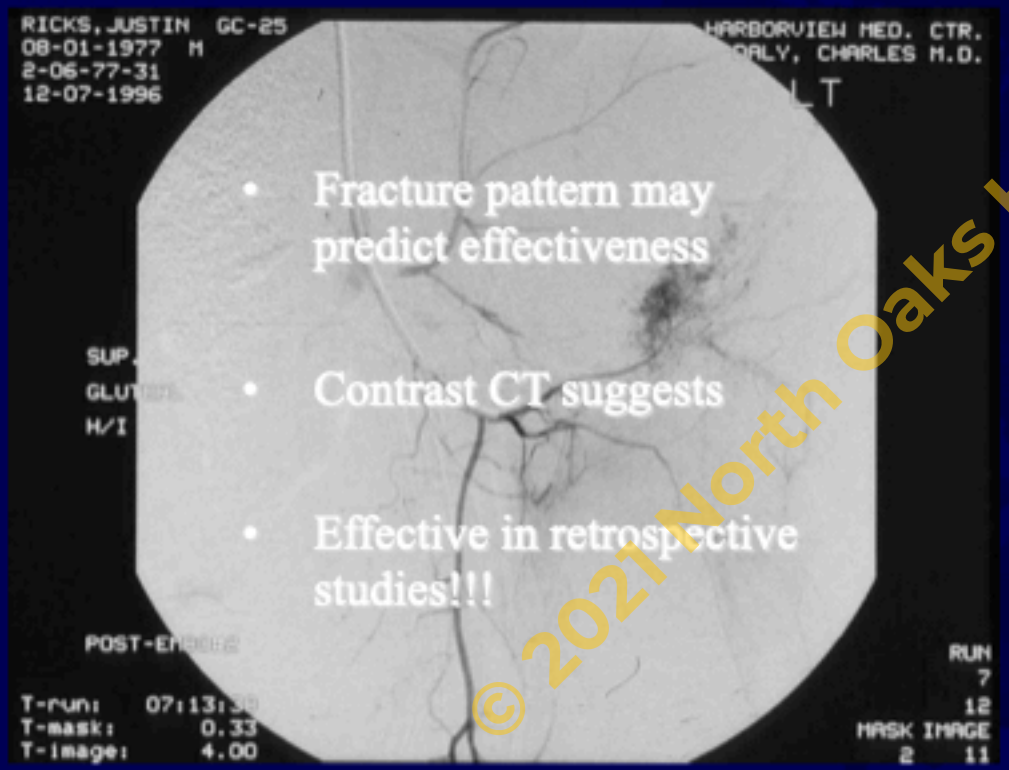
Role of Angiography???



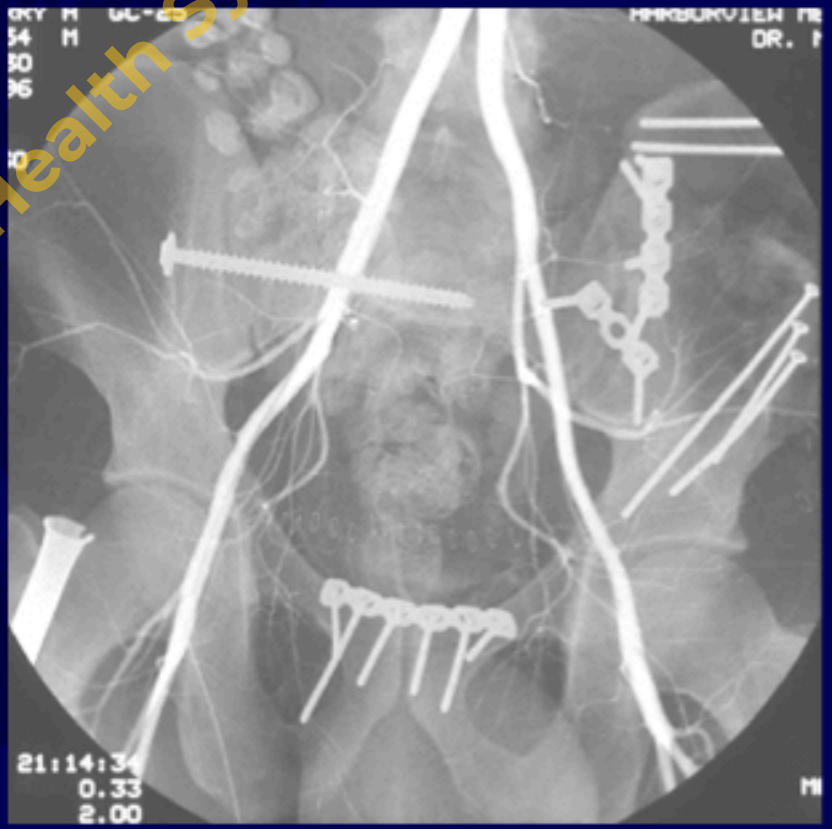
- Valuable for arterial only
- Estimated at 5-15%
- Timing (early vs late)
- Institution dependent



Role of Angiography???



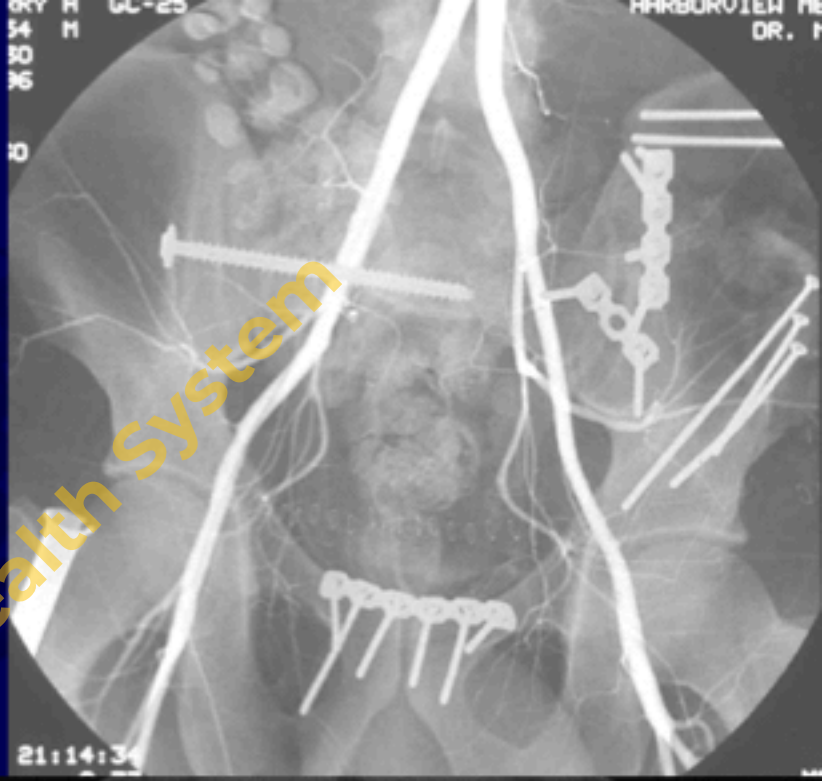
- Fracture pattern may predict effectiveness
- Contrast CT suggests
- Effective in retrospective studies!!!

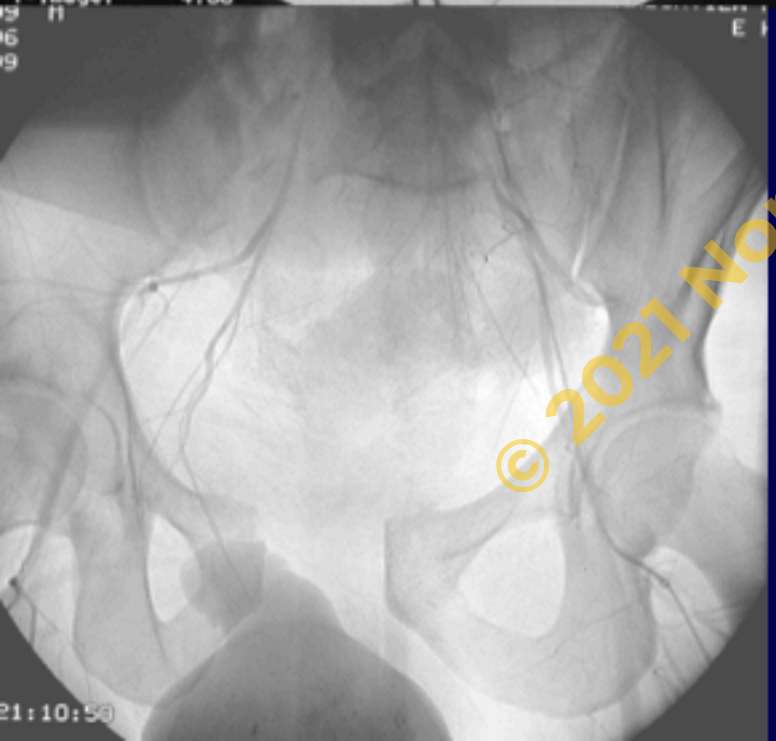


Vascular Injuries

- Arterial vs Venous vs Cancellous
- Unstable posterior ring association
- Associated fracture extension into notch
- Role of angiography

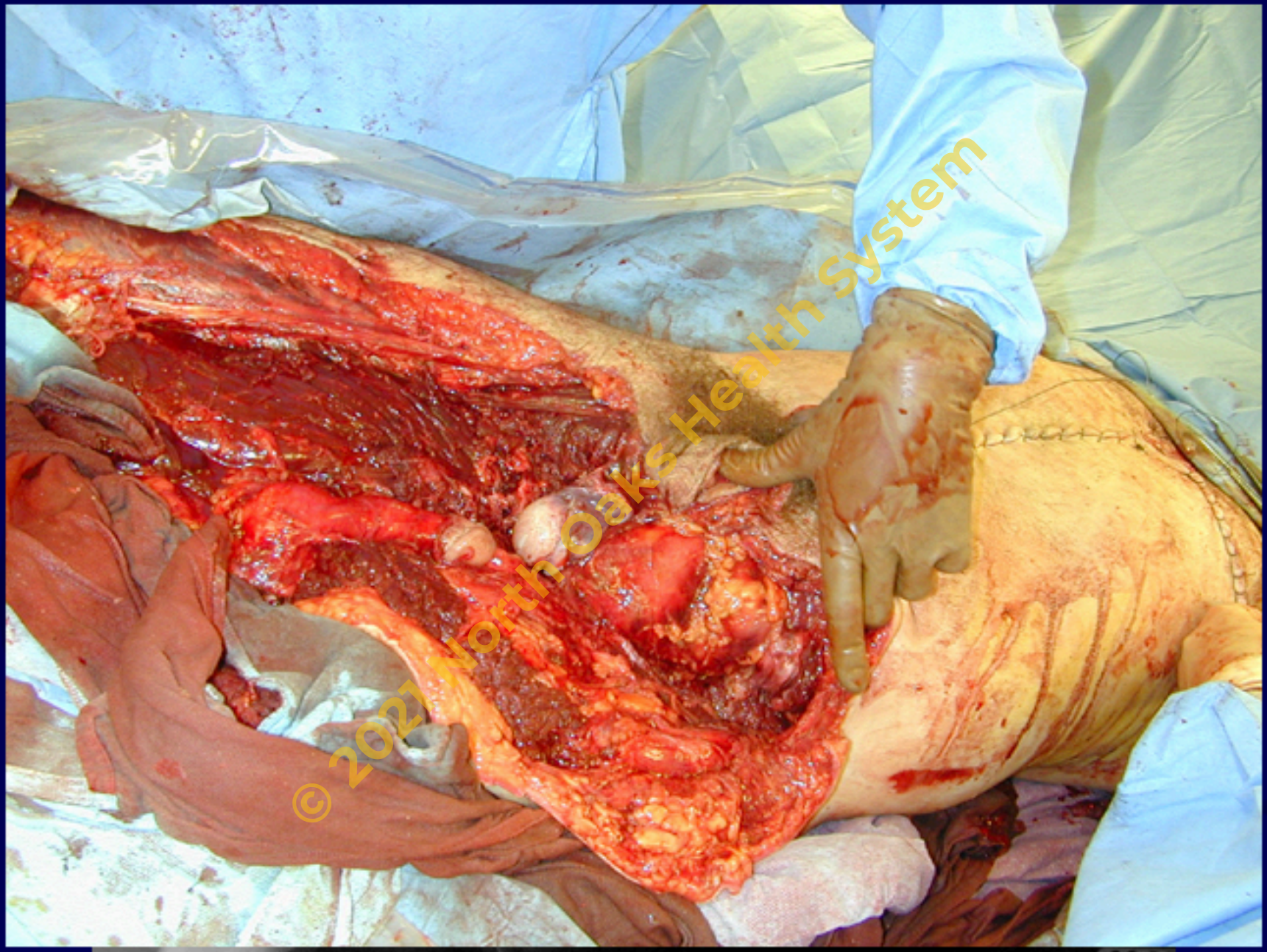
Cryer et al, JT, 1988
O'Neill et al, CORR, 1996
Goldstein et al, JT, 1994





Acute Hemipelvectomy

Acute Hemipelvectomy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Retrospective evidence suggests…

- Hypotensive with stable pelvic pattern…
- Proceed to Laparotomy *(85% with abdominal hemorrhage)*

- Hypotensive with unstable pelvic pattern…
- Proceed to Angio *(59% with positive angio)*

Eastridge et al, JT, 2002

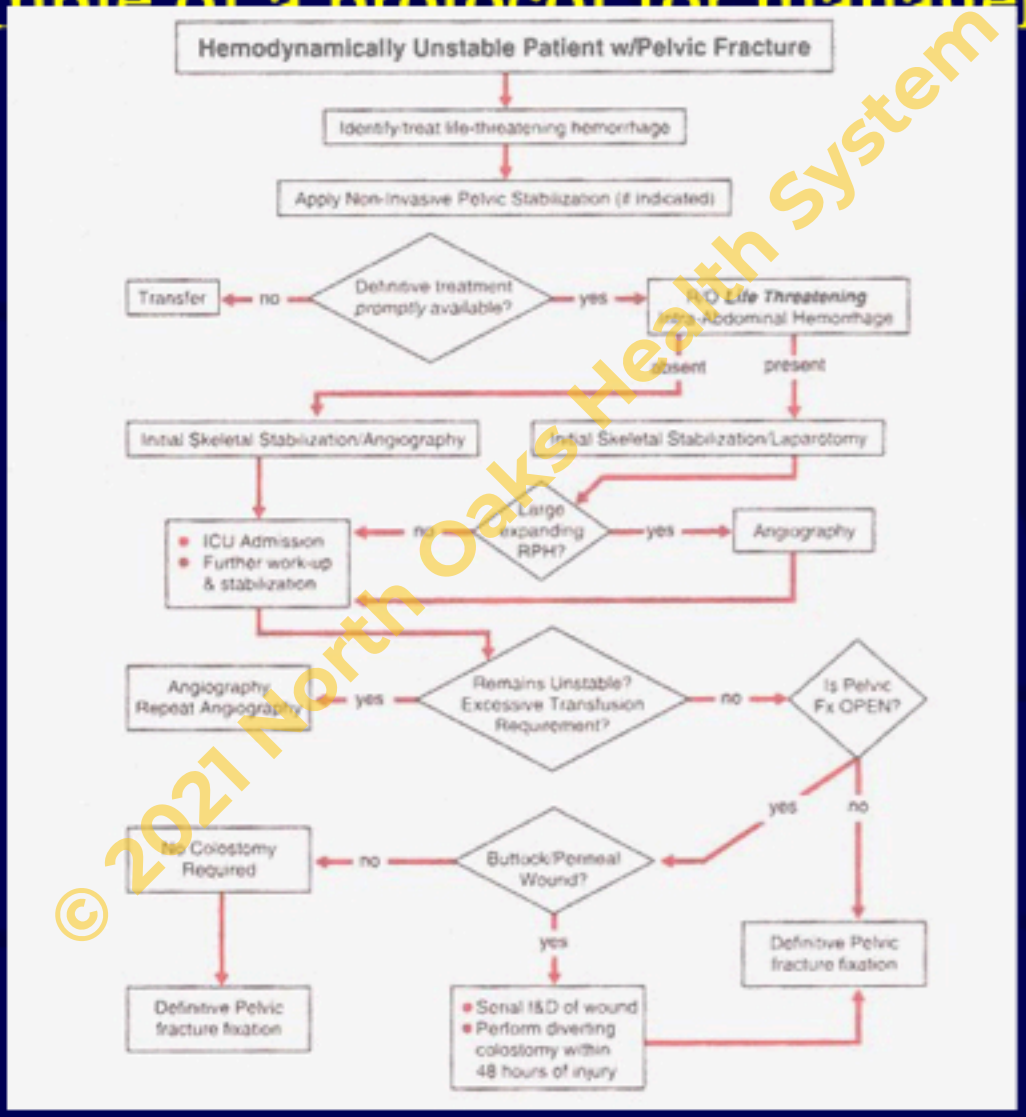
Contrast enhanced CT very suggestive of arterial source

(40 fold likelihood ratio)

(PPV and NPV of 80%, 98%)

Stephen et al, JT, 1999

Example of a protocol for management



Example of a protocol for management

- Hypovolemic shock and no response to fluids…
- (+) DPL: 1. Laparotomy (+/- packing with ex fix)
- 2. Angio
- (-) DPL: 1. Sheet/binder/ex-fix (some still crash lap)
- 2. Angio

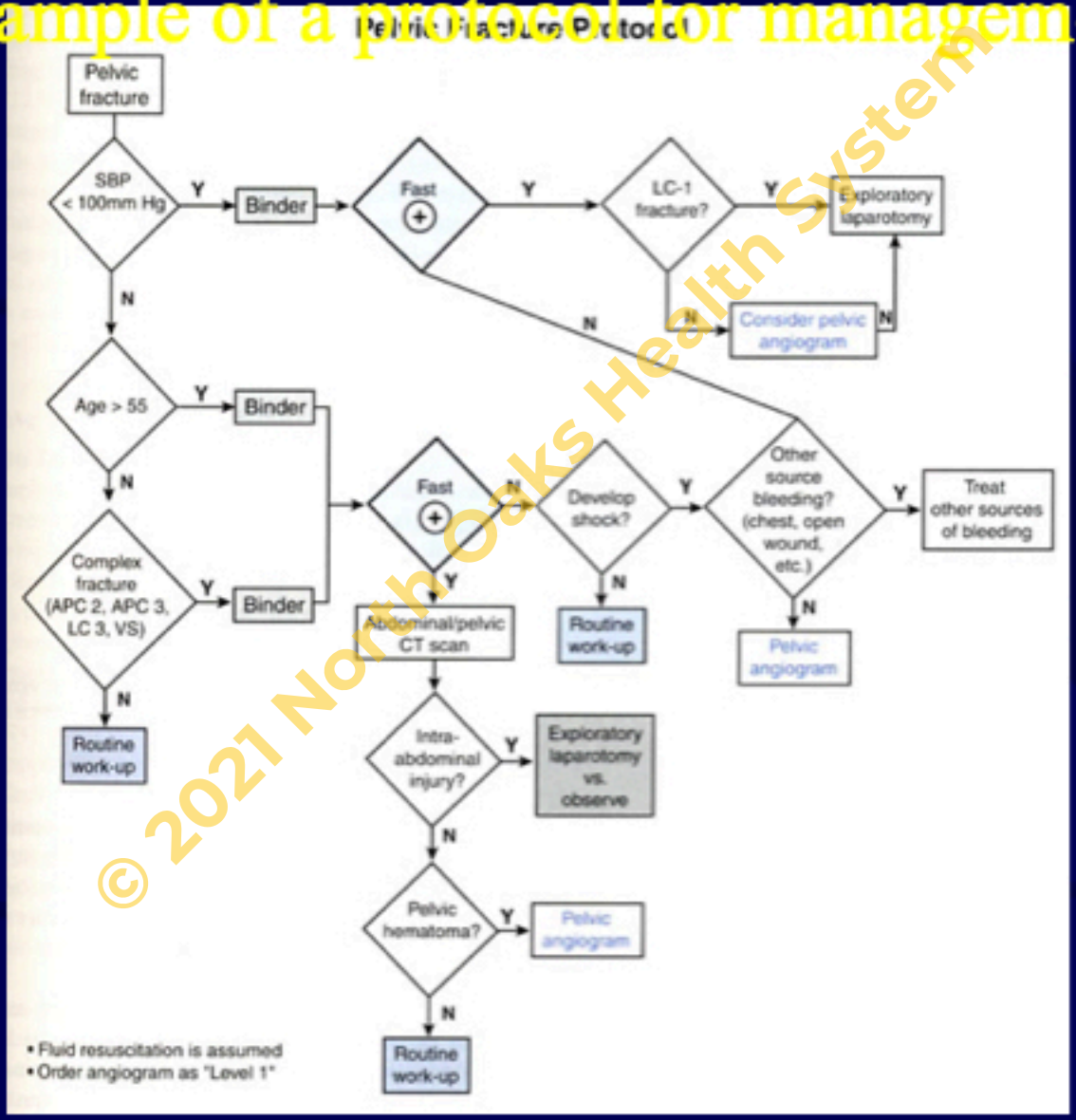
Hypovolemic shock with response to fluids…

(++) DPL: 1. Laparotomy (+/- packing with ex fix)
2. Ex Fix
3. Angio

(+) DPL: 1. Ex Fix
2. Laparotomy
3. Angio

(-) DPL: 1. Sheet/binder
2. Angio
3. Ex Fix

Example of a protocol for management



Protocol for Management

- **Biffl et al,** Evolution of a mutlidisciplinary clinical pathway for the management of unstable patients with pelvic fractures. JOT, 2001

5 elements:

Immediate trauma surgeon availability (+ Ortho!)

Early simultaneous blood and coagulation products

Prompt diagnosis & treatment of life threatening injuries

Stabilization of the pelvic girdle

Timely pelvic angiography and embolization

Changes:

Patients more severely injured (52% vs 35% SBP < 90)

DPL phased out for U/S

Pelvic binders and C-clamps replaced traditional ex fix

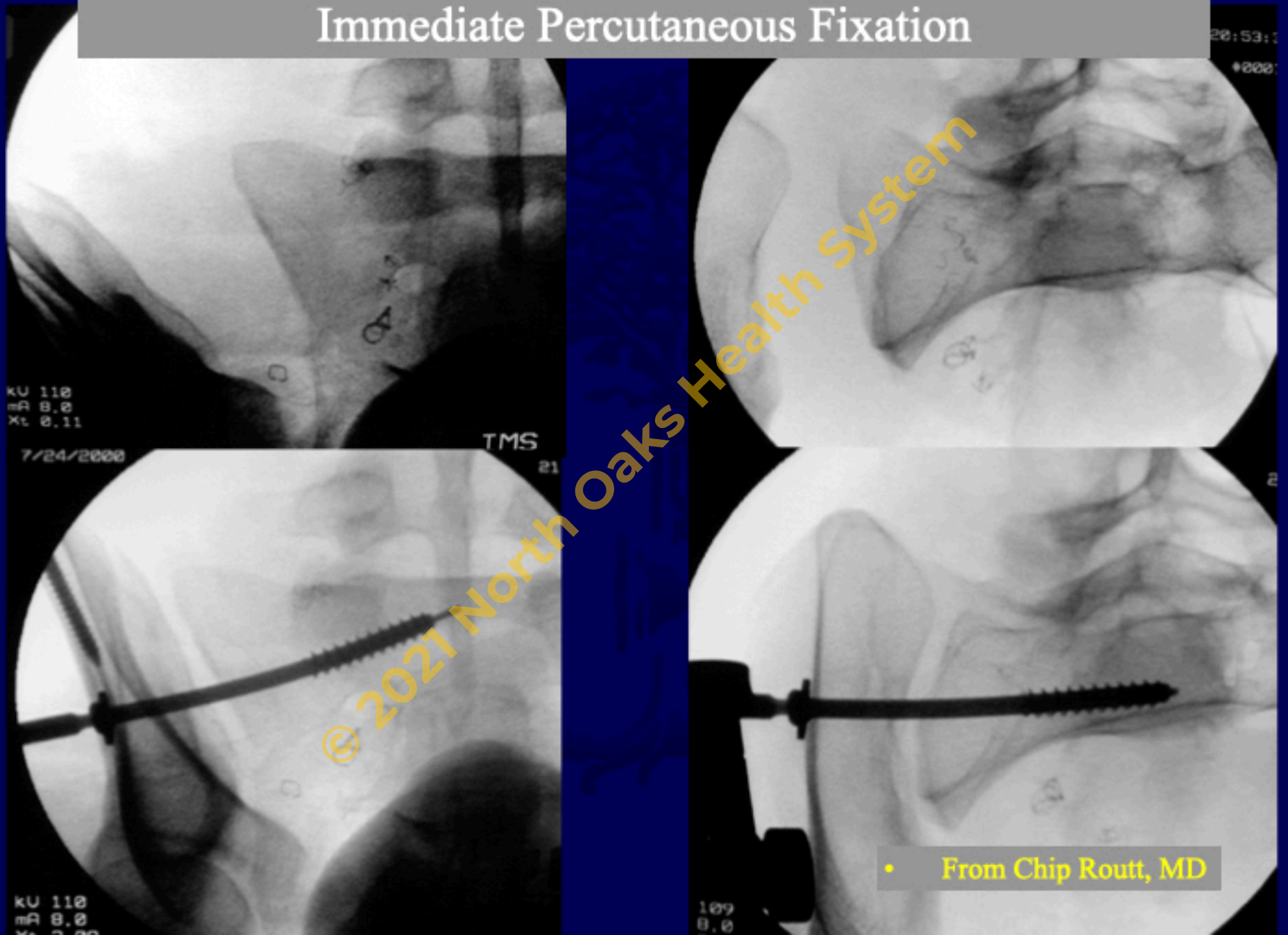
Protocol for Management

- Biffl et al, Evolution of a mutlidisciplinary clinical pathway for the management of unstable patients with pelvic fractures. JOT, 2001

Mortality decreased	**from 31% to 15%**
Exsanguination death	**from 9% to 1%**
MOF	**from 12% to 1%**
Death (<24 hours)	**from 16% to 5%**

The evolution of a multidisciplinary clinical pathway, coordinating the resources of a level 1 trauma center and directed by joint decision making between trauma surgeons and orthopedic traumatologists, has resulted in improved patient survival. The primary benefits appear to be in reducing early deaths from exsanguination and late deaths from multiple organ failure.

Immediate Percutaneous Fixation



- From Chip Routt, MD

Summary: Acute Management

- Play well with others (general surgery, urology, interventional radiology, neurosurgery)
- Understand the fracture pattern
- Do something (sheet, binder, ex fix, c-clamp)
- Combine knowledge of the fracture, the patients condition, and the physical exam to decide on the next step

Acetabular Fracture

- Acetabulum is the concave Bony articulation of the pelvis that allows motion through the hip, facilitating bipedal gait.

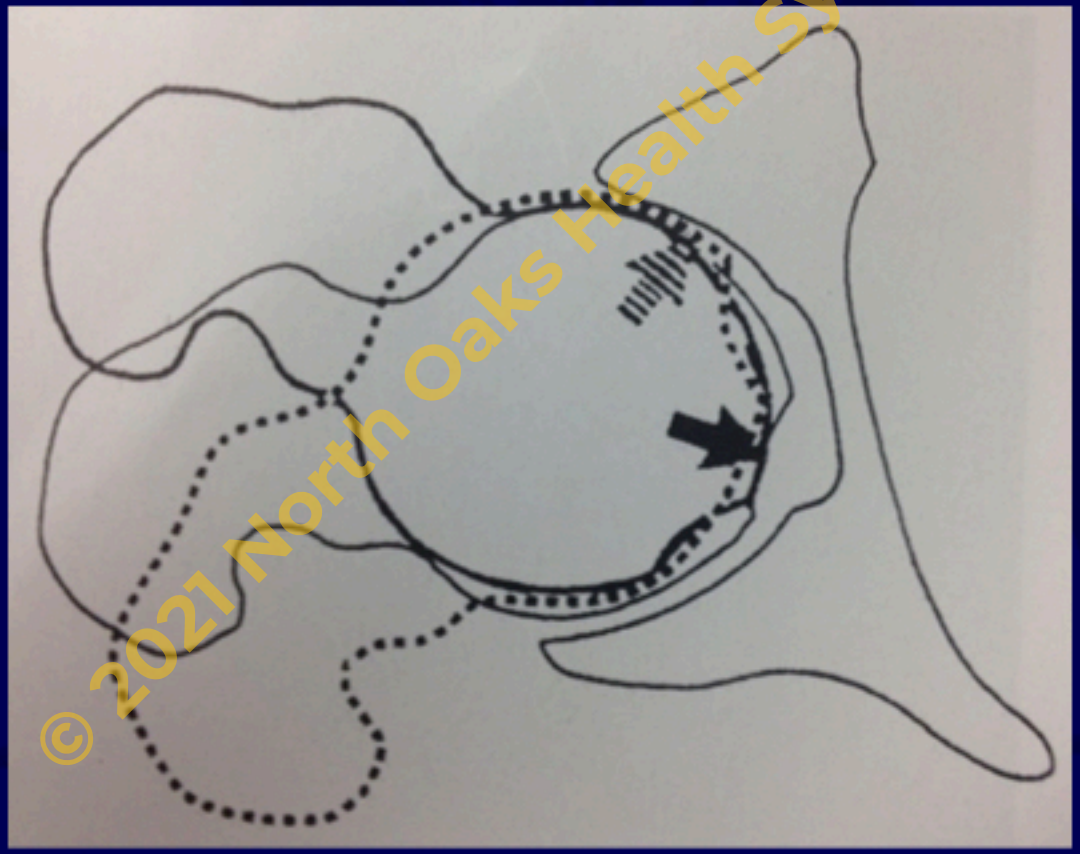
- Epidemiology of fractures:
- bimodal distribution
- high energy for young patients
- low energy for elderly patients

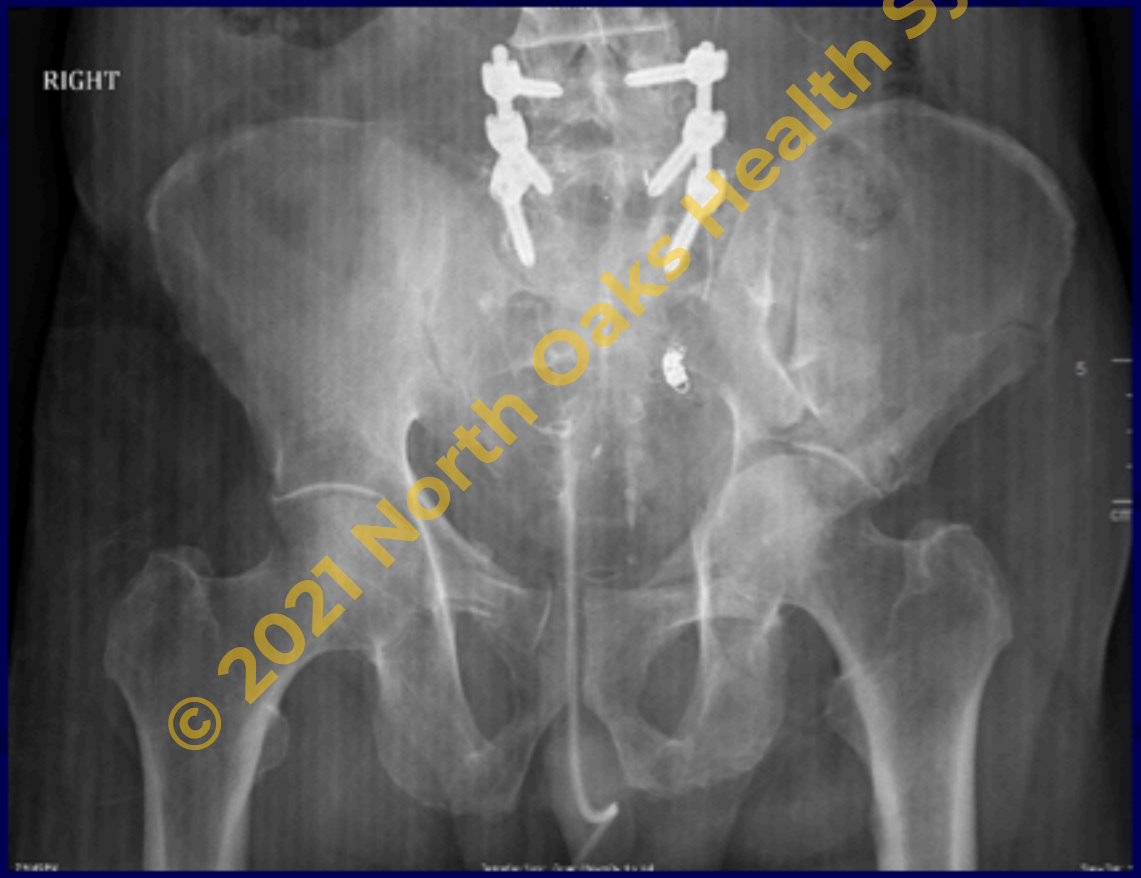
Anatomy

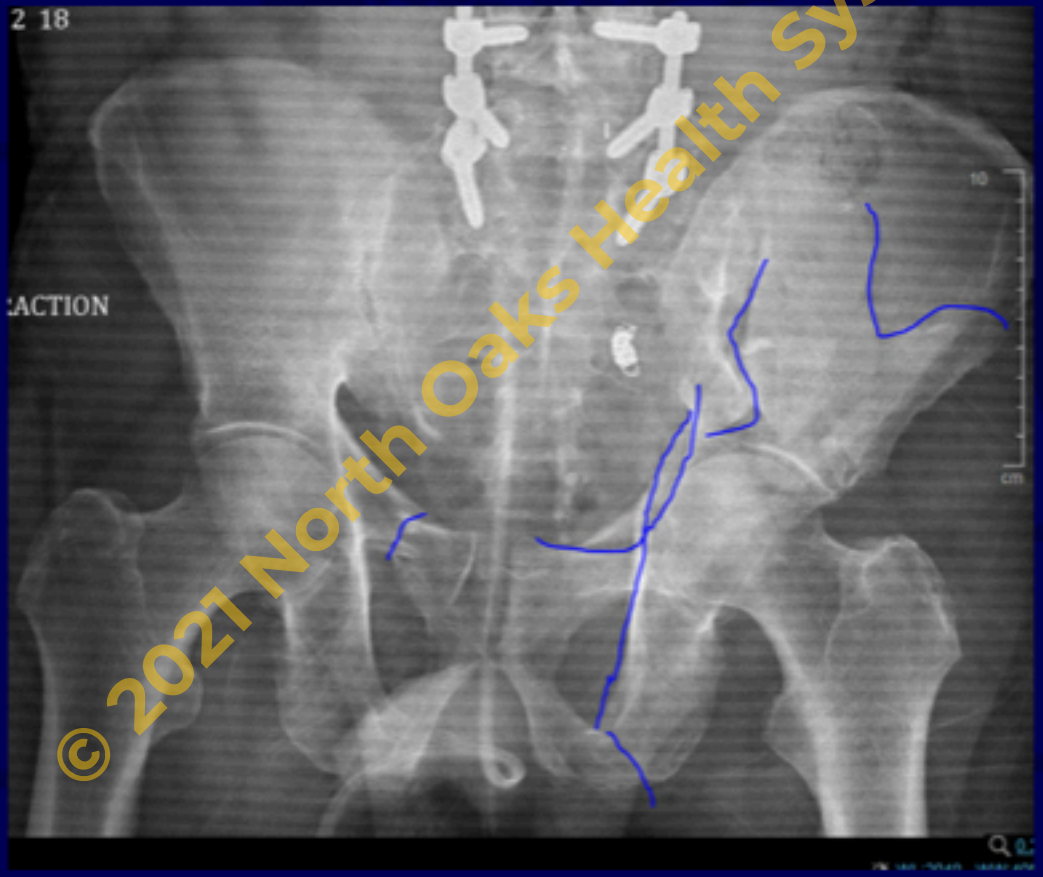
- anterior column (green)
- posterior column (blue)
- sciatic buttress (red)

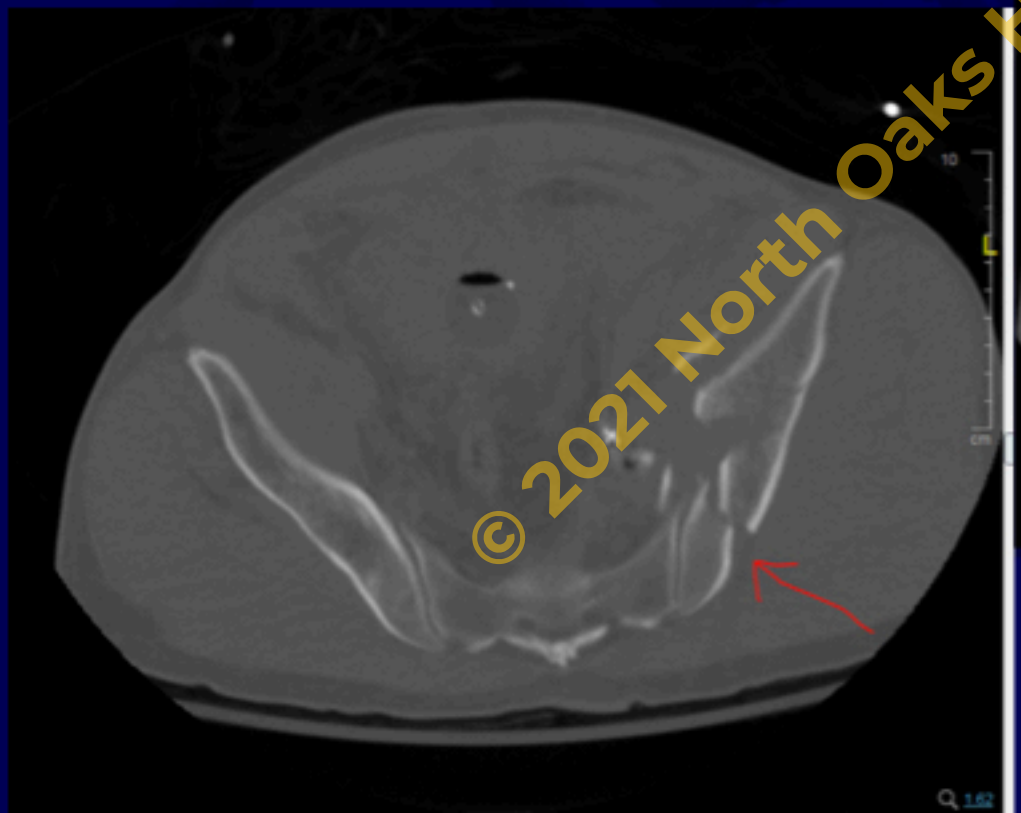
- Sciatic buttress thickest portion of ilium 5 cm posterior to AIIS

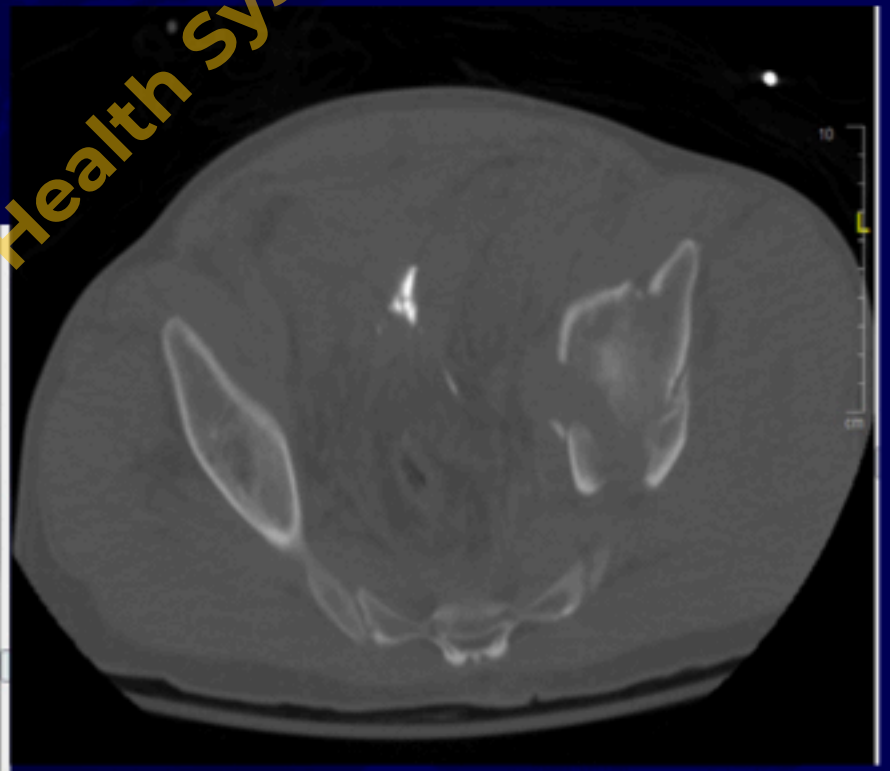
Position Matters

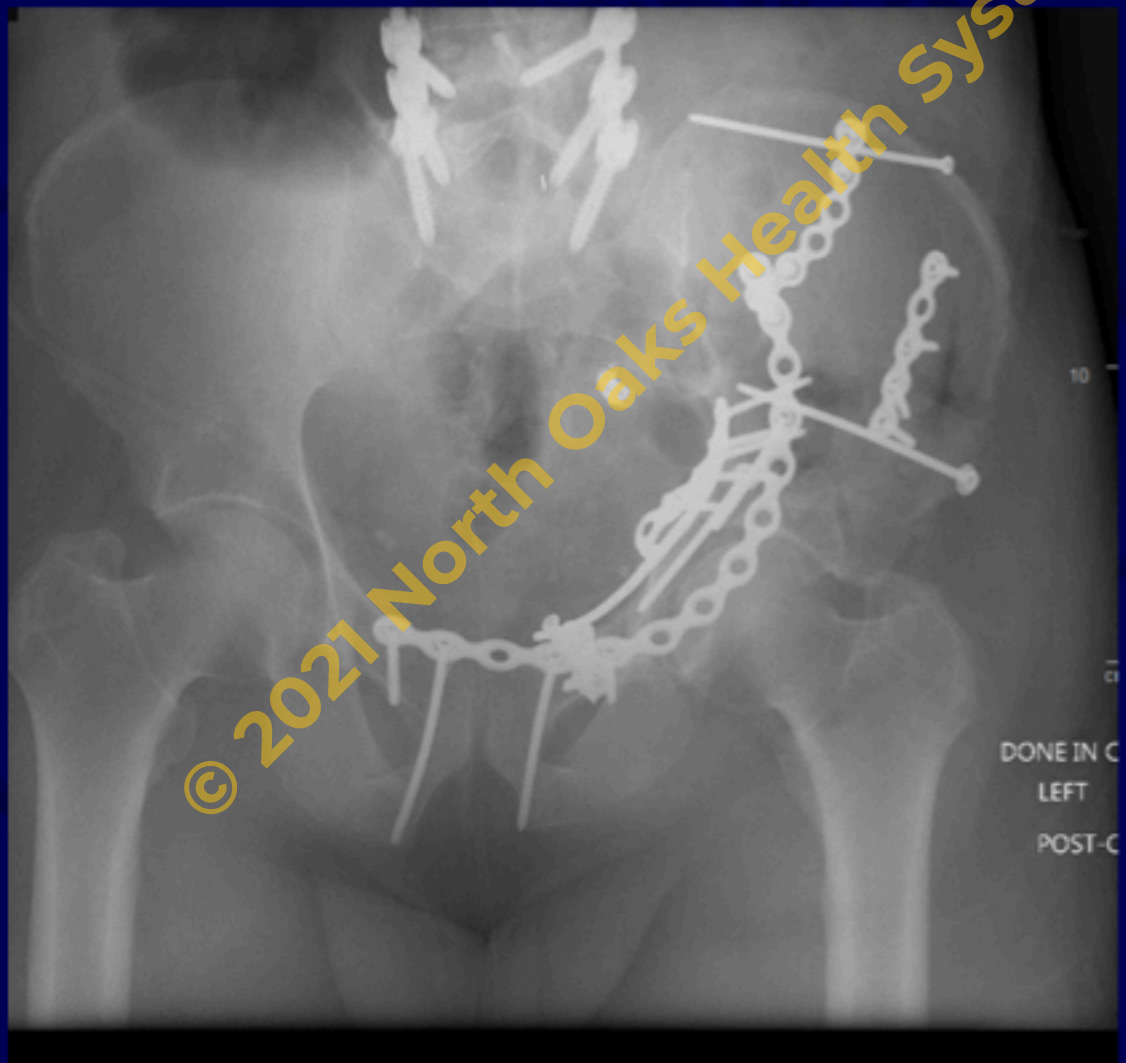




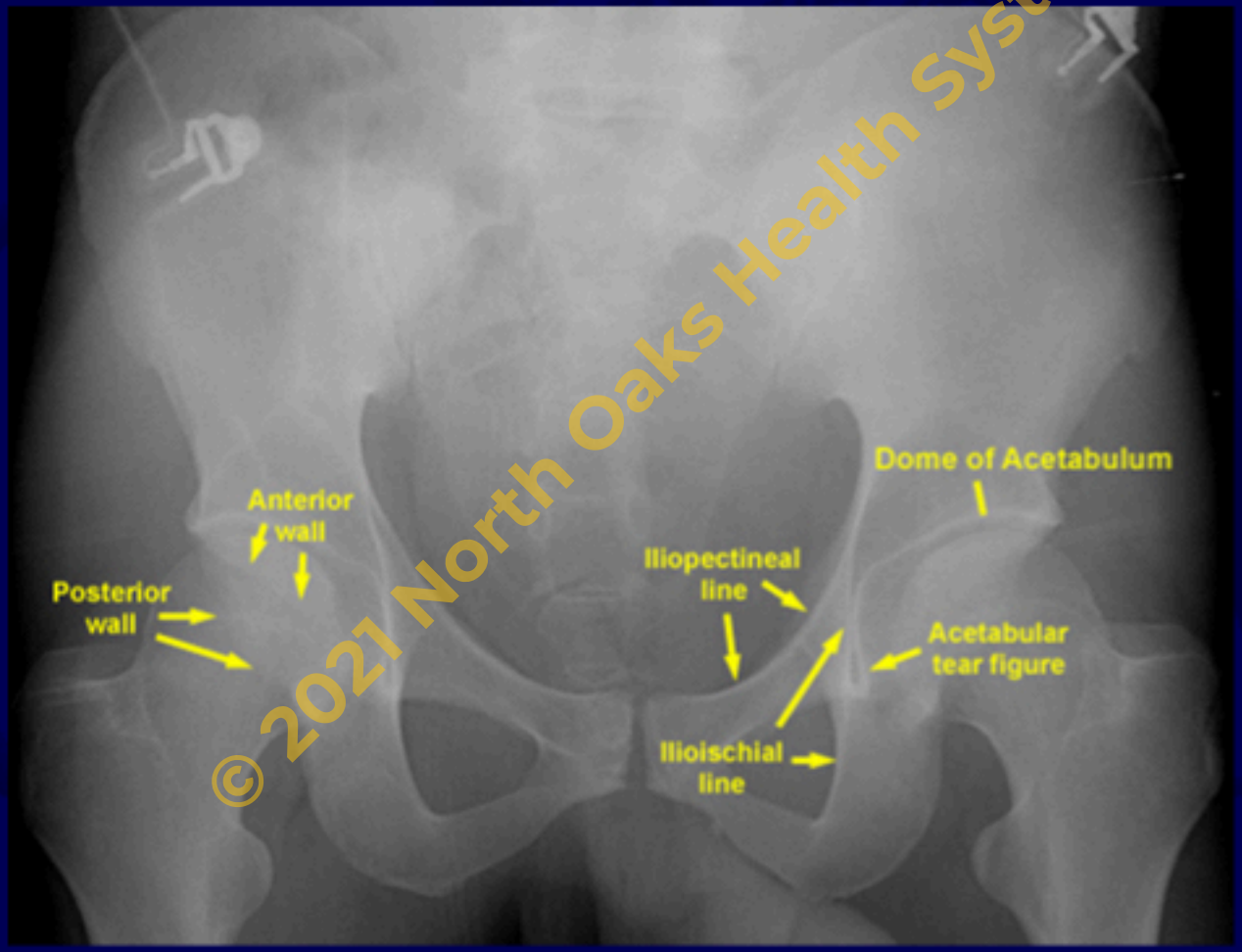


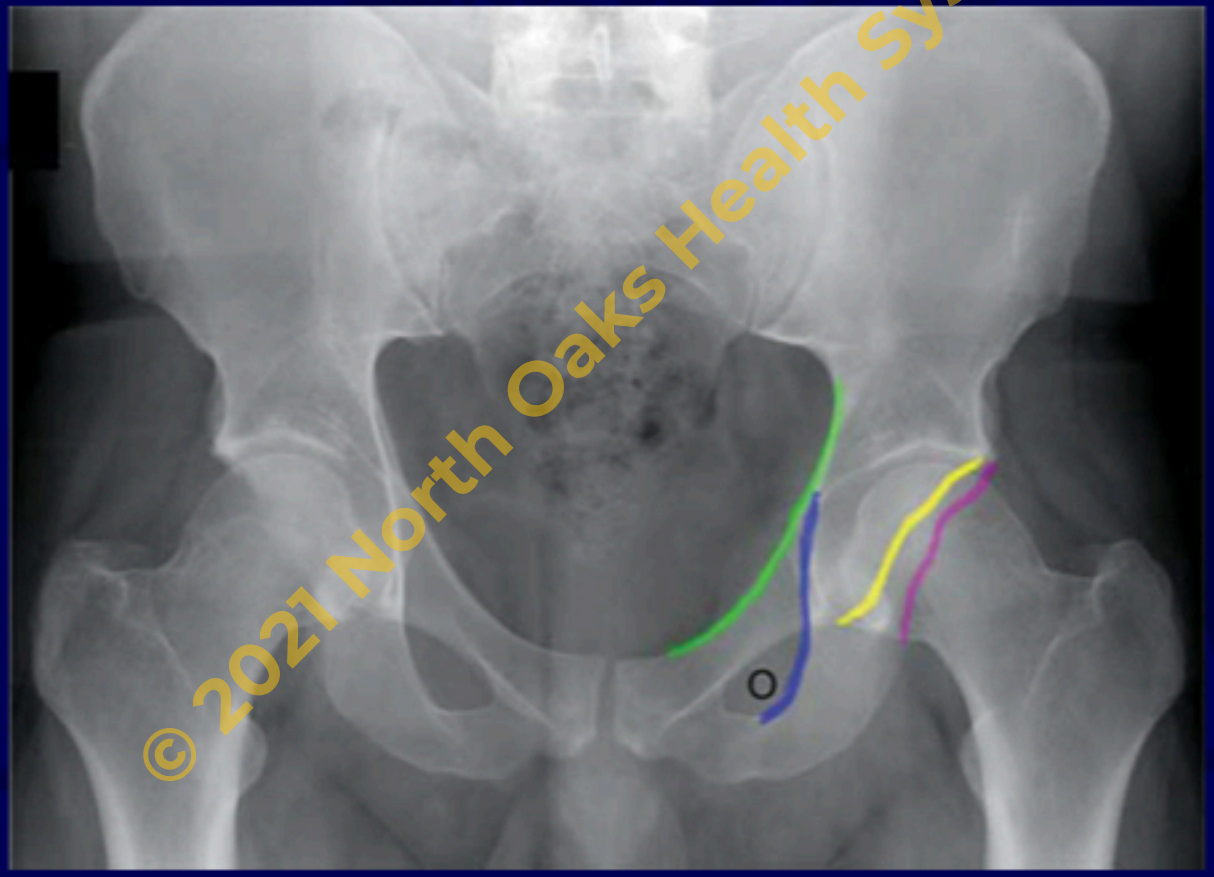




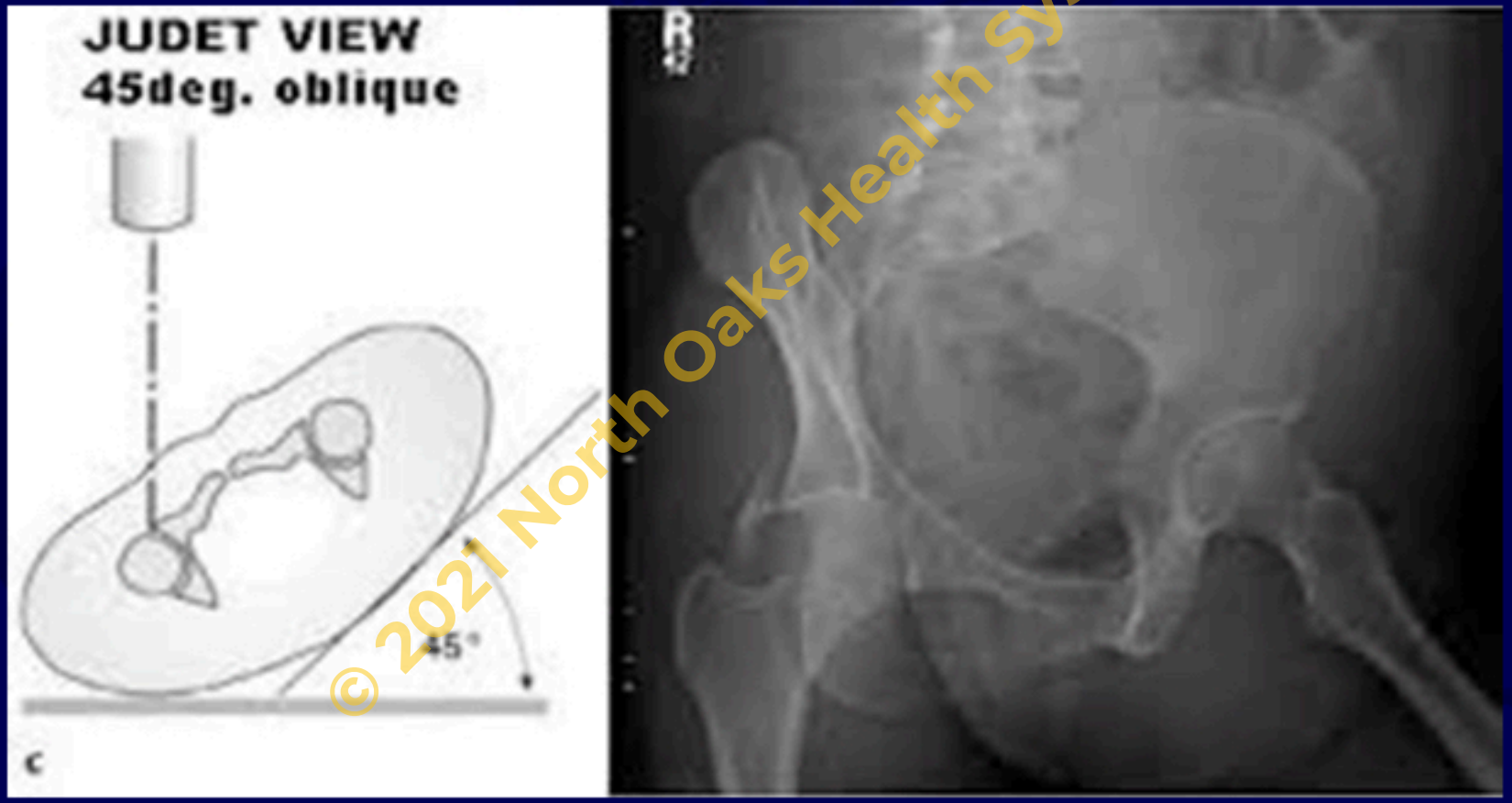


6 Lines: AP Pelvis (Letournel)

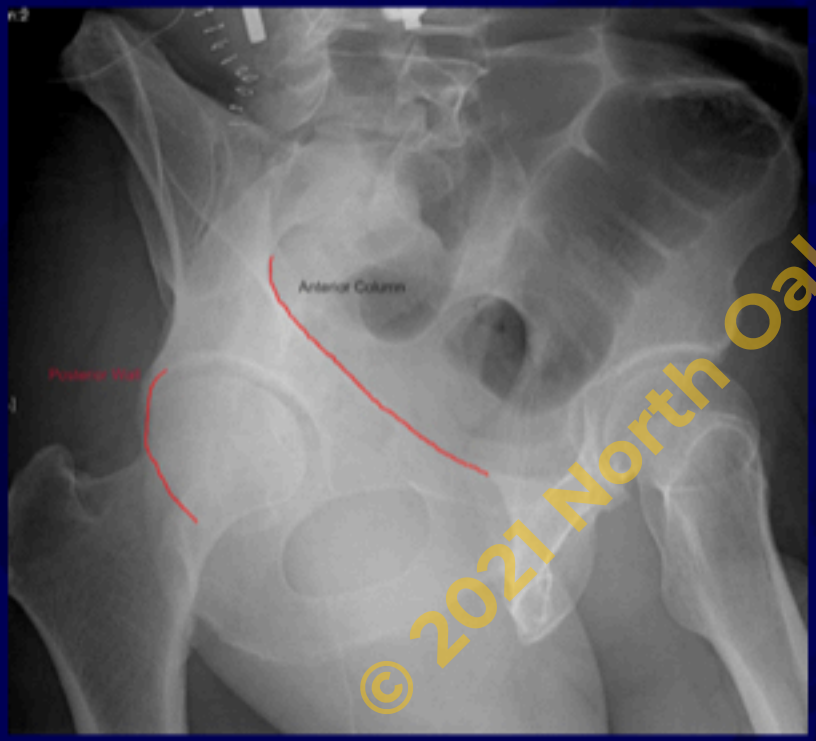


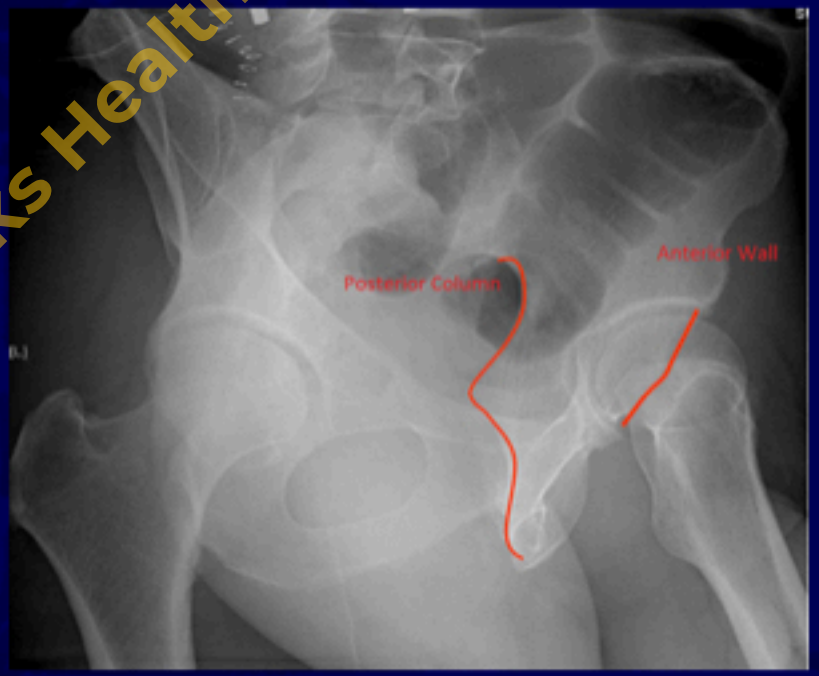


Technique For Judet Films

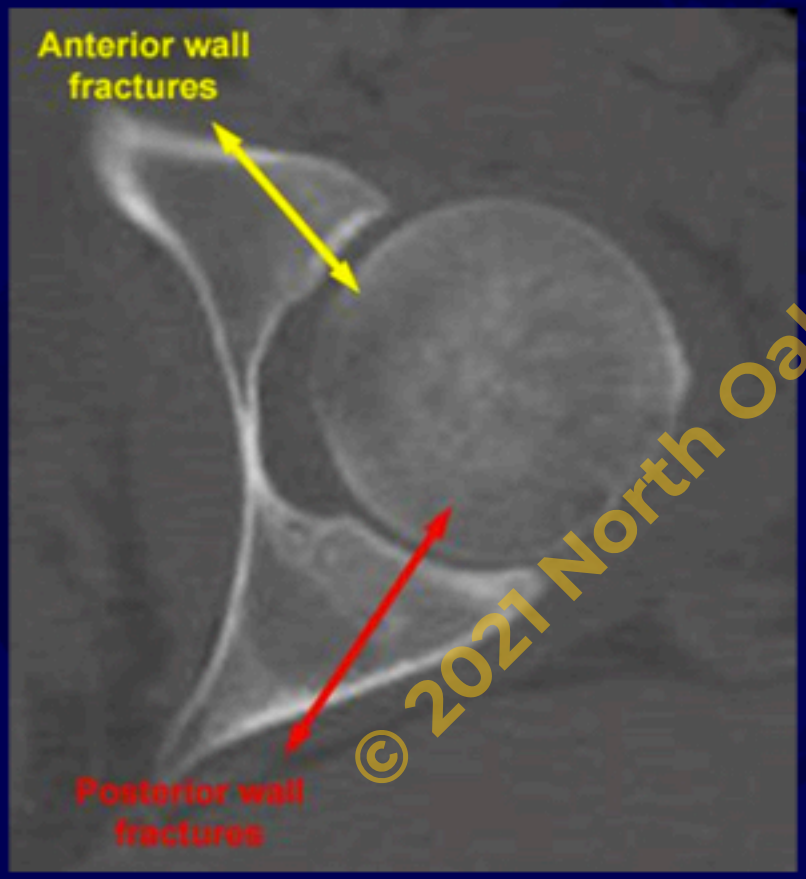


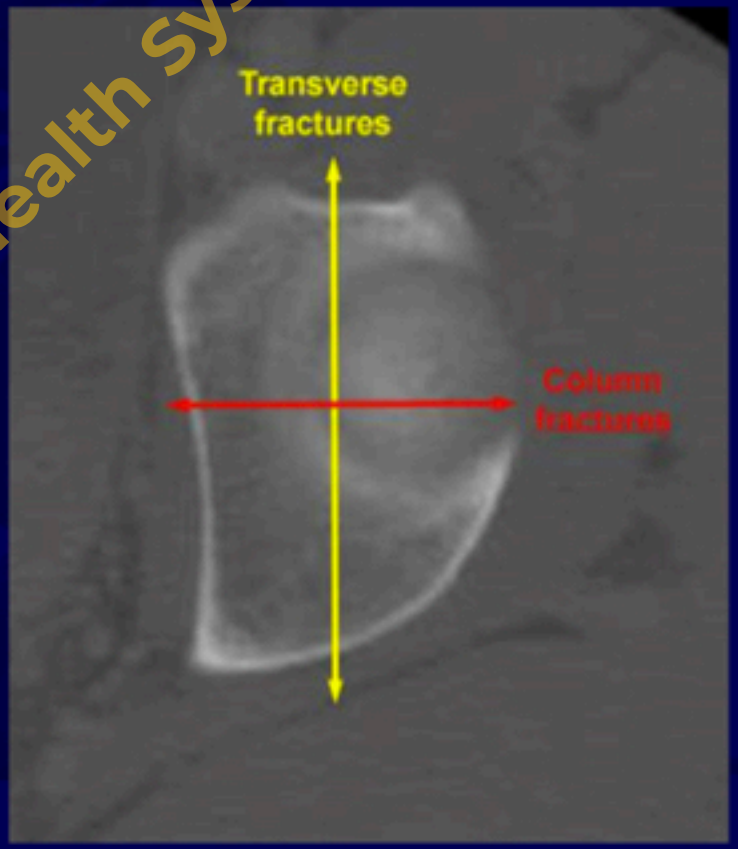
Judet views: Obturator and Iliac Oblique views (Supine 45 deg obliques)



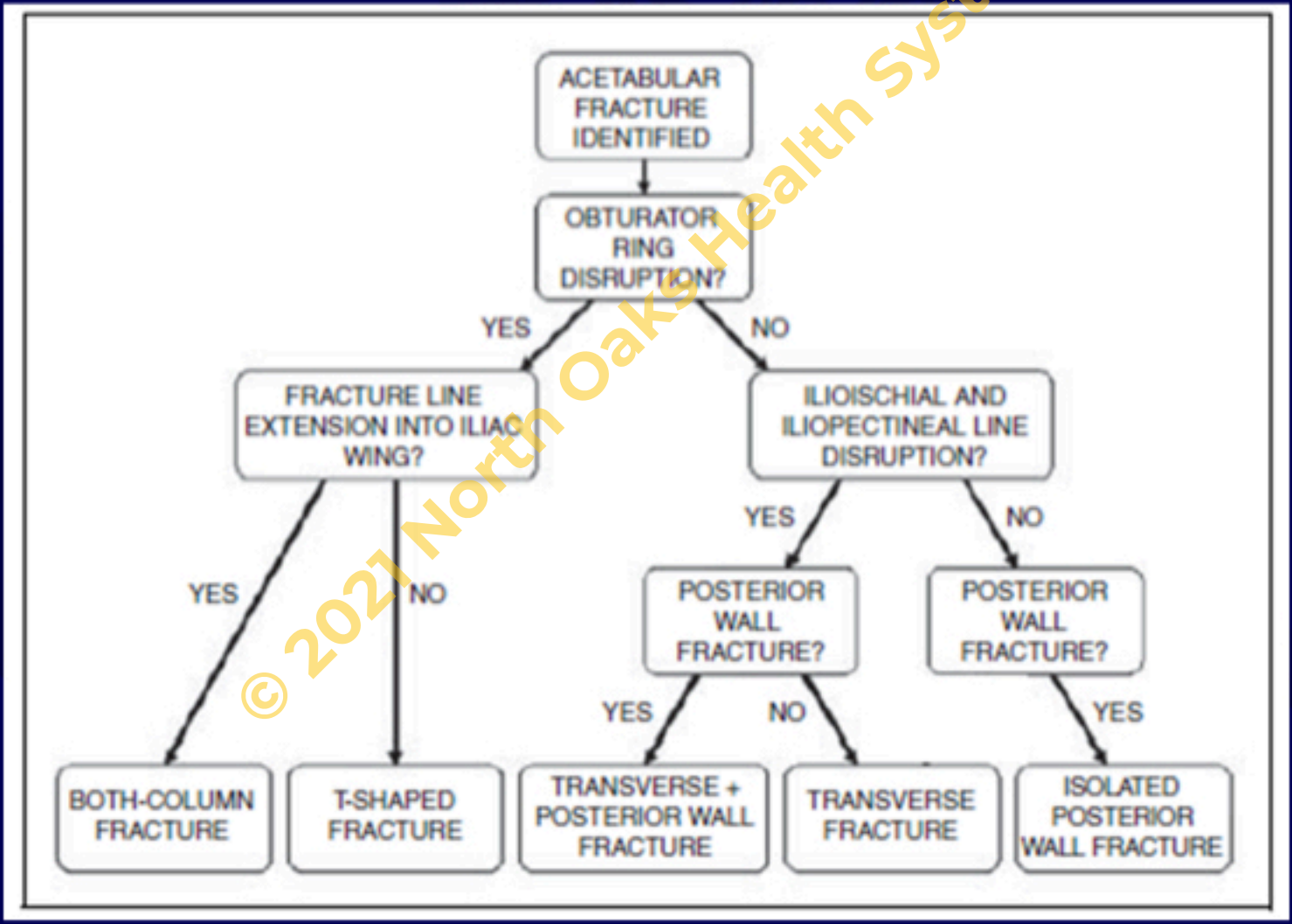


CT

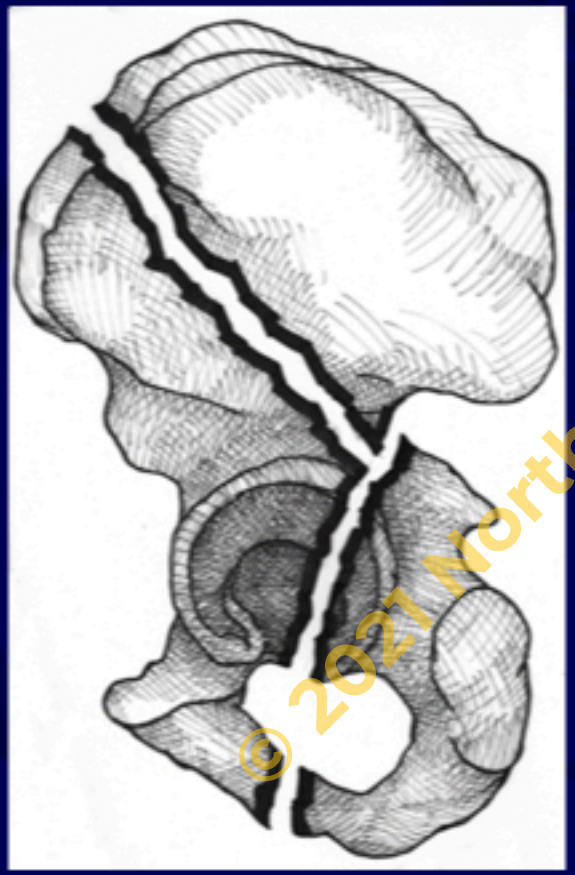


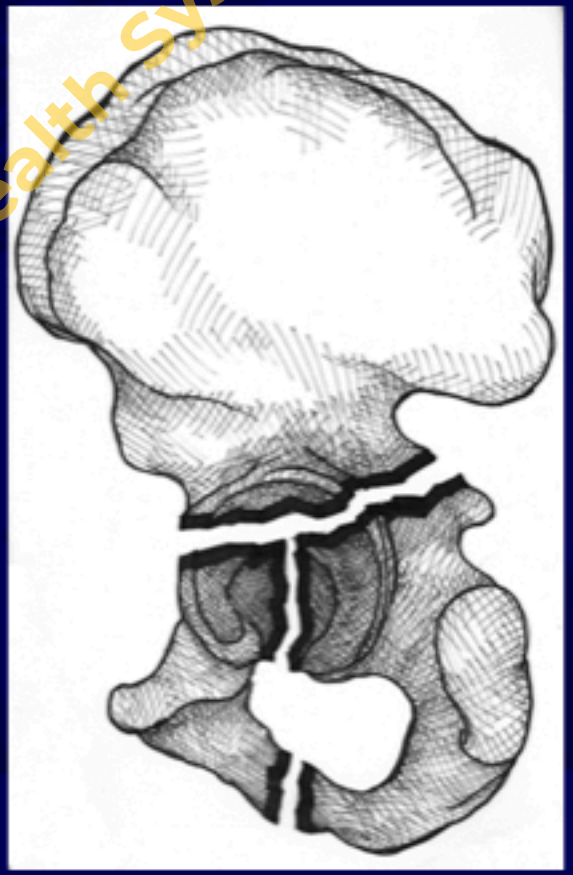


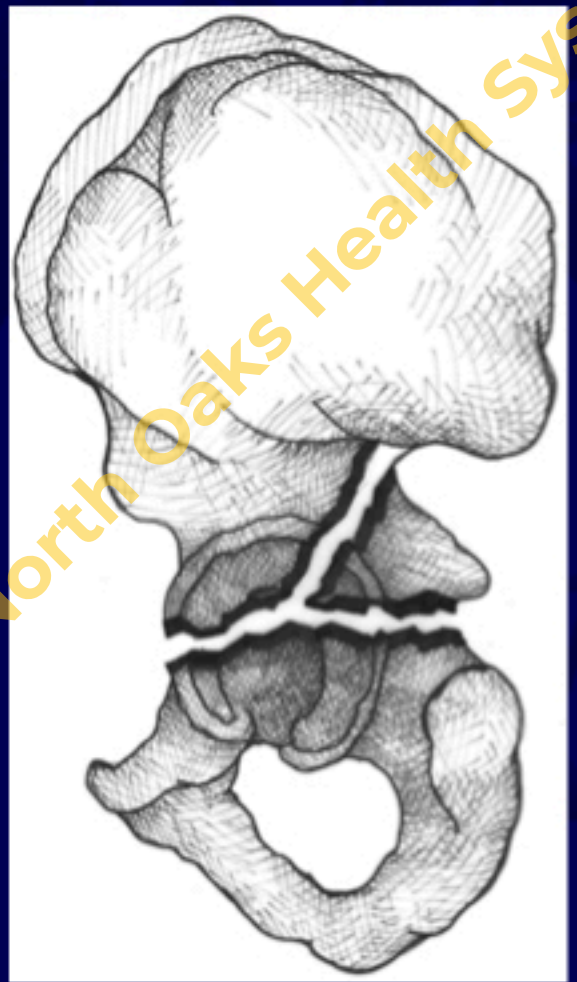
Algorithm to Classify

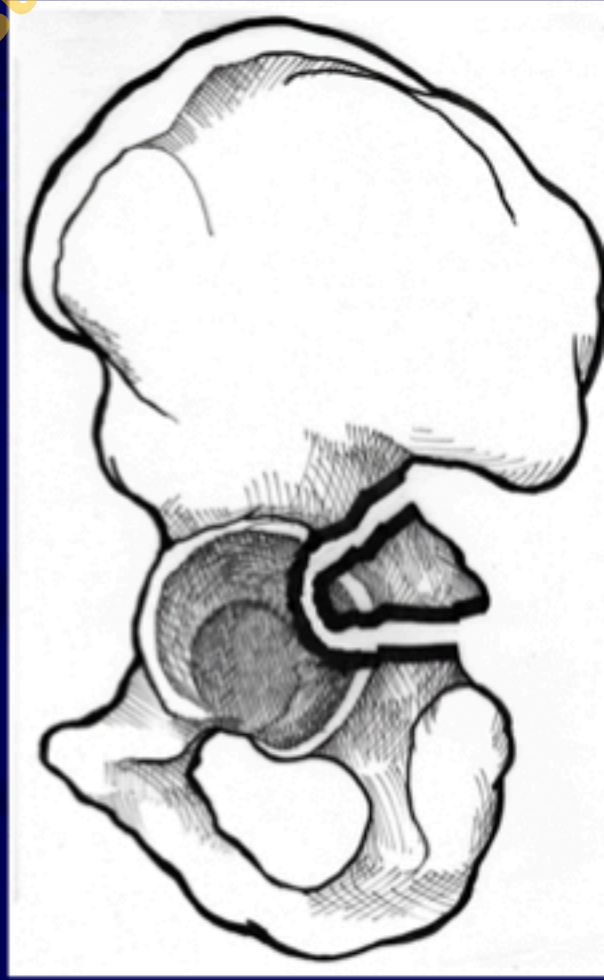


Five Most Common









Thank you