
# Pediatric pelvic fractures: Which Ones Need Surgery

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No conflicts of interest

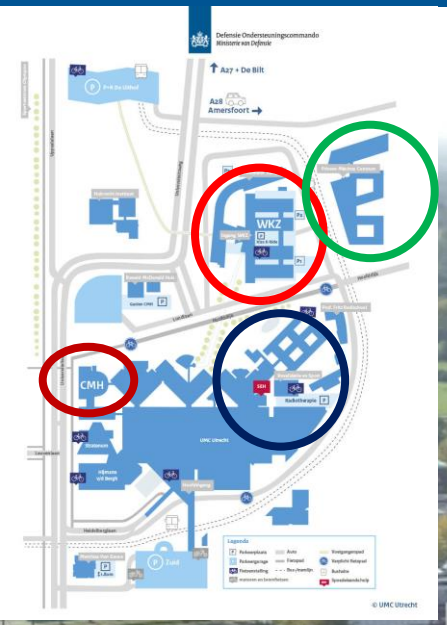
UMC Utrecht

UMC Utrecht
Wilhelmina Children's Hospital

# Disclosure: No potential conflicts of interest


- Faculty: Victor de Ridder

- I have no financial relationships with commercial entities that produce health-care related products.





**Utrecht Science Center and University**

Univerity Hospital of 1000 beds

Wilhelmina Childrens Hospital 400 beds

Military Hospital 64 beds

Disaster Hospital 100-300 beds: ready to use

Next to ER and Trauma Department

National Information Centre for Poisonings

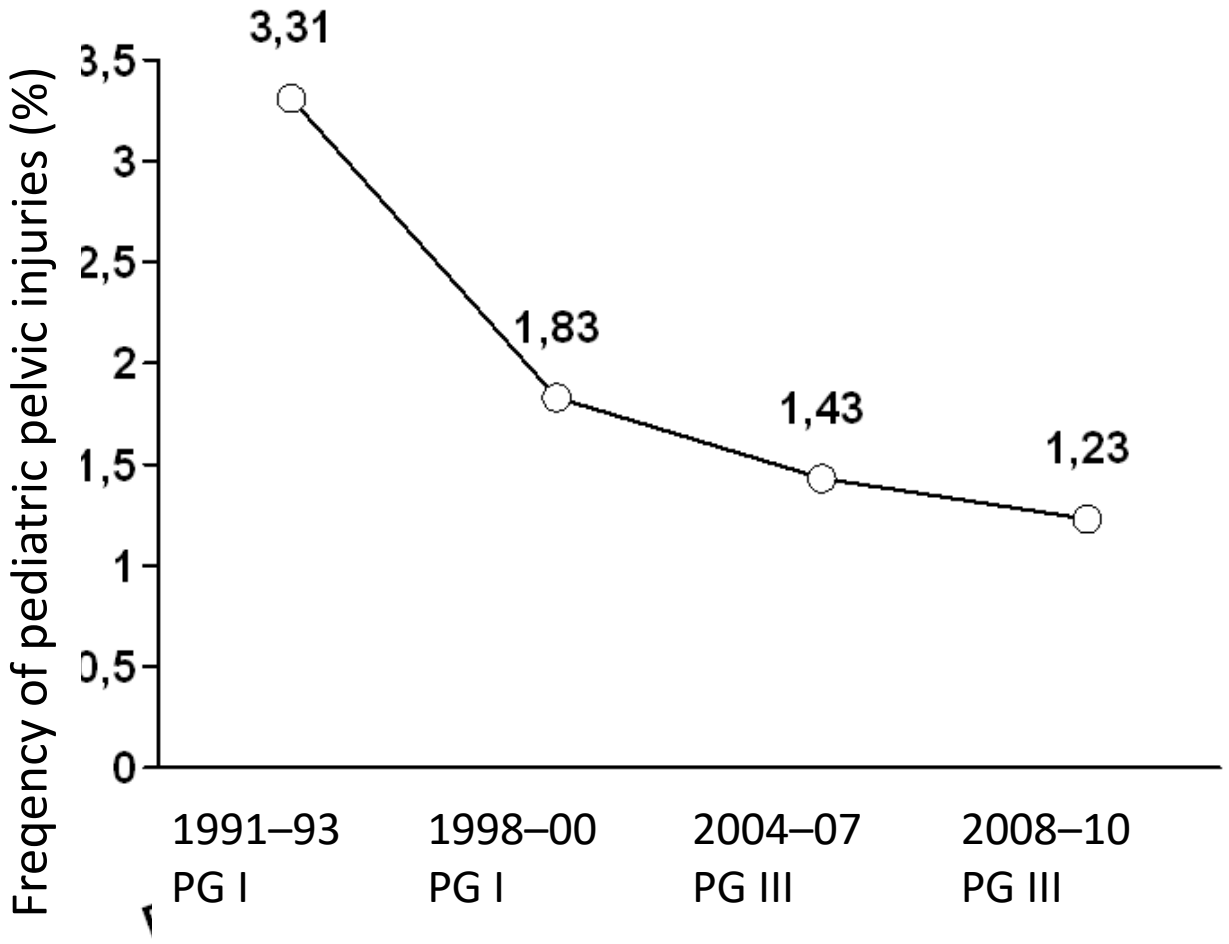
National Cancer Centre for Children

**Pelvic and acetabular fractures in children are rare**

If it looks right, it will be OK

If it looks wrong, it will be a disaster

# **Incidence of pelvic** ring injuries in childhood




PG = German pelvic study group

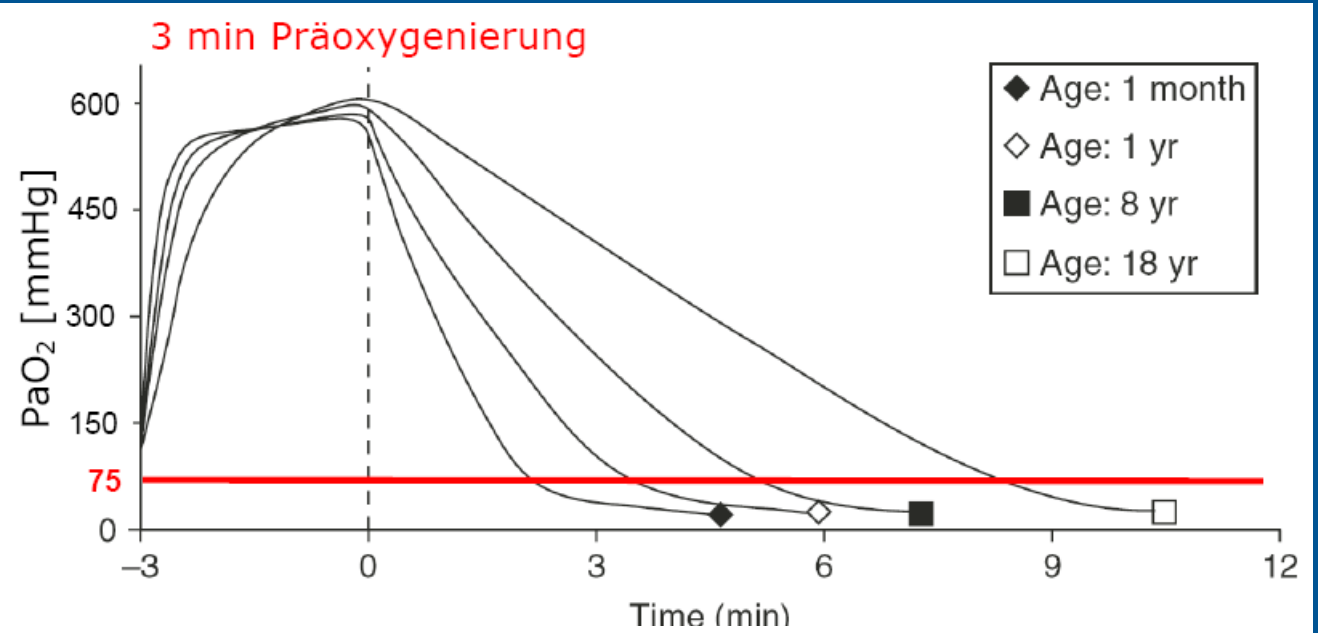
# Pelvic Injury in Children

- **Incidence Utrecht 2019-2021**
  - Children, *n* = 37 (incl. transfers from other hospitals)
    - Shockroom: n = 19 (10% of polytraumatized children)
  - Adults
    - Shockroom: *n* = 172

- **Literature**
  - Overall rare injury: 2.4 – 7.5%
  - In polytraumatized children: ~10%
    - *Schlickewei, Keck Injury 2005, Ismail et al J Pediatr Surg 1996, Peltier JBJS Am 1965, Quick Clin Orthop 2005*

# Specifics of pediatric trauma

- more brain / cervical spine injuries
- more thoracic injuries
- higher elasticity of bone (under estimate of the trauma!)
- baseless fear
- large body surface: cool down faster




Hardman JG et al. The development of hypoxaemia during apnoea in children: a computational modelling investigation. Brit J Anaesth 2006 ;97: 564–70

oxygen consumption 2-3x
less tolerance of hypoxia!

Review > J Orthop Trauma. 2019 Dec;33 Suppl 8:S33-S37.
doi: 10.1097/BOT.0000000000001644.

# Operative Treatment of Pediatric Pelvic and Acetabulum Fractures

Victor A de Ridder [1], Steven A Olson [2]

Review > J Am Acad Orthop Surg. 2020 May 1;28(9):353-362.
doi: 10.5435/JAAOS-D-19-00082.

# High-Energy Fractures of the Pelvis and Acetabulum in Pediatric Patients

David Galos [1], Travis A Doering

Review > Orthop Traumatol Surg Res. 2020 Feb;106(1S):S125-S133.

doi: 10.1016/j.otsr.2019.05.017. Epub 2019 Sep 11.

# Pelvic fractures in children (pelvic ring and acetabulum)

Jean-Marc Guillaume [1], Sébastien Pesenti [2], Jean-Luc Jouve [2], Franck Launay [2]

Review > J Trauma Acute Care Surg. 2012 Jun;72(6):1502-9.

doi: 10.1097/TA.0b013e318246efe5.

# Osseous fixation pathways in pelvic and acetabular fracture surgery: osteology, radiology, and clinical applications

Julius A Bishop [1], Milton Lee Chip Routt Jr

> Clin Orthop Relat Res. 2000 Jul;(376):80-6. doi: 10.1097/00003086-200007000-00012.

# Acetabular fractures in children and adolescents

M Heeg [1], V A de Ridder, P Tornetta 3rd, S de Lange, H J Klasen

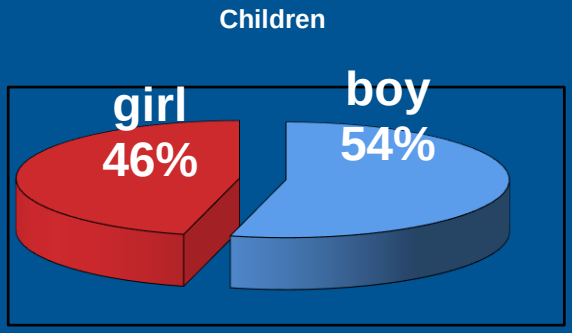
Affiliations + expand

PMID: 10906861 DOI: 10.1097/00003086-200007000-00012

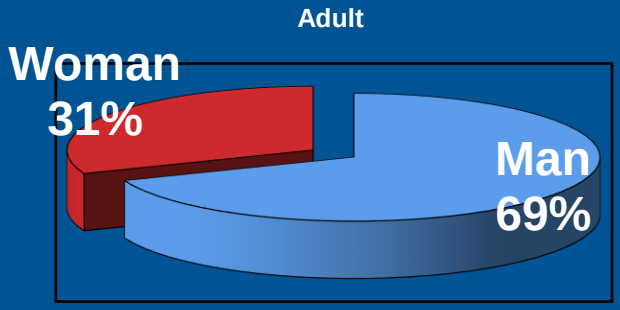
# Epidemiology

## Age

- *Children*: 11,8 y (3-16)
  - *Smith et al JBJS Am 2005:* 9.5 ys
  - *Grisoni et al. J Orthop Trauma 2002:* 9 ys
  - *Chia et al. J Trauma 2004*: 9 ys
  - *Spiguel et al The American Surgeon 2006:* 8 ys
  - *De Ridder and Olson JOT 2019:* 10 ys




- *Adults*: 40.9 ys (17-80)



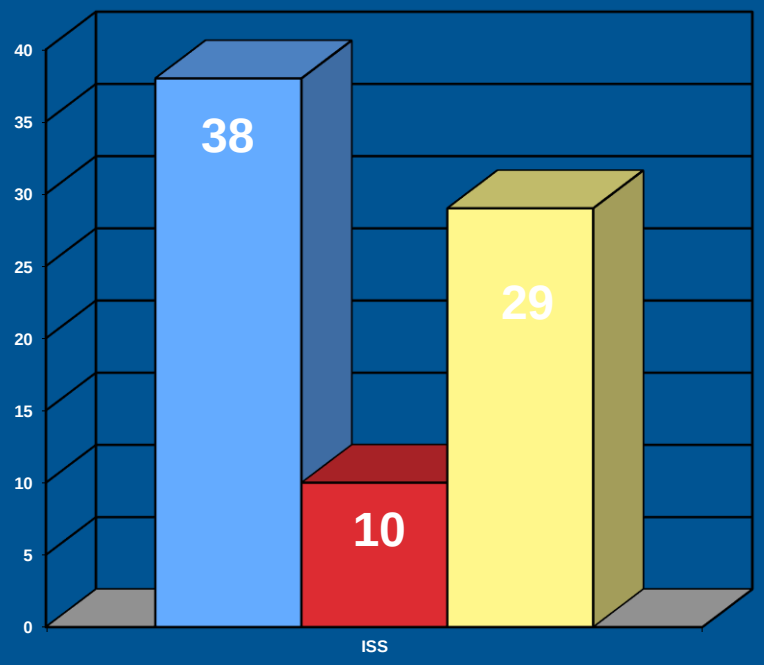

## Gender

- *Children*: 17 f (46%), 20 m (54%)
- *Adults*: 54 f (31%), 118 m (69%)

## Injury Mechanism

– High Energy Trauma: Traffic accidents, Fall from great height

# Injury Severity and associated Injuries




*Children with pelvic injuries*

*All children treated in the shock room*

*Adults*

**Associated injuries in Children:**

1. Chest 73%
2. Brain 63%
3. Extremity fractures 58%
4. Abdominal trauma 47%

**ISS in Children:** 30.5 points

*Rieger, Brug Clin Orthop Relat Res 1997*

# Associated Injuries

- **Urogenital Injuries**
  - More rare compared to adults
    - 6-8% *(Demetriades J Trauma 2003, McIntyre J Trauma 2003)*
    - Children: 11% vs. Adults: 22% *(Schneidmüller Unfallchirurg 2011)*

- **Vascular Injuries**
  - More rare compared to adults

    *(Demetriades et al . J Trauma 2003; McIntyre et al. J Trauma 1993)*

  - Higher elasticity and no artherosclerosis

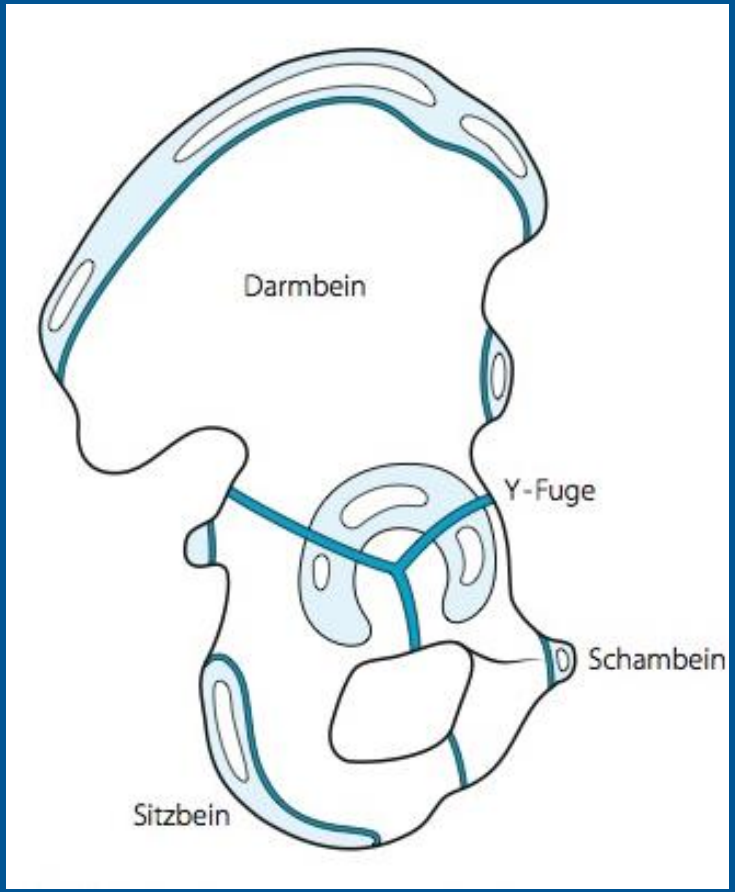
    *(Schlickewei, Keck Injury 2005, Quick Clin Orthop 2005)*

# The pediatric pelvis

**High elasticity** (thicker cartilage symphysis + SI joint,

Pelvic injuries within high-energy trauma

High risk of intrapelvic / intraabdominal injuries




High stability of ligaments, thick periost

Pelvis more flat → less protection for organs

Growth plates and apophysis are anatomic weak locations

Growth arrest in case of closure of the growth plates

*Marzi, Kindertraumatologie*
*2. Aufl., 2009*

# Growth speed

From BIRTH to 5yr the growth is FAST

Size doubles from birth to 5 yr

From 5 yr to 10yr growth is regular

Above age 10yr to PUBERTY the growth accelerates

# Experimental biomechanical studies

**age 1 y:** **up to 10.000 N plastic deformation, *No fracture***

**age 12 y:** **up to 8000 N *No fracture***

| | |
|---|---|
| dislocation of the triradiate cartilage | **2300 N** |
| disruption of the SI – joint | **8000 N** |
| disruption of the SI – joint | **10000 N** |

**age 14 y:** **up to 3000 N:**

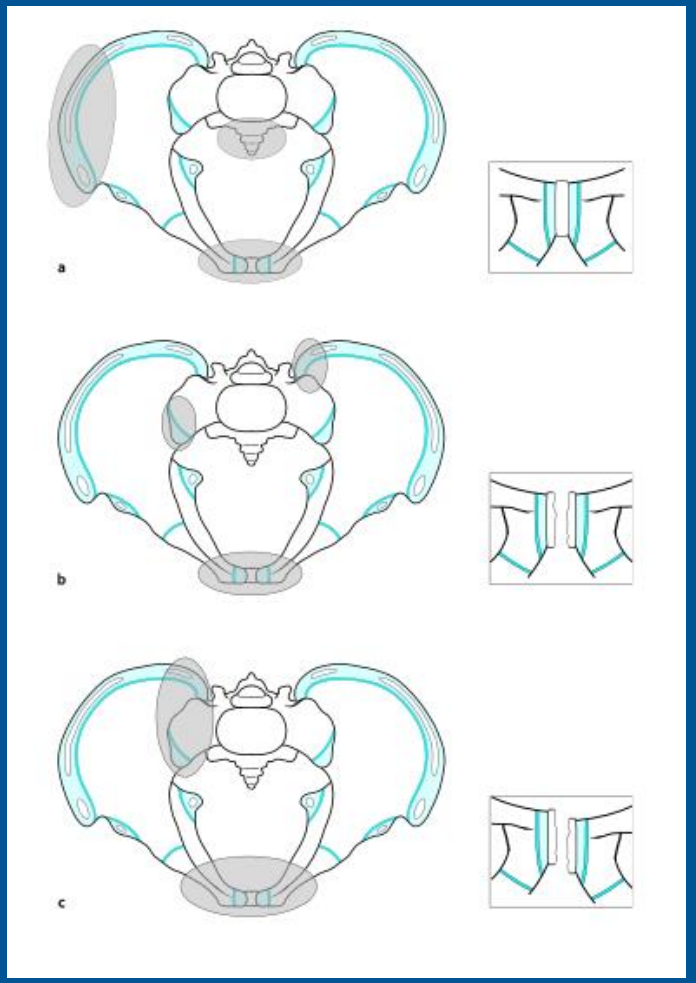
| | |
|---|---|
| fracture of the acetabulum | **2000-3000 N** |
| disruption of the SI – joint | **2000-3000 N** |
| disruption of the symphysis | **6000 N** |
| transpubic instability | **6000 N** |

***Stuhler, 1977***

# Classification

- **AO Classification**
  - Pennal und Tile
    - Type A: Stable
    - Type B: Part. unstable (rotation)
    - Type C: Unstable (+ vertical instability)
- **Children-specific Classification**
  - Torode and Zieg (1985)
    - **Type I:** Avulsion Fractures
    - **Type II:** Fractures of the ilium
    - **Type III:** Transpubic instability without posterior injury
    - **Type IV:** Any fracture pattern creating a free bony fragment

As the bone/pelvis matures, the fractures will resemble more and more the adult type of fractures




*Pennal und Tile*

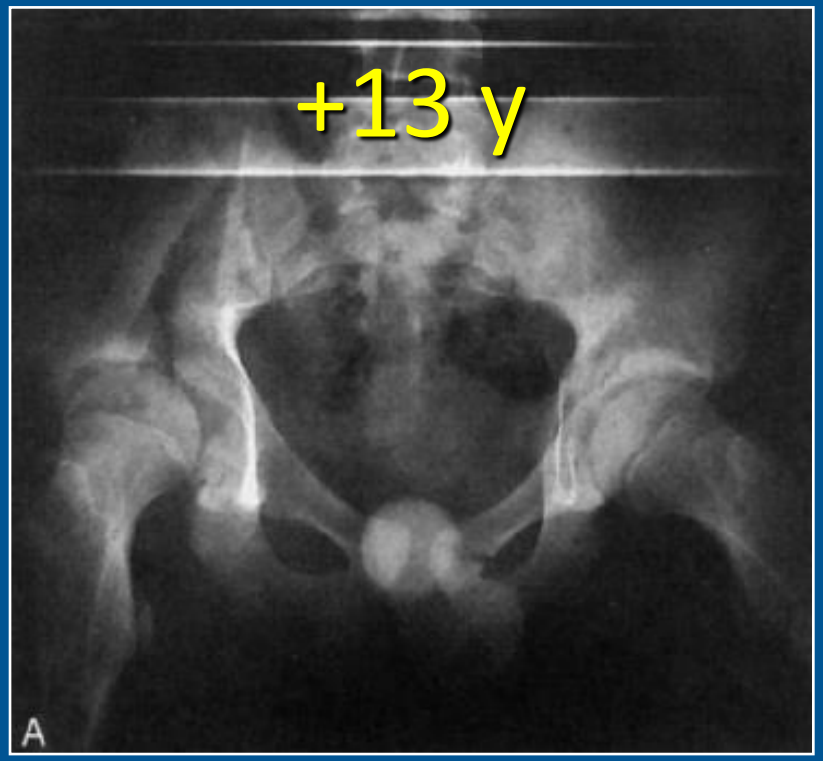
Distinguish between patients under 6 y. and older

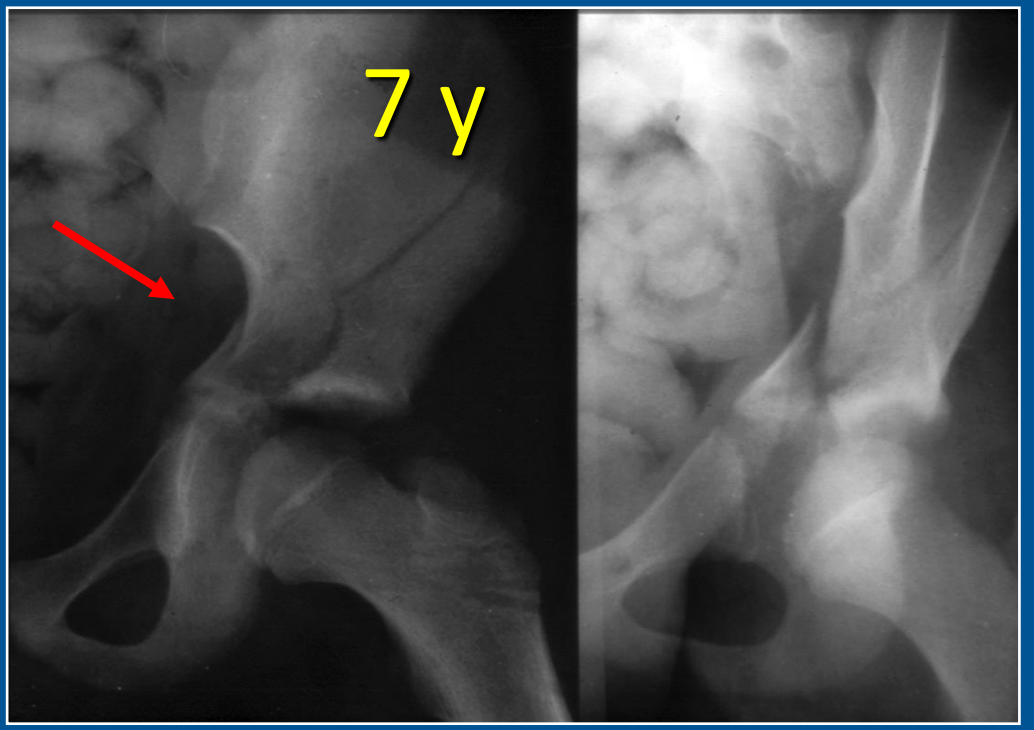
10 – 12 y  pts have to be treated as adults

adolescent

children

(from Heeg M/de Ridder VA:  COOR 2000 )



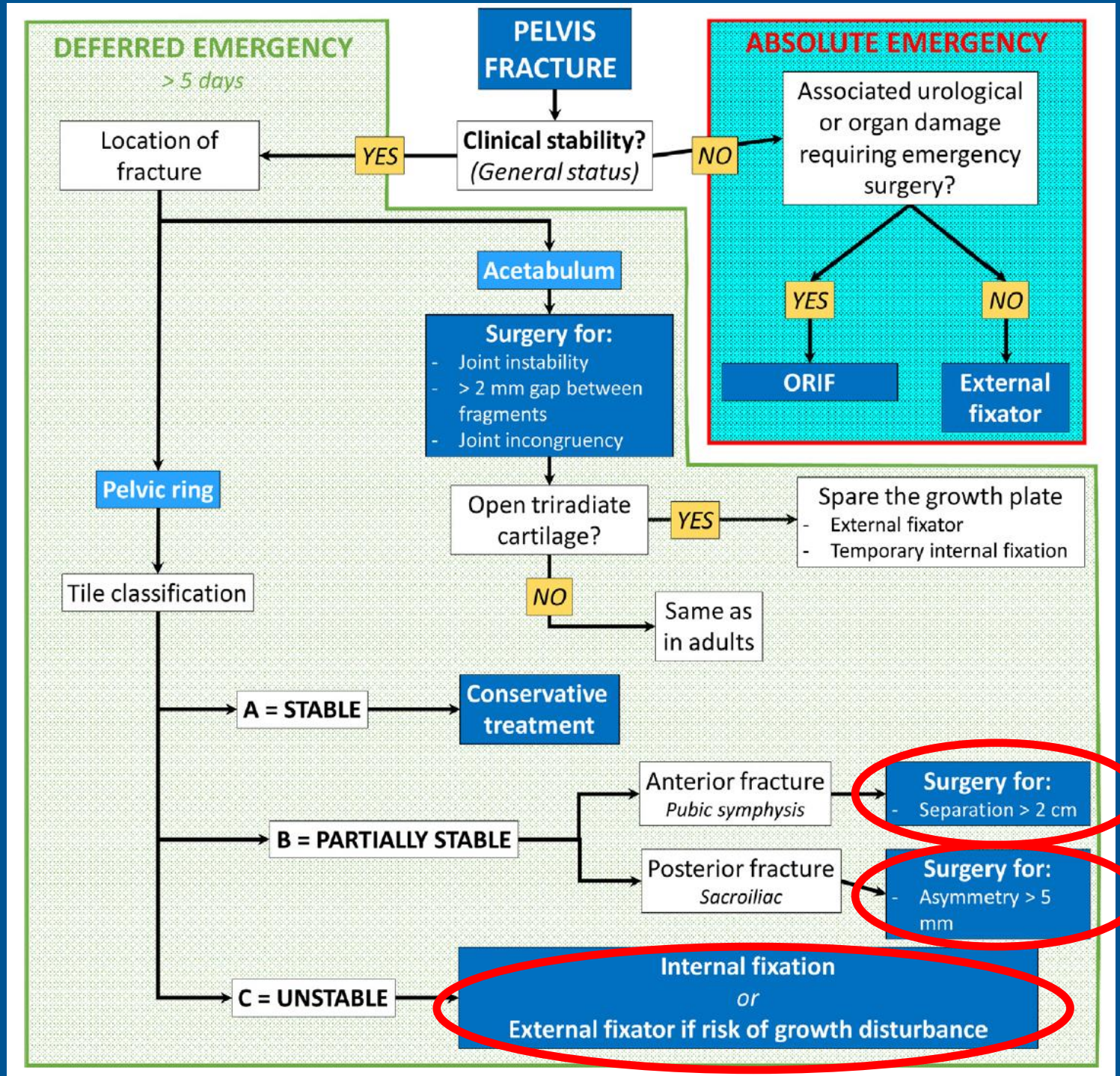



# Pelvic Fracture with Soft Tissue Injury

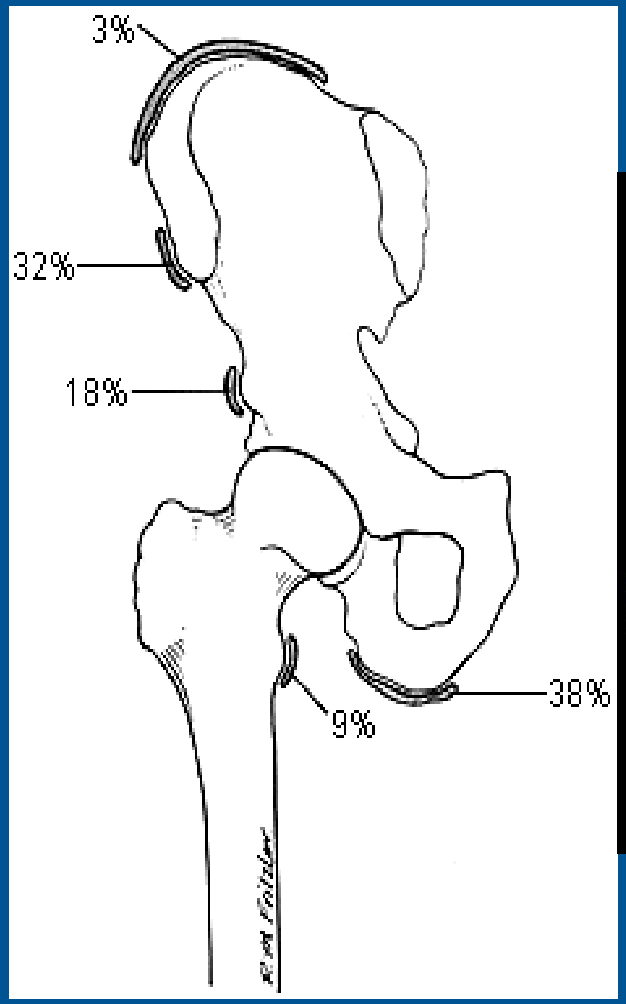
Girl, 10 y

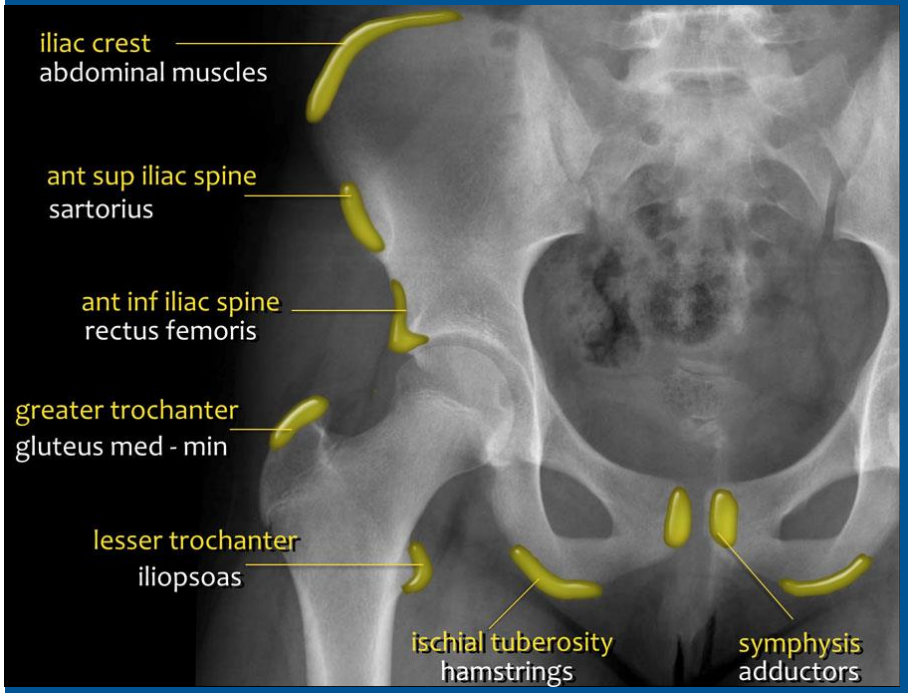


(from Heeg M/de Ridder VA:  COOR 2000 )


DEFERRED EMERGENCY
> 5 days
PELVIS FRACTURE
ABSOLUTE EMERGENCY
Clinical stability?
(General status)
YES
NO
Location of fracture
Associated urological or organ damage requiring emergency surgery?
YES
NO
ORIF
External fixator
Acetabulum
Surgery for:
- Joint instability
- > 2 mm gap between fragments
- Joint incongruency
Pelvic ring
Open triradiate cartilage?
YES
Spare the growth plate
- External fixator
- Temporary internal fixation
NO
Same as in adults
Tile classification
A = STABLE
Conservative treatment
B = PARTIALLY STABLE
Anterior fracture
Pubic symphysis
Surgery for:
- Separation > 2 cm
Posterior fracture
Sacroiliac
Surgery for:
- Asymmetry > 5 mm
C = UNSTABLE
Internal fixation
or
External fixator if risk of growth disturbance

# Relative Percentages of Pelvic Avulsion Fracture Locations




Rossi F, Dragoni S. Acute Avulsion Fractures of the Pelvis in Adolescent Competitive Athletes. *Skeletal Radiol.* 2001;30(3):127-31.

# ASIS Avulsion Fracture

Need for operation/fixation??

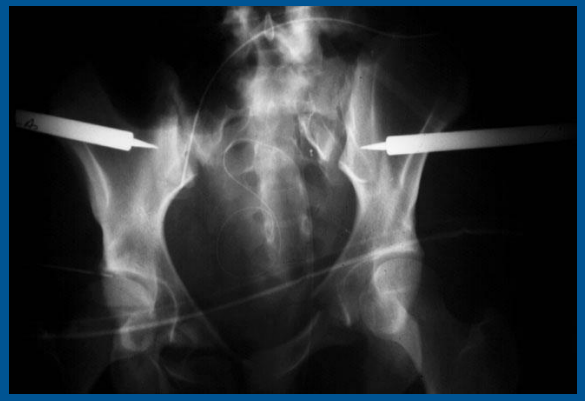
- atletes
- gross deformity or callus formation

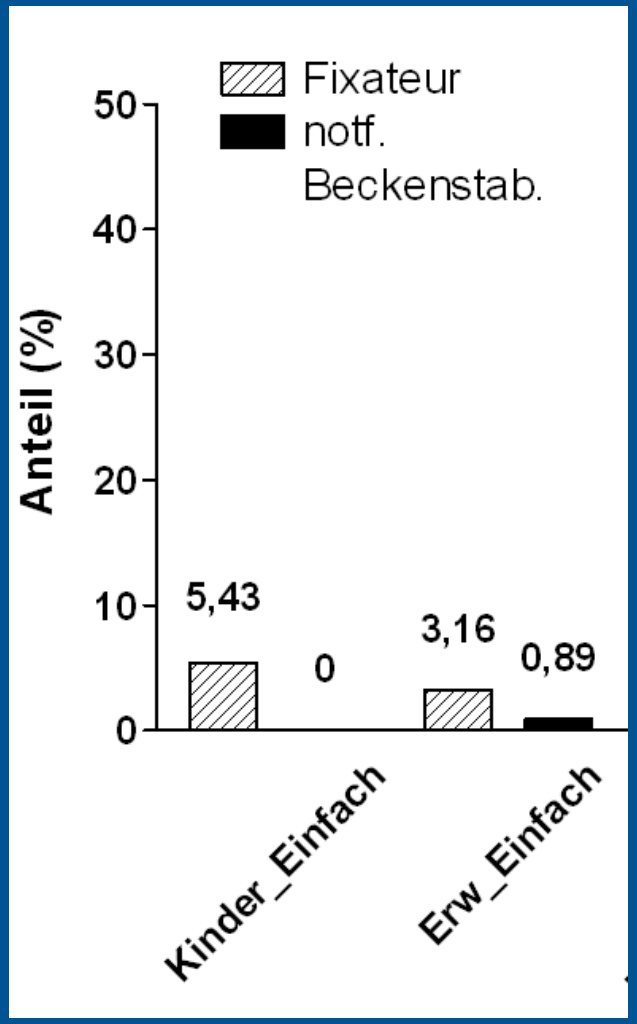
- mostly no fixation needed, just rest and temporary sports limitation

Figure 1: Type 1 Avulsion fracture

# Emergency treatment in „simple“ fractures

- acute stabilisation of the pelvic girdle:
  - pelvic sling
  - external fixator
  - pelvic clamp
- osteosynthesis?

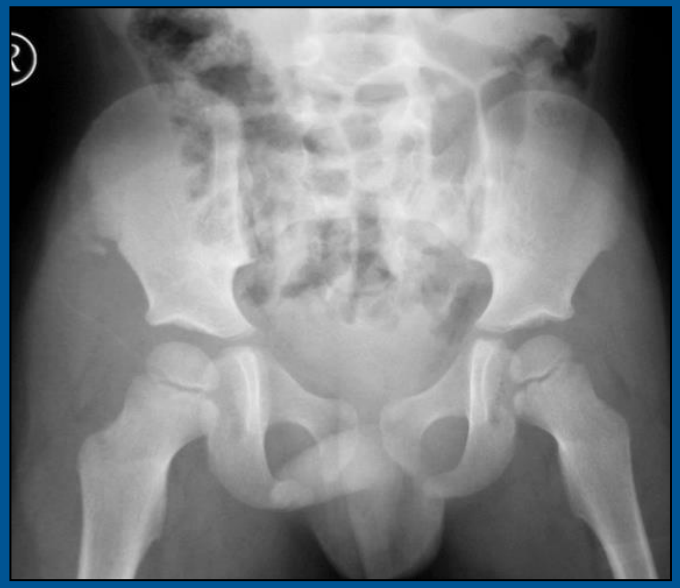


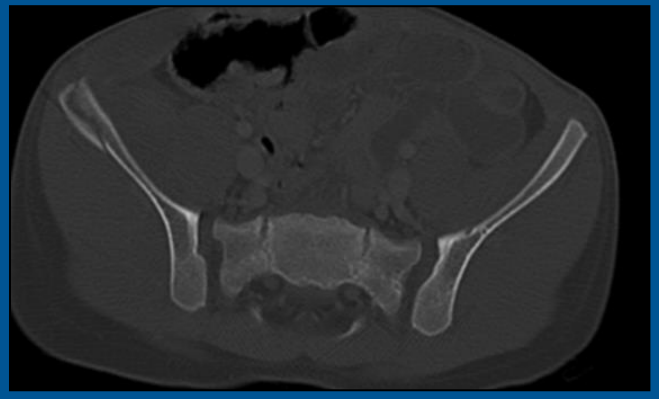


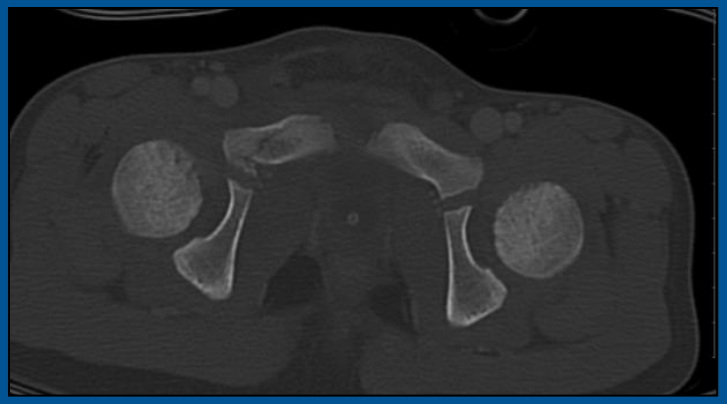
# Type A Injury

Boy, 4 years, Roll over by motorvehicle

Fracture of os ilium and Ramus pubis – conservative management



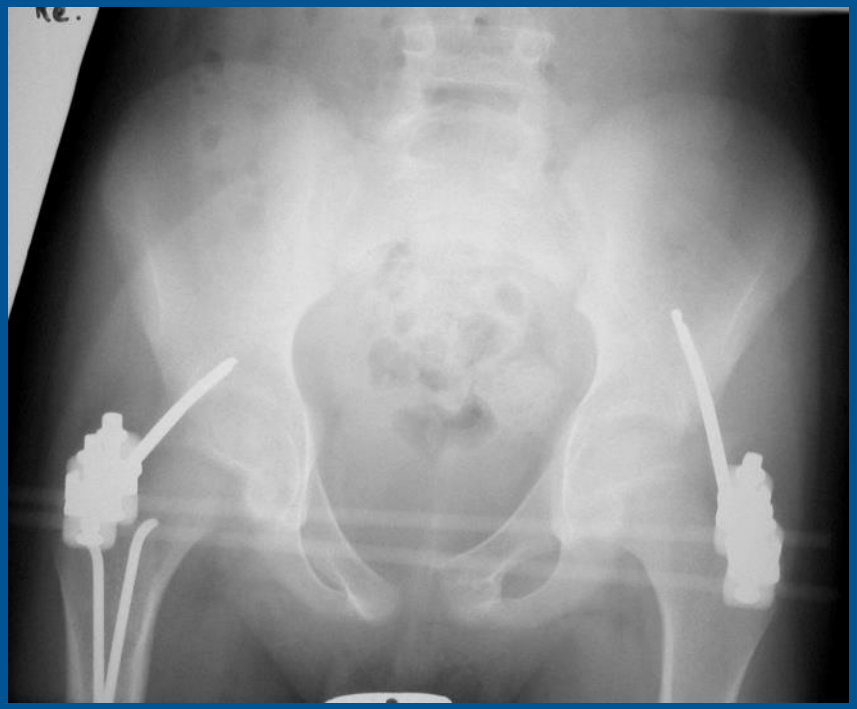




# Type B Injury

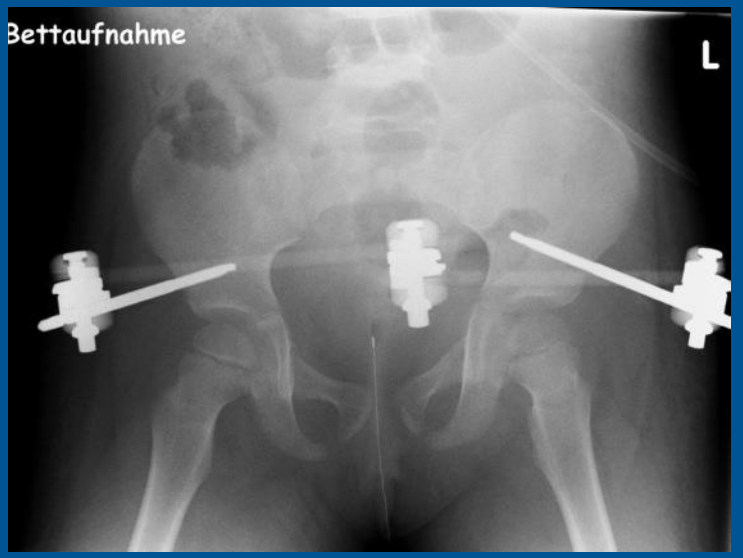
Boy, 11 years

Open book fracture, fracture of femur – external fixateur

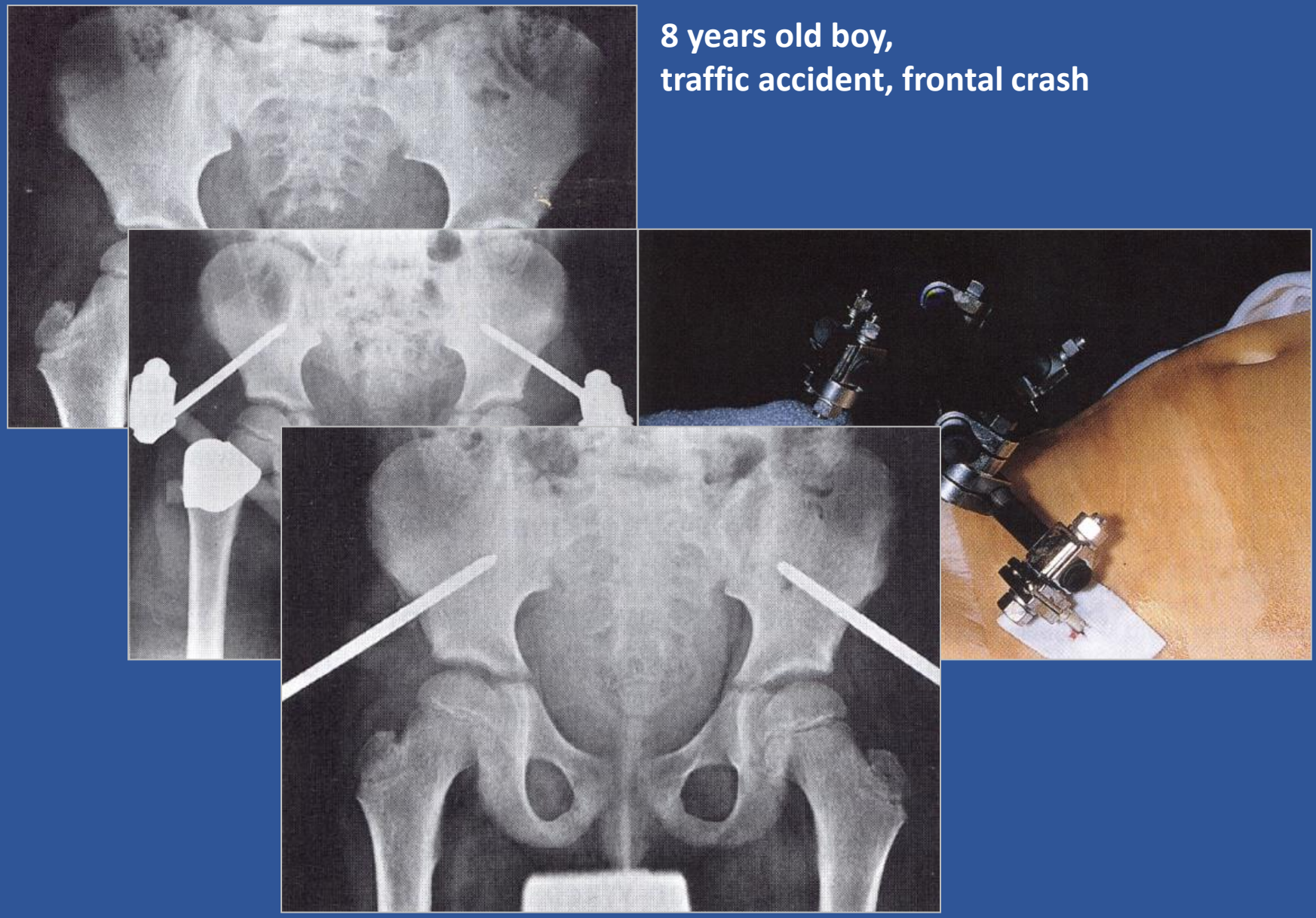


# Type C Injury

Girl, 3.5 years, Roll over by motorvehicle, initial GCS 8

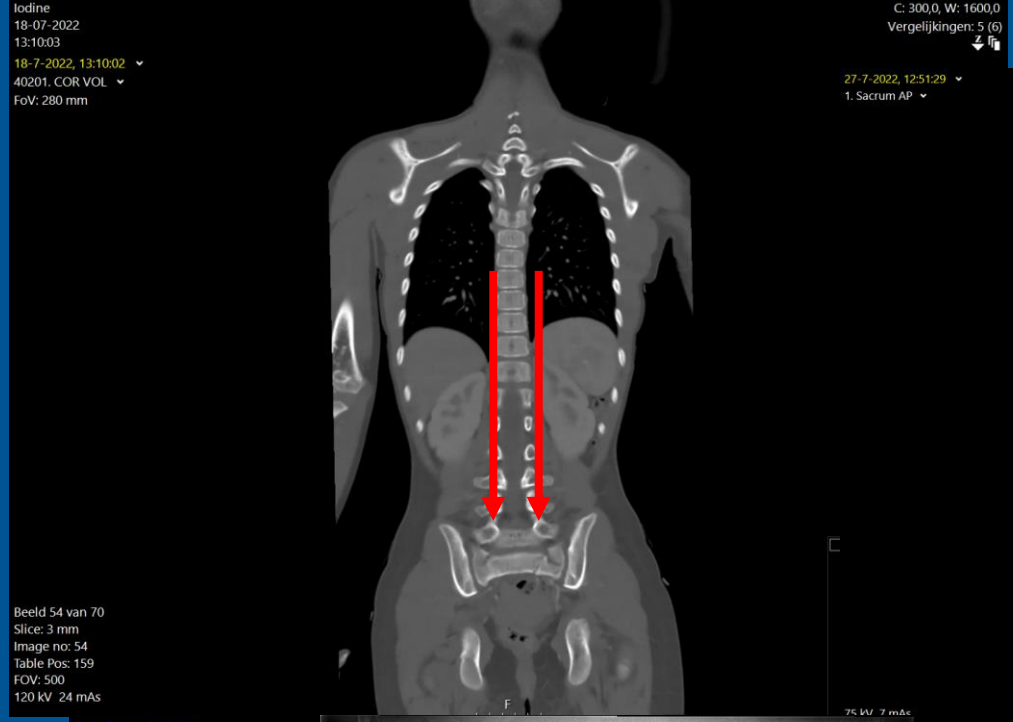


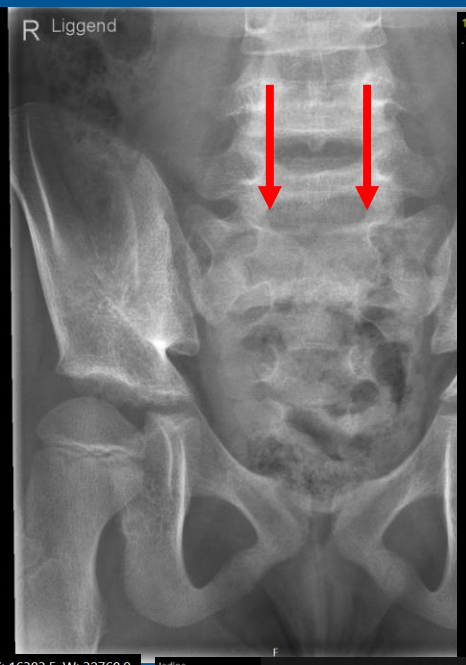

After removal of ext. fix.



8 years old boy,
traffic accident, frontal crash

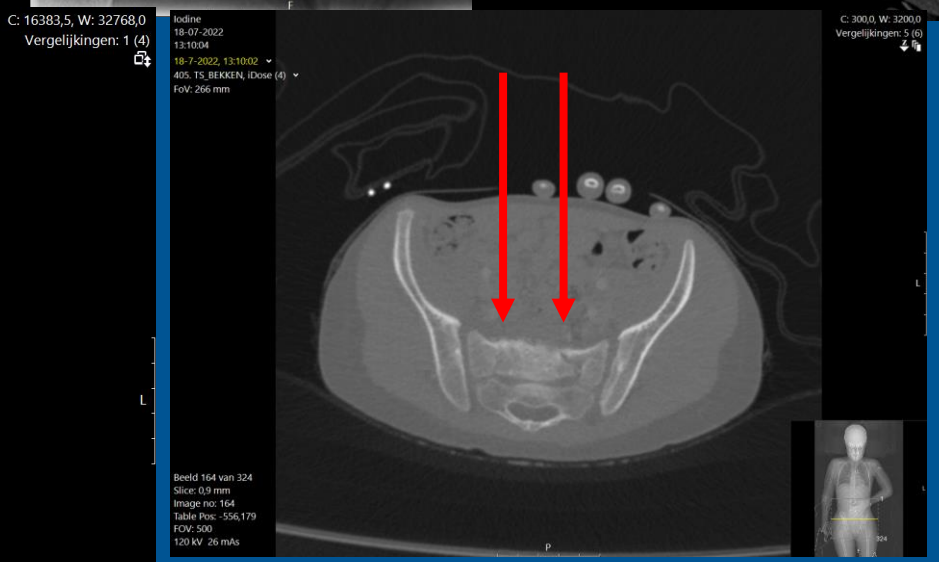
Healing after 6 weeks,
removal of ext. Fixator after 3 weeks


Iodine
18-07-2022
13:10:03
18-7-2022, 13:10:02
40201. COR VOL
FoV: 280 mm
C: 300,0, W: 1600,0
Vergelijkingen: 5 (6)
27-7-2022, 12:51:29
1. Sacrum AP
Beeld 54 van 70
Slice: 3 mm
Image no: 54
Table Pos: 159
FOV: 500
120 kV 24 mAs


R Liggend


18-7-2022, 13:10:02
. Sectra Reconstruction

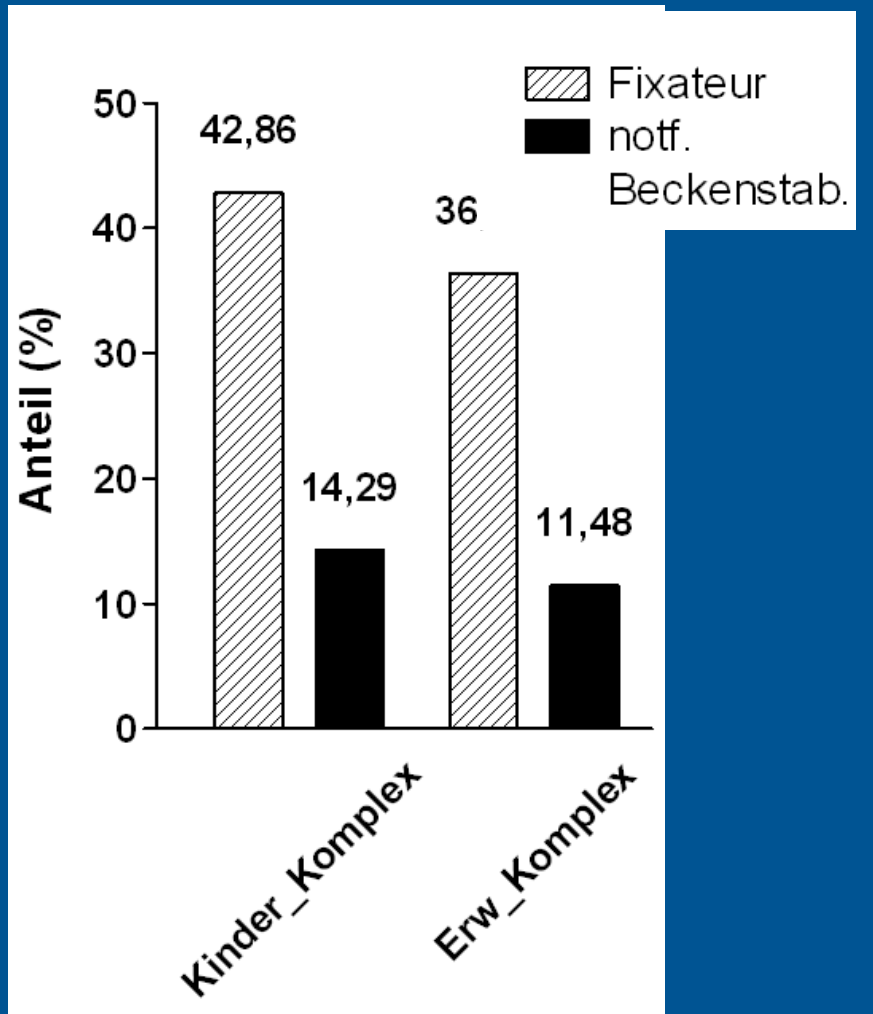

27-7-2022, 12:45:30
2. LWK PA
L
Staand


C: 16383,5, W: 32768,0
Vergelijkingen: 1 (4)
Iodine
18-07-2022
13:10:04
18-7-2022, 13:10:02
405. TS_BEKKEN, iDose (4)
FoV: 266 mm
C: 300,0, W: 3200,0
Vergelijkingen: 5 (6)
Beeld 164 van 324
Slice: 0,9 mm
Image no: 164
Table Pos: -556,179
FOV: 500
120 kV 26 mAs

# Emergency treatment in „complex“ trauma

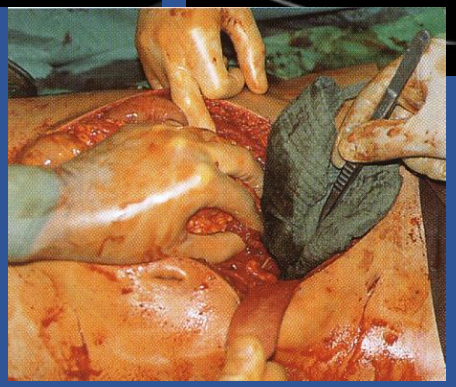
- acute stabilisation of the pelvic girdle:
  - pelvic sling
  - external fixator
  - pelvic clamp
- osteosynthesis?

- pelvic packing / coiling



**9 year** old boy **overrolled by truck** as pedestrian

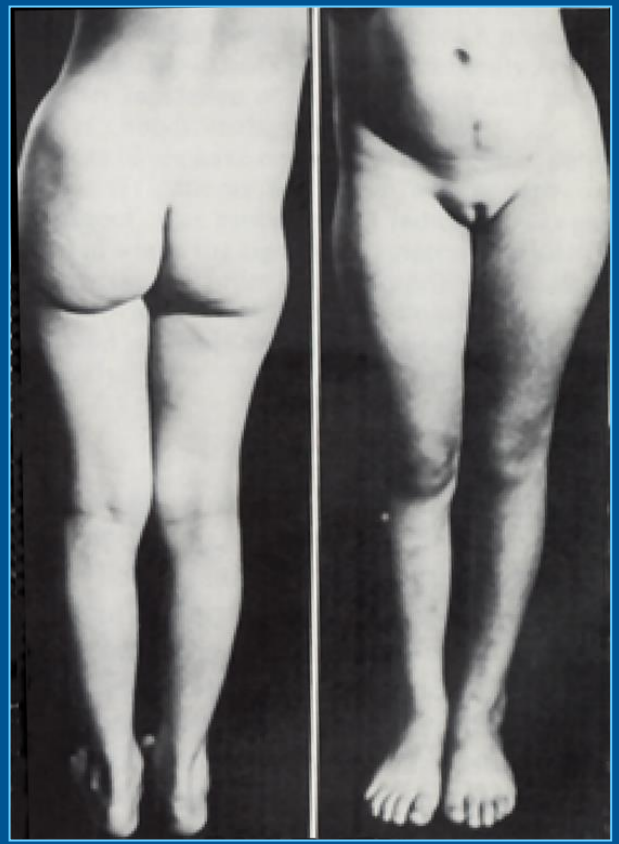
**stabilisation by external fixator**

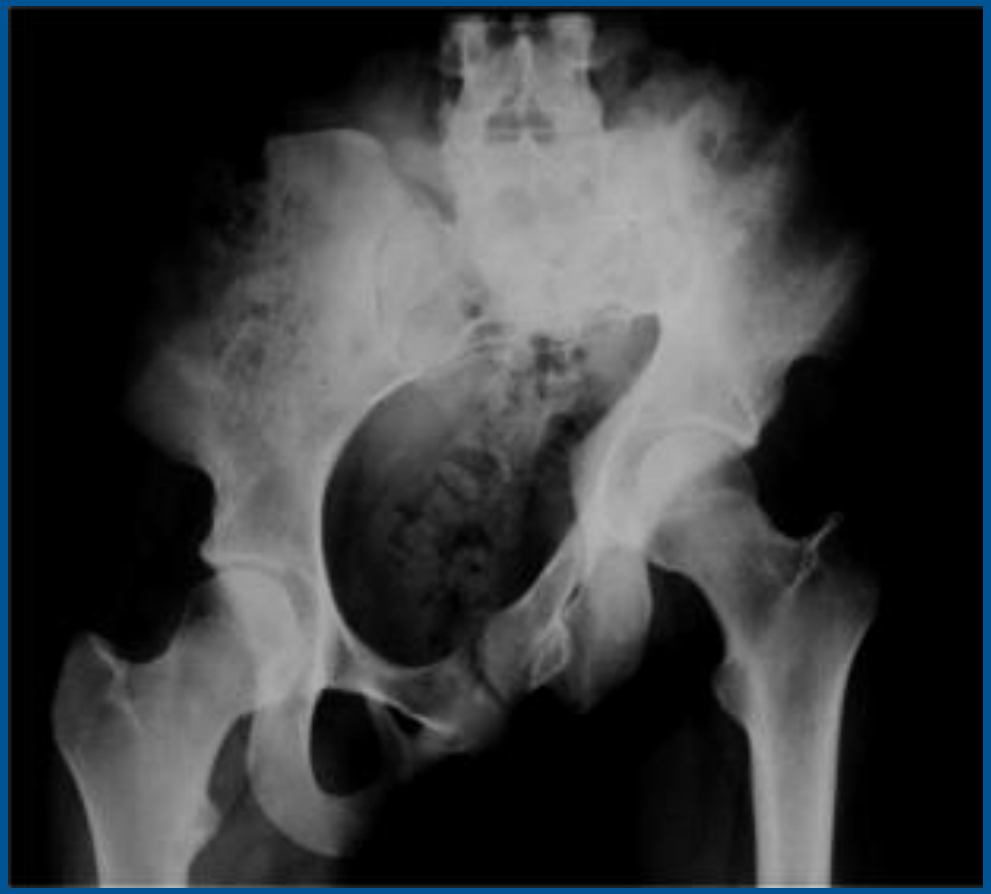


**pelvic packing in** case of ongoing bleeding

# Unstable pelvic fracture

Great potential of deformity and growth disturbance at any age





Literature is confusing : this case was classified as a triradiate cartilage injury

( Heeg, de Ridder COOR 2000 )

Post Traumatic Acetabular Dysplasia and Pelvic Obliquity,
correction osteotomie at age of 25

# Summary

- Significant pelvic injury mostly in polytraumatized children
- Aim for reconstruction of pelvic ring
- Mostly type A pelvic ring fractures – conservative therapy
- Type B and C injuries - operative management (ext. fix..; plate osteosynthesis)
- Distinguish between patients under 12 y. and older 12 y have to be treated as adults
- In some cases: angio-embolisation necessary

Long term prognosis depends on achieved pelvic symmetry and injury to the acetabulum

And depending on age at time of trauma and sex

If it looks right, it will be OK

If it looks wrong, it will be a disaster

# Pelvic Fractures in children: selectiveoperative or nonoperative management (SNOM) management

- Minimal displacement
- Stable normal ring

- Simple bedrest
- Follow-up average 14 (4 - 25) years

- Polytrauma
- Totally deformed pelvic ring

- ExFix
- Anterior plating
- Posterior reduction and screw fixation
- Follow-up average 14 (4 - 25) years

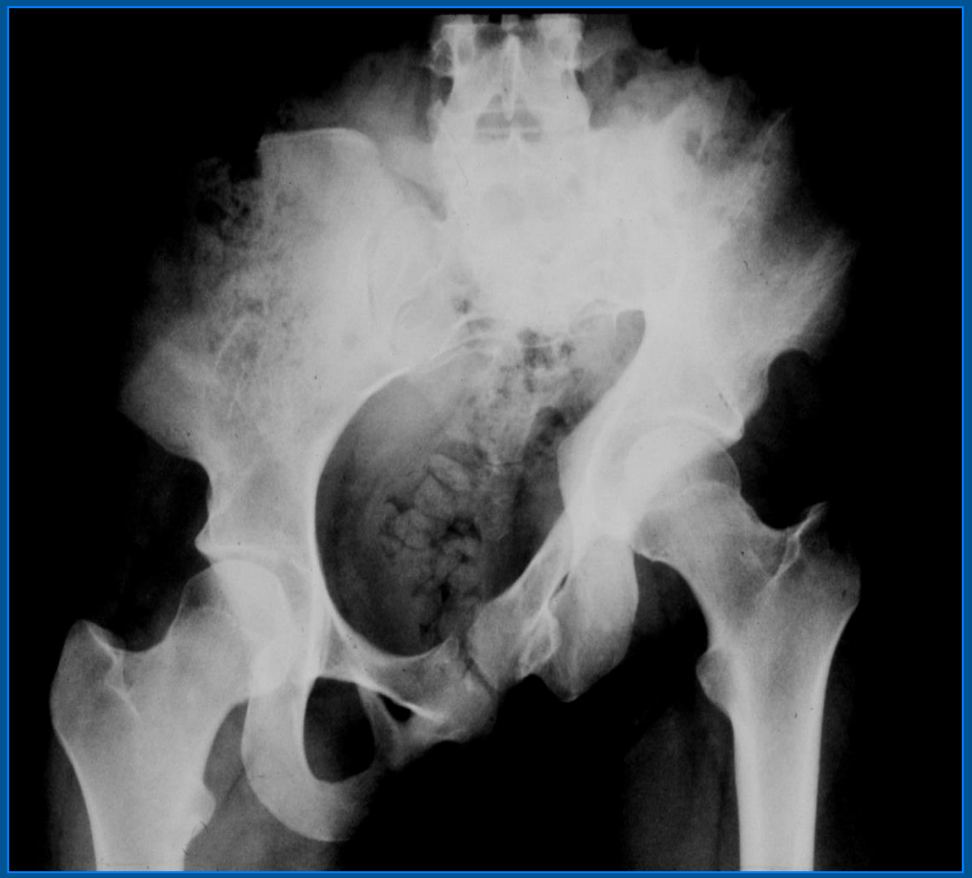
During FU, simple grow into normal pelvic ring,
deformed grow often into deformed ring

If static or dynamic problems in puberty, correction osteotomy

Our series presented referrals to date 59, 13 corrections

# Take home message

The unstable pelvic fracture requires anatomical reduction to avoid deformity



# IOTA meeting Amsterdam
# 14-16 December 2022