

APPLICATION OF DIAGNOSTIC ULTRASOUND IN DDH

MAREK SYNDER

**CLINIC OF ORTHOPAEDICS
AND PEDIATRIC ORTHOPAEDICS
MEDICAL UNIVERSITY OF LODZ, POLAND**



APPLICATION OF DIAGNOSTIC ULTRASOUND IN DDH :

- 1. DDH - definition**
- 2. Development of the hip joint**
- 3. Diagnosis of DDH – clinical examination**
- 4. Diagnosis of DDH – imaging techniques**
- 5. Why ultrasound ?**
- 6. Ultrasound techniques**
- 7. Graf's method**
- 8. Harcke's method**
- 9. Monitoring of DDH**
- 10. Why early ultrasound ?**
- 11. Conclusions**

In 1832 Guillaume Dupuytren

*first described the condition of the hip
and termed it*

„original or congenital dislocation of the hip”

CDH

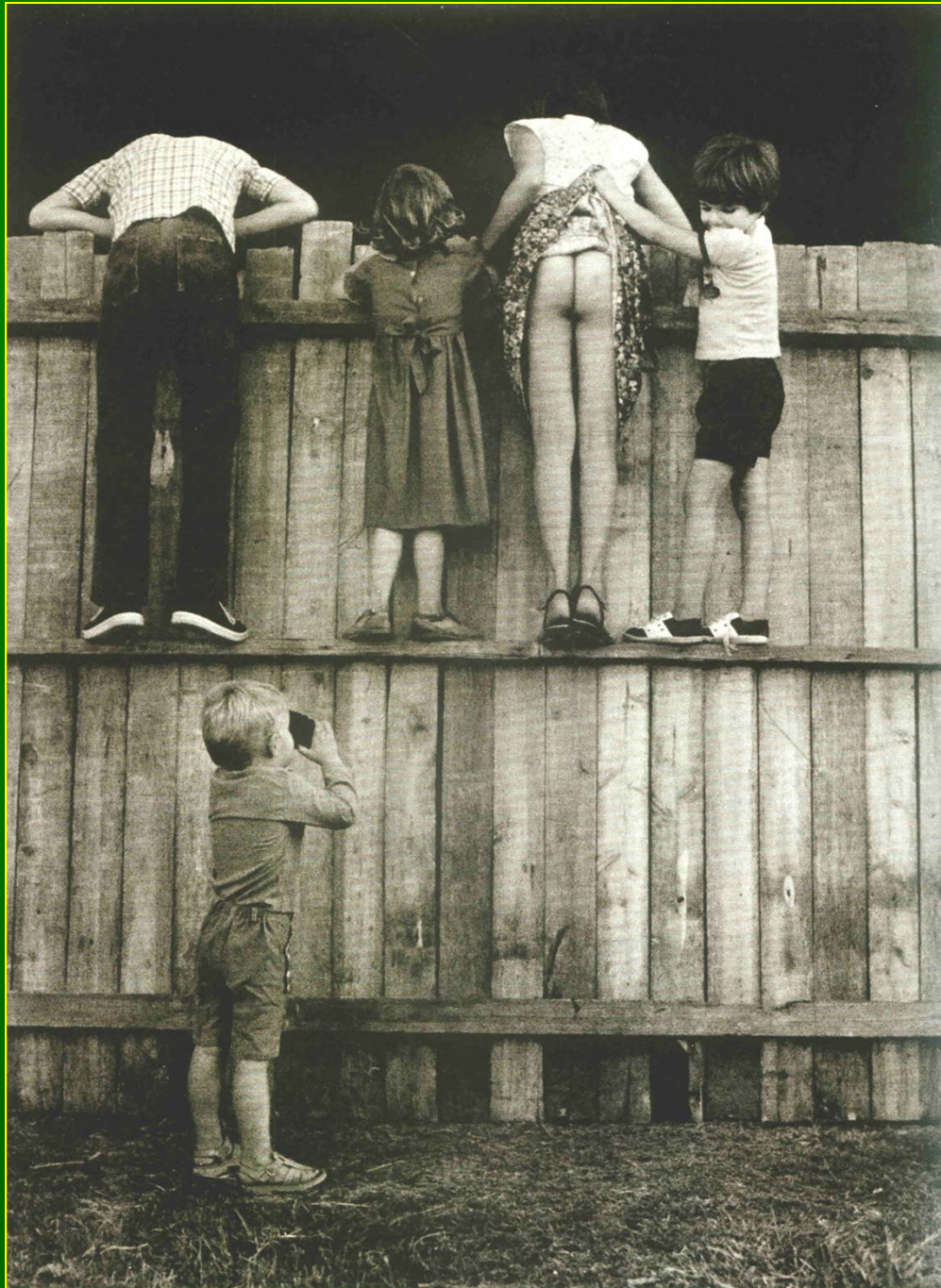
CDH vs. DDH

- *The term CDH has gradually been replaced by DDH in the 1980s*
- *Include in the disorder infants normal at birth but in whom hip dysplasia subsequently developed.*
- *Kliscic in 1989 recommended use of the term „developmental displacement of the hip” to indicate dynamic disorder potentially capable of getting better or worse as the child develops*
- *The term DDH has been used to denote both dislocation & dysplasia*

DDH is a *spectrum of disorders of development of the hip that present in different forms at different ages*

The common etiology is *excessive laxity of the hip capsule, which fails to maintain the femoral head within the acetabulum.*

DDH is a *disease that evolves over time.*



**Do we know
everything
about DDH
???**

DDH

OCCURENCCE



COUNTRY, Region, Race



Poland - Dega - 4%

Scandinavia 0,1 – 1,9%

UK 0,23 – 1,9%

USA 0,23 – 1,49%

Japan 0,28 – 3%

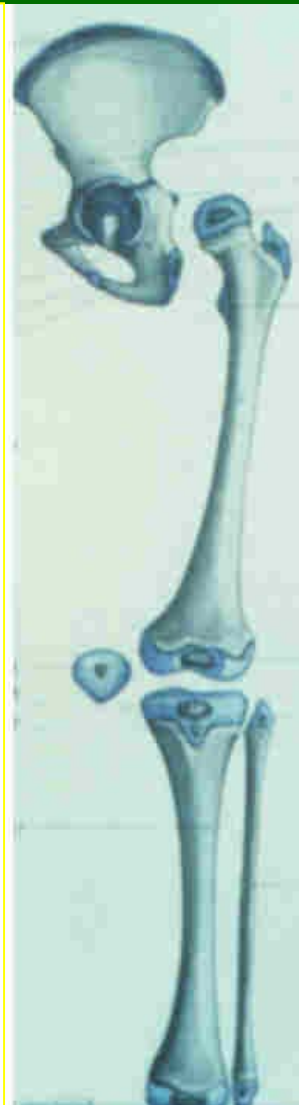
10% of all THR

**are necessary because of
hip maturation disorders**

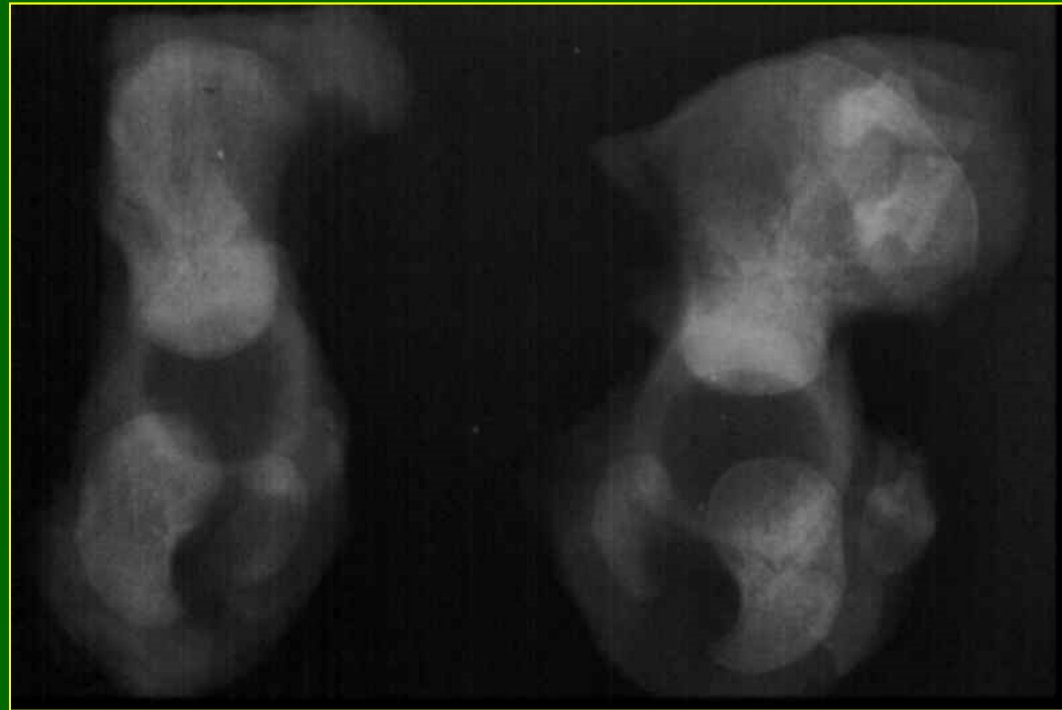


DDH

Development of the hip joint



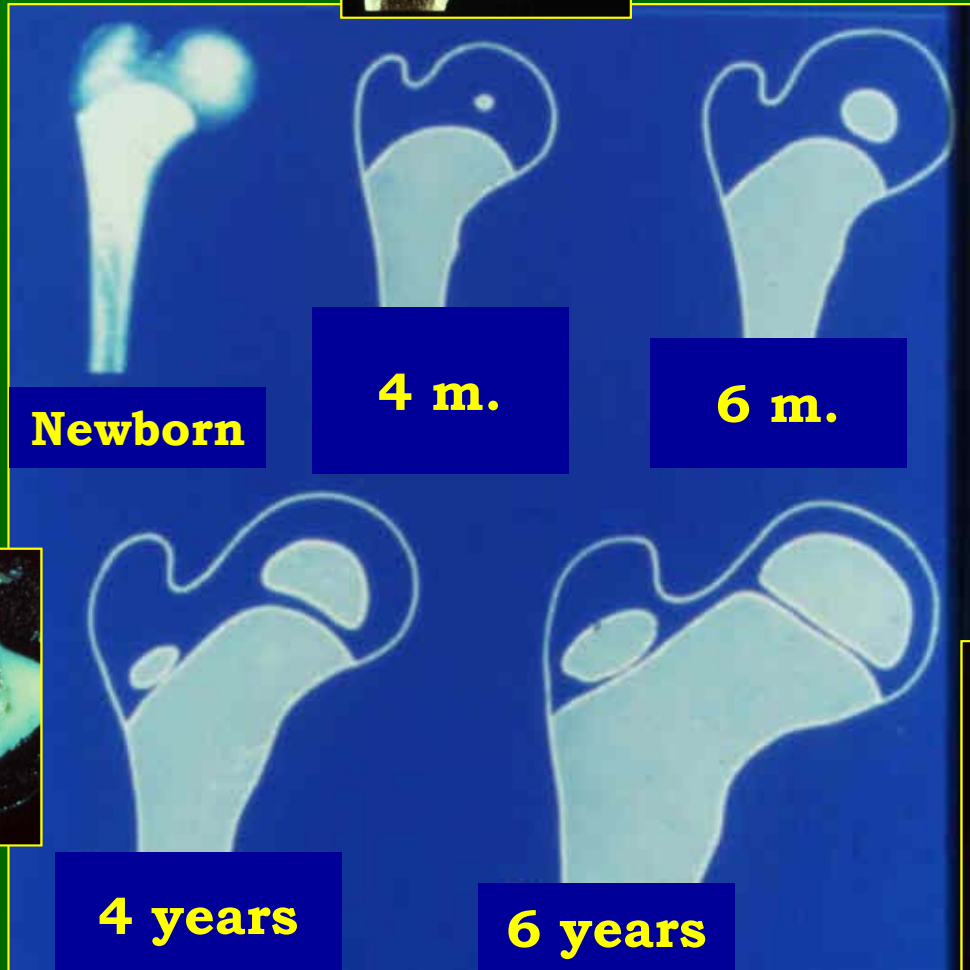
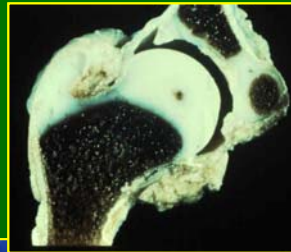
Development of the hip joint



Development of the hip joint



Development of the hip joint



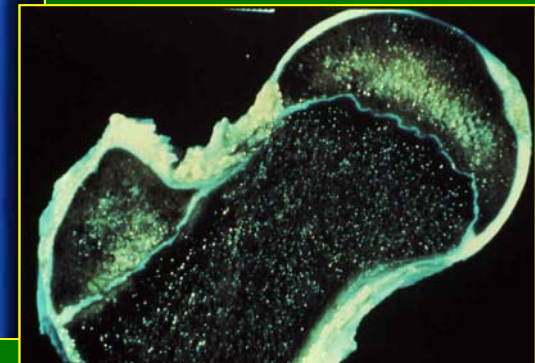
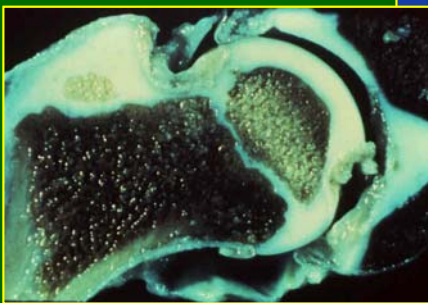
Newborn

4 m.

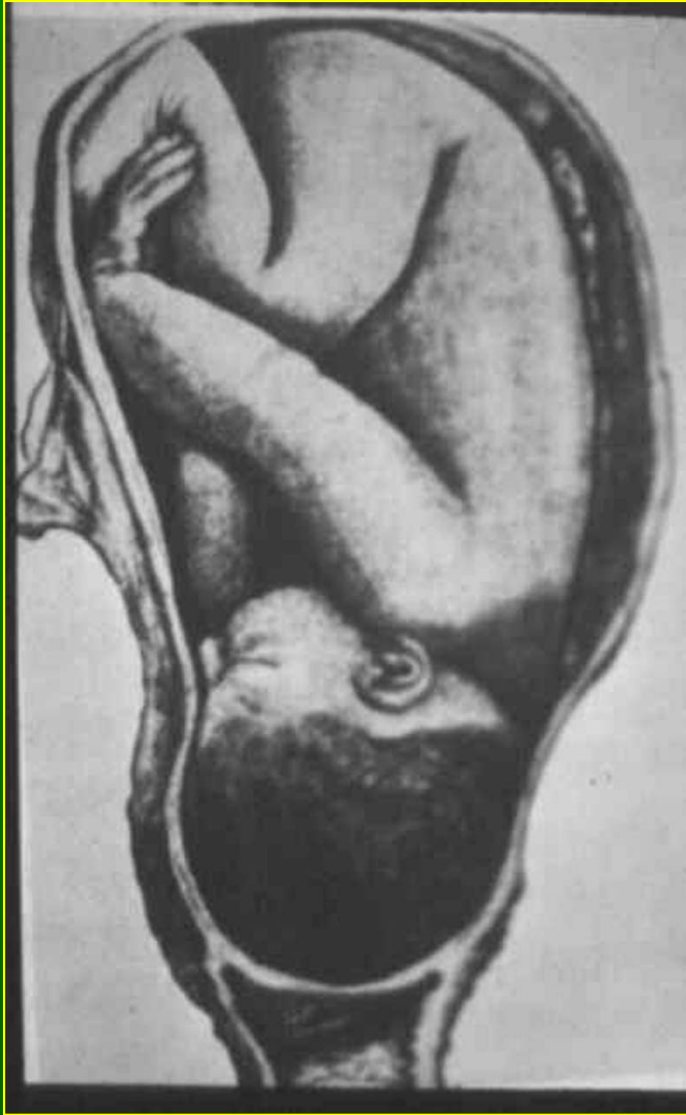
6 m.

4 years

6 years



Fetus position in uterus

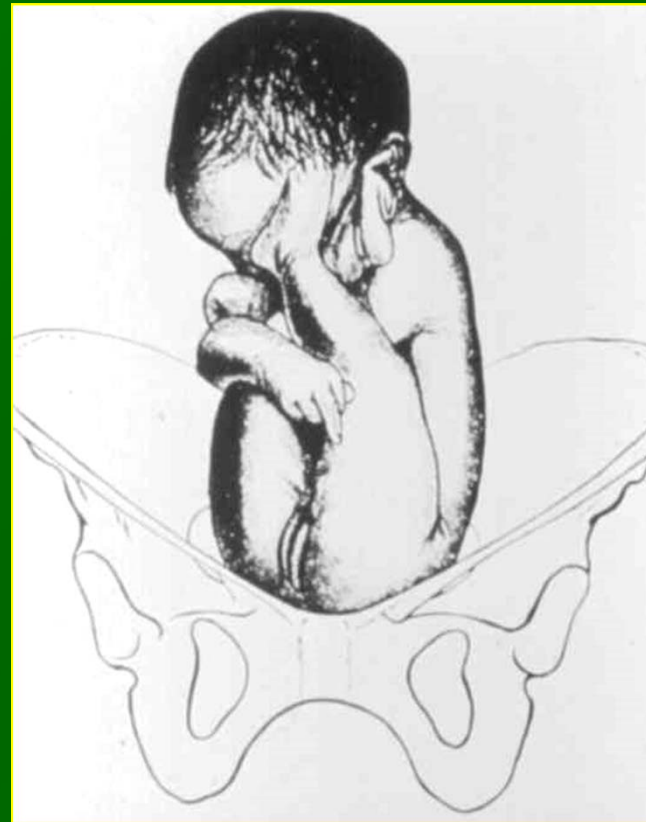
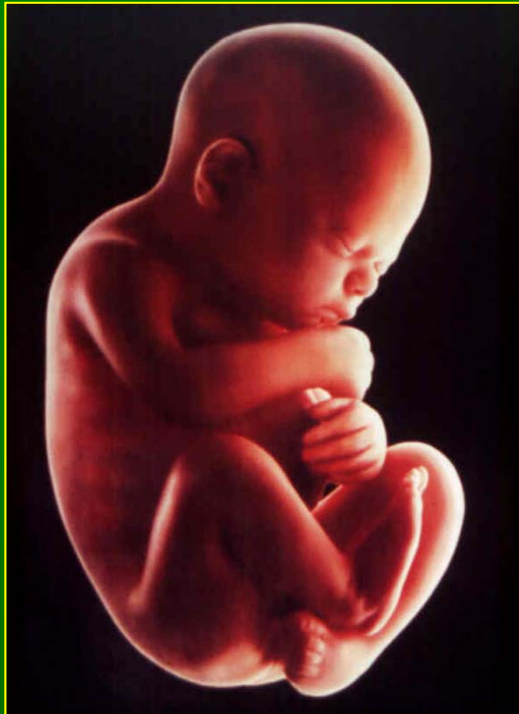


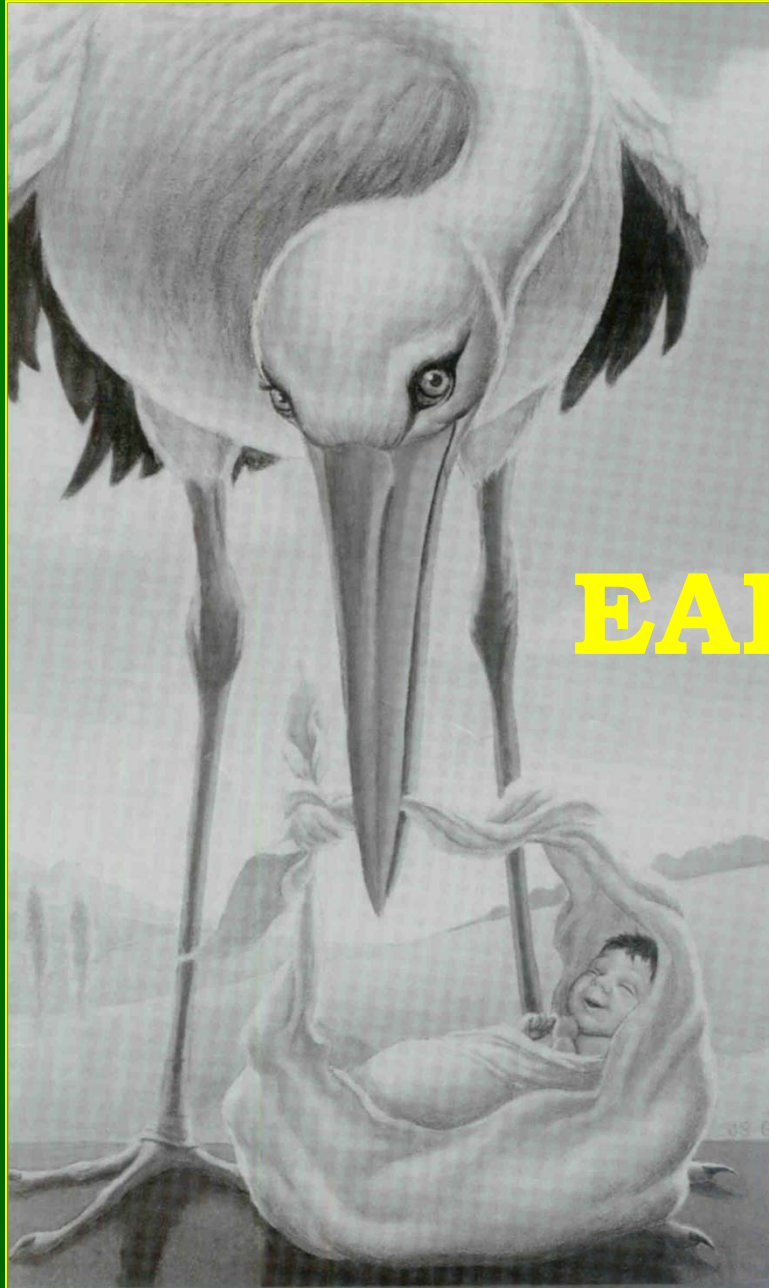
Physiologic



Breech position

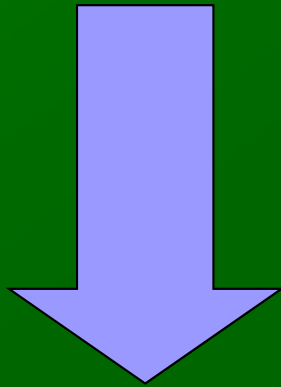
ULTRAPHYSIOLOGIC FETUS POSITION






EARLY DIAGNOSIS

DDH must be identified and treated appropriately.



**The better the diagnosis
the more selective and effective
the treatment**

DDH

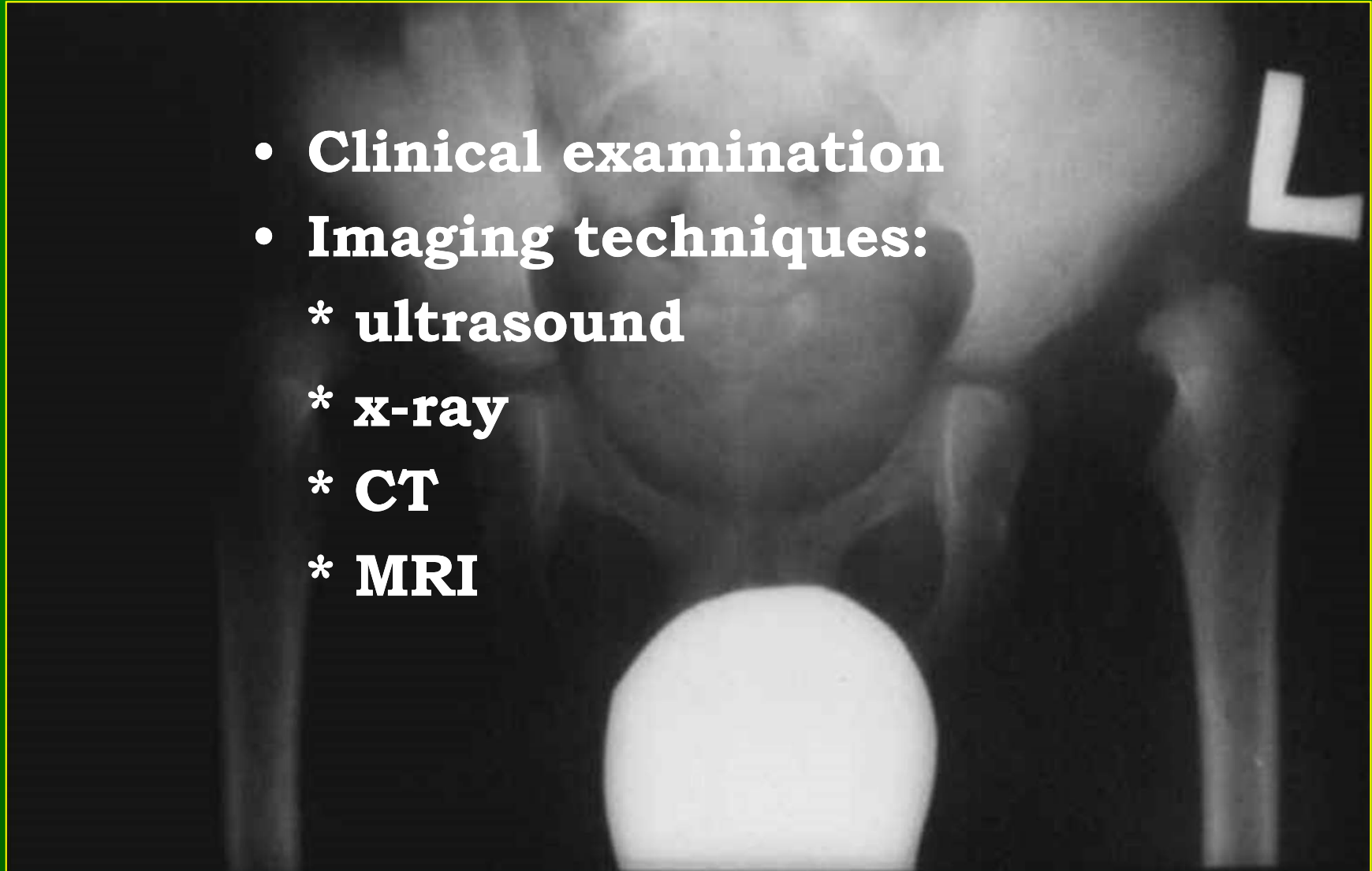
Late diagnosis ⇒  **chance for recovery**

According to Lehman :

- ⇒ **„golden period” = 0 – 3 weeks**
- ⇒ **„grey period” = till 3 month of life**
- ⇒ **„black period” > 3 month of life**

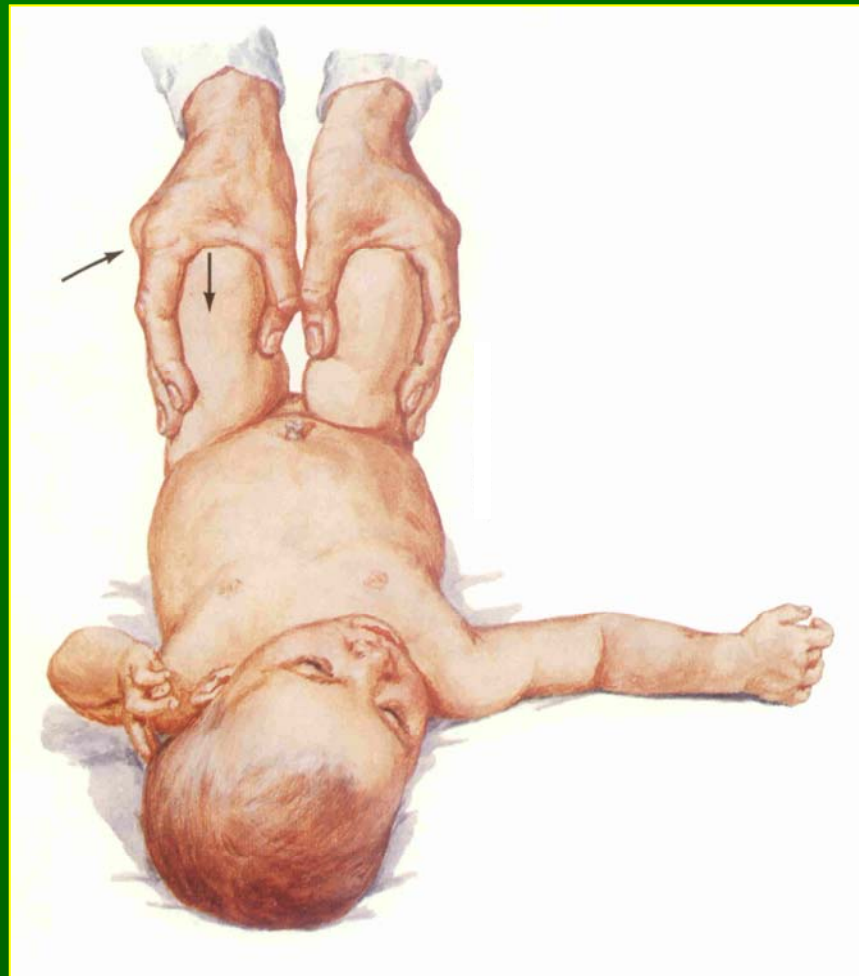
EARLY DIAGNOSIS

- **Clinical examination**
- **Imaging techniques:**
 - * **ultrasound**
 - * **x-ray**
 - * **CT**
 - * **MRI**

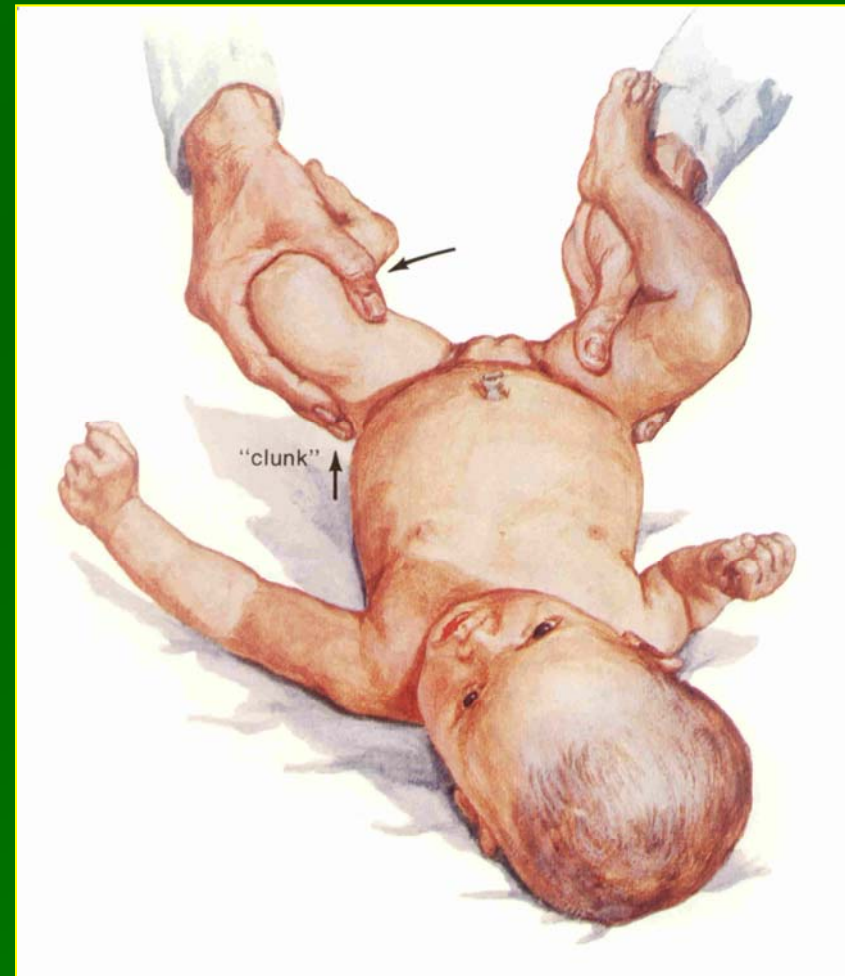


CLINICAL EXAMINATION

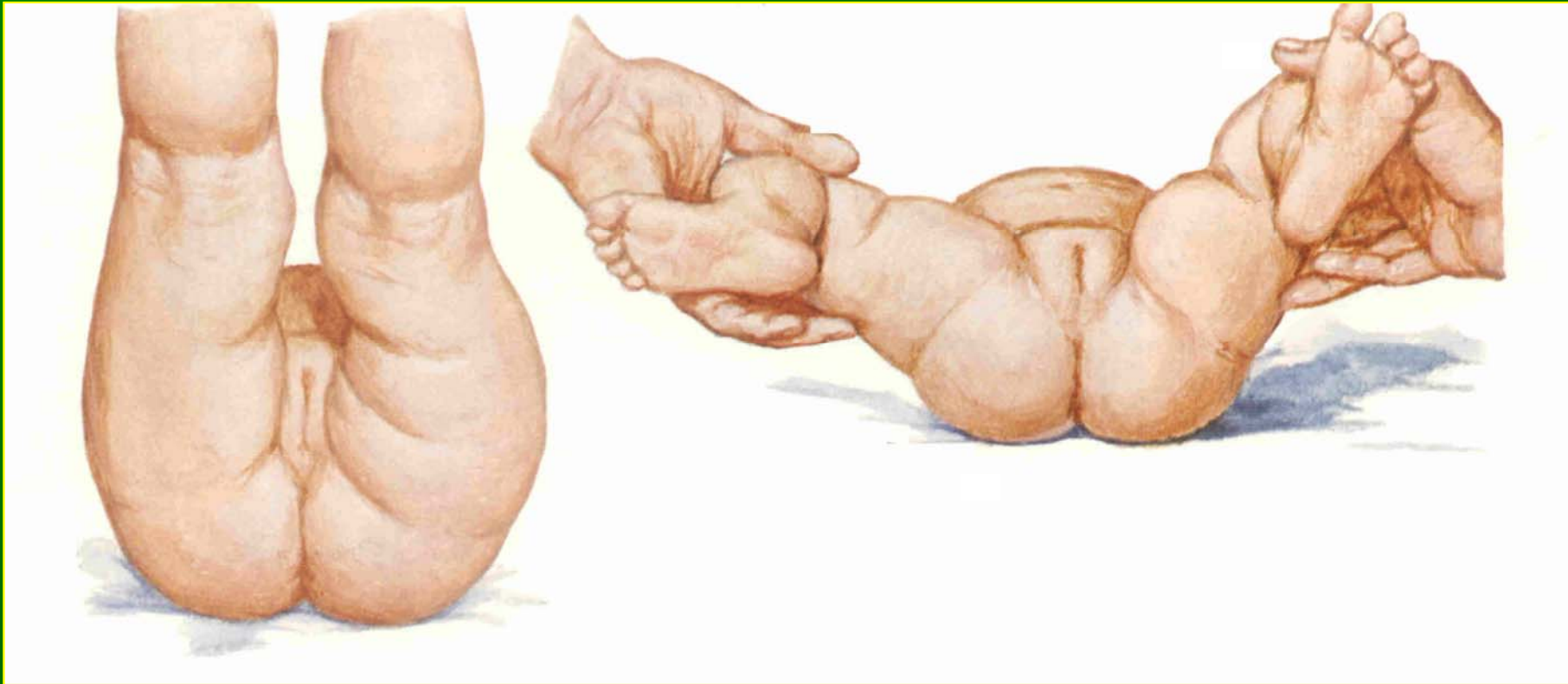
Barlow (dislocation) test



Ortolani (reduction) test



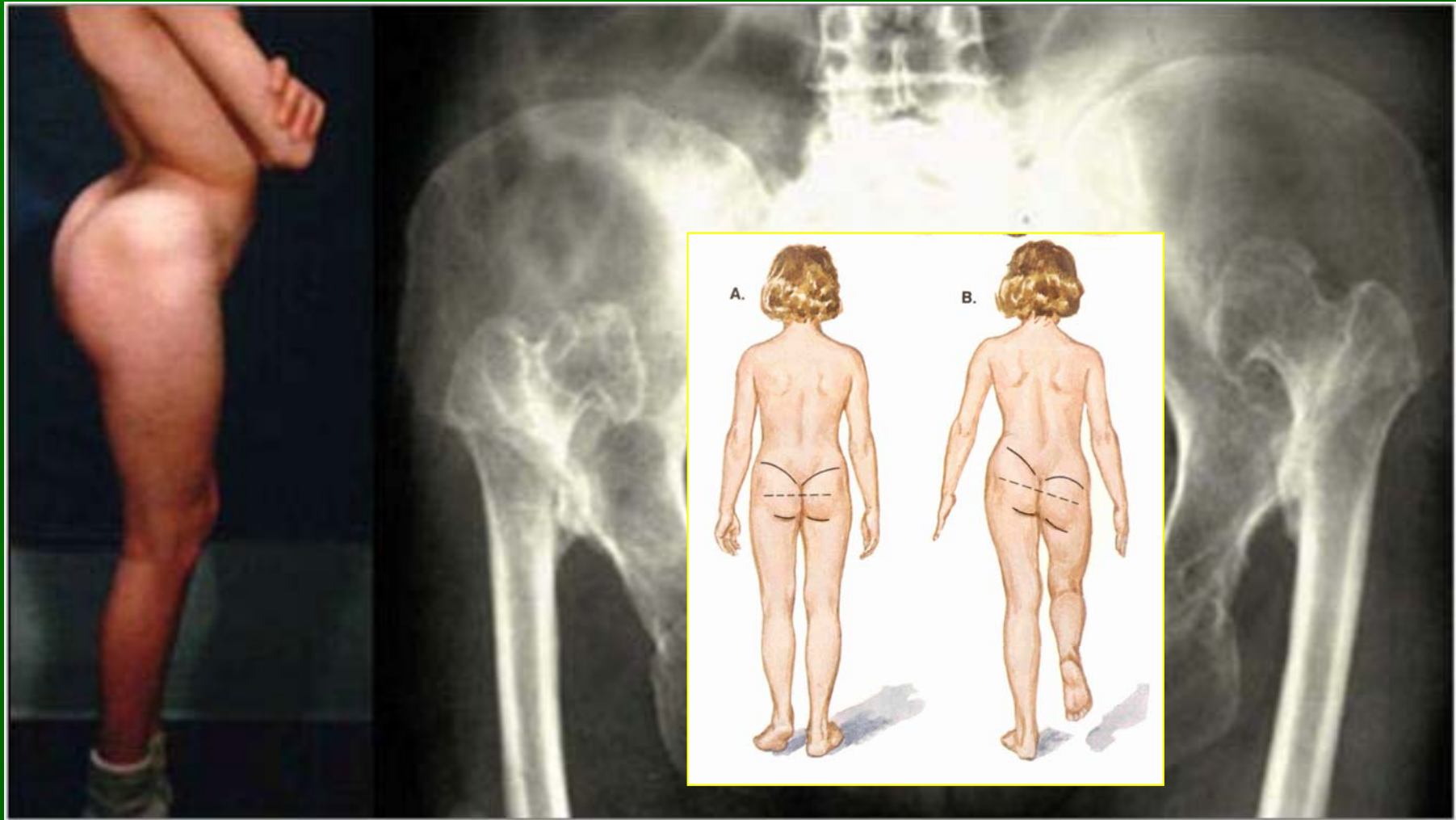
CLINICAL EXAMINATION



Asymmetric skin folds

Limitation of abduction

CLINICAL EXAMINATION



Hyperlordotic lumbar spine and waddling type of gait

Imaging techniques for DDH

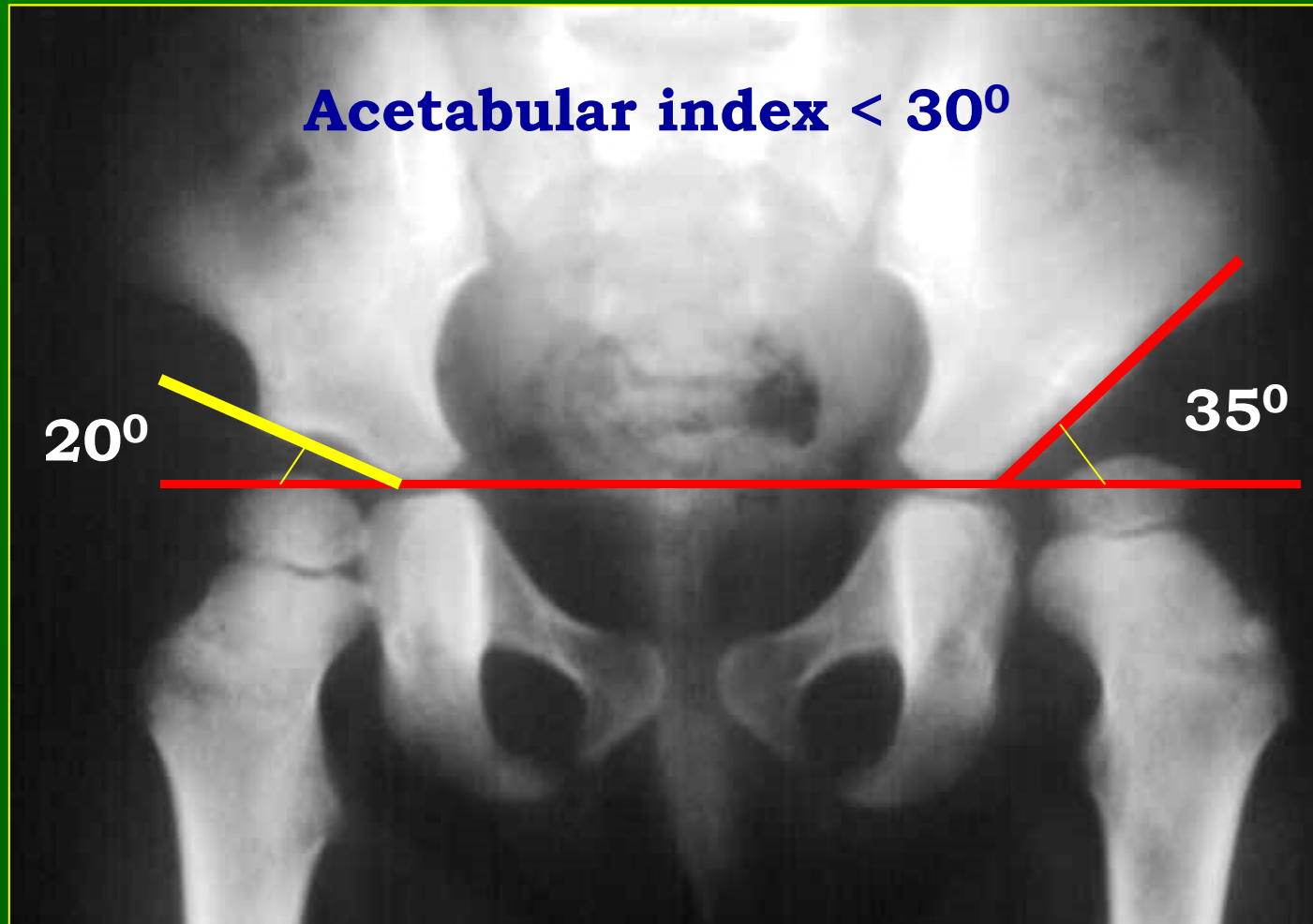
1. Ultrasound

2. X-ray

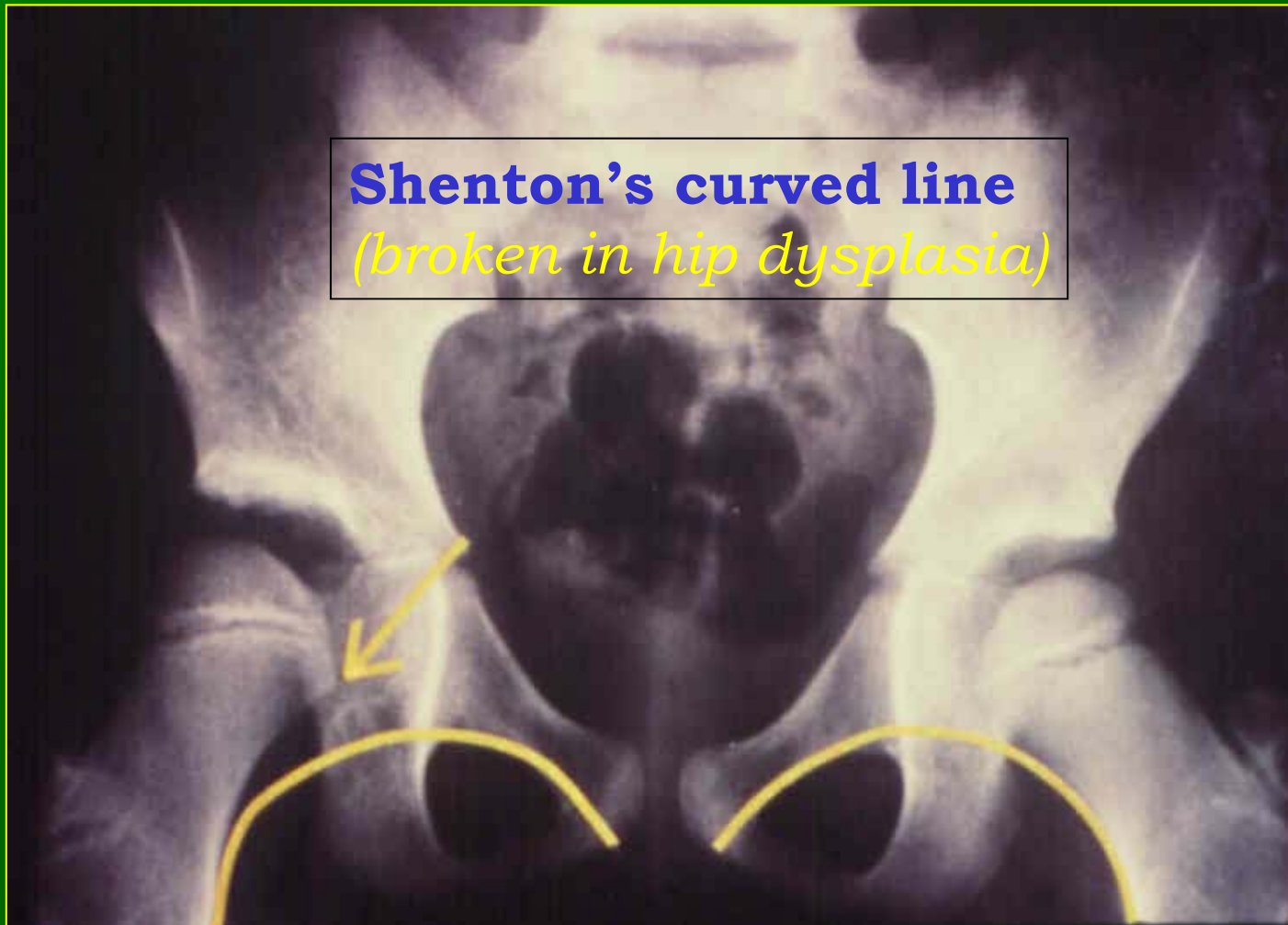
3. CT

4. MRI

Radiologic findings



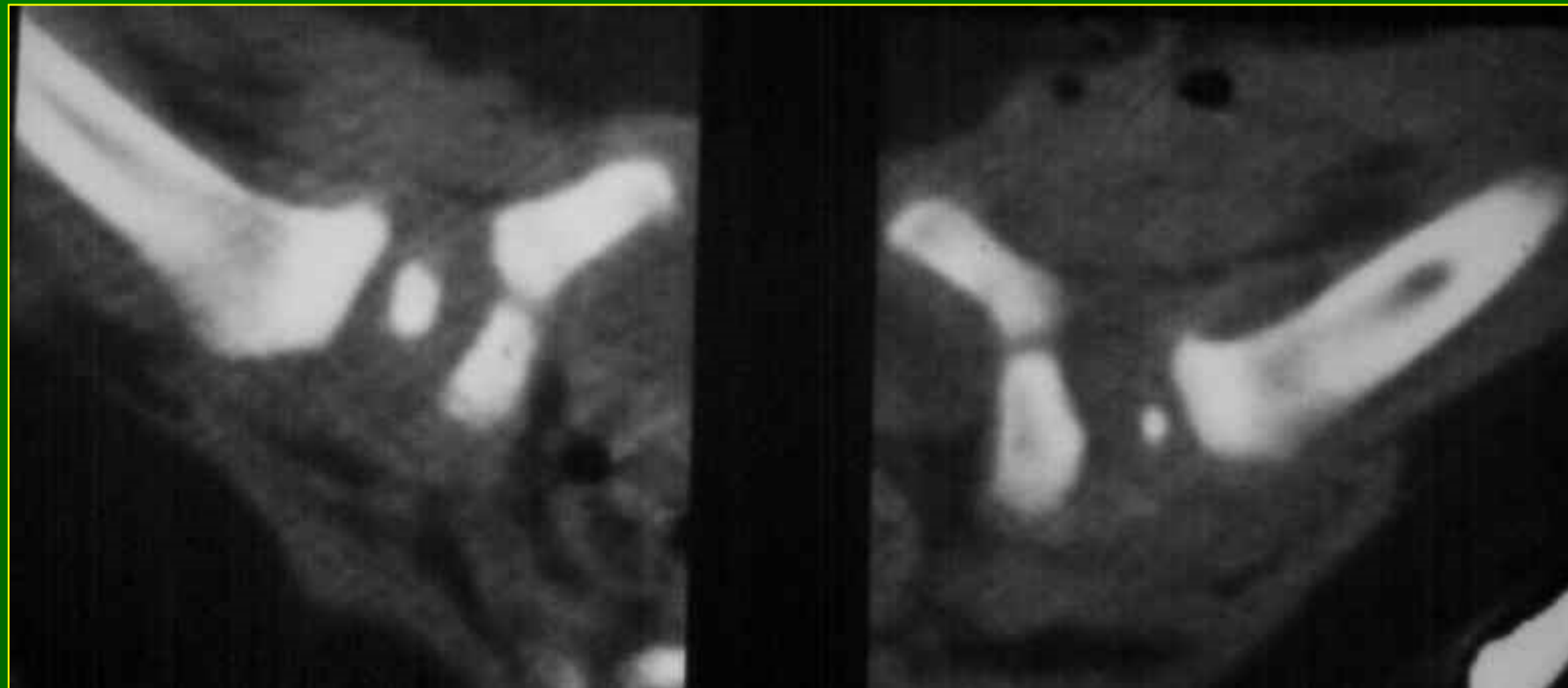
Radiologic findings



ARTHROGRAM



CT SCAN



DIAGNOSIS

**Now based on clinical examination
and ultrasound**

US :

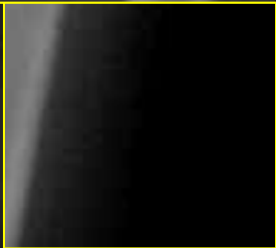
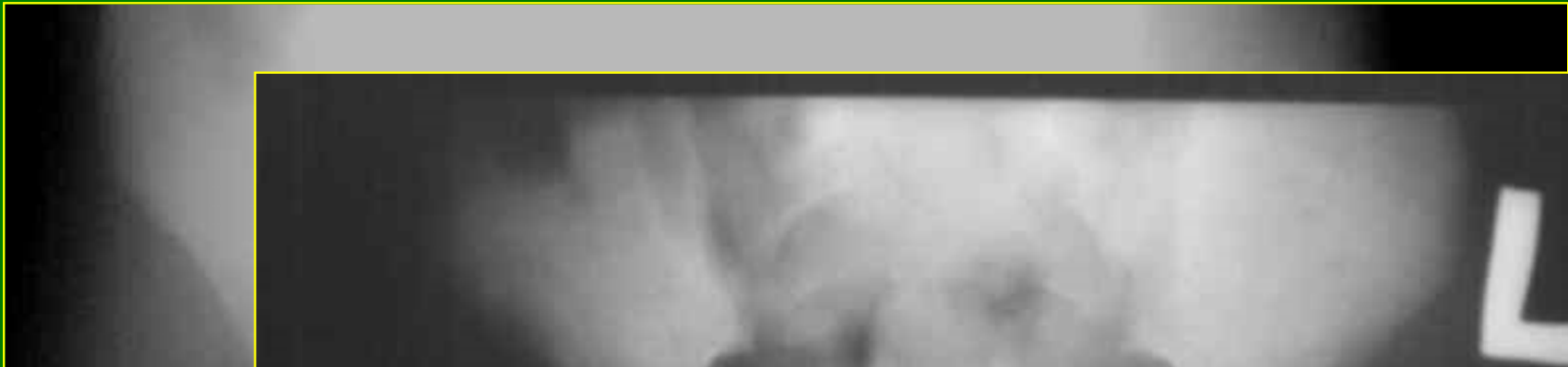
From 5 day of life till the end of 1 year

~~**X-ray**~~

X-Ray

Indicated :

- 1. Difficulties with US interpretation**
- 2. In children older than 12 months**
- 3. Before the surgery**
- 4. In some difficult cases**



Hip Ultrasound

- ⇒ is now a standard in diagnostic procedures of DDH in newborns and infants**
- ⇒ support clinical examination**
- ⇒ enable detailed description of the development of the hip joint**



DIAGNOSIS

- *Who should be examined ?*

Every child after birth

Who should be examined by ultrasound :

- 1. Infants with abnormal
physical examination**
- 2. Infants with increased risk
of DDH**

Why ultrasound ???

DDH

without any clinical signs

6 – 8 %

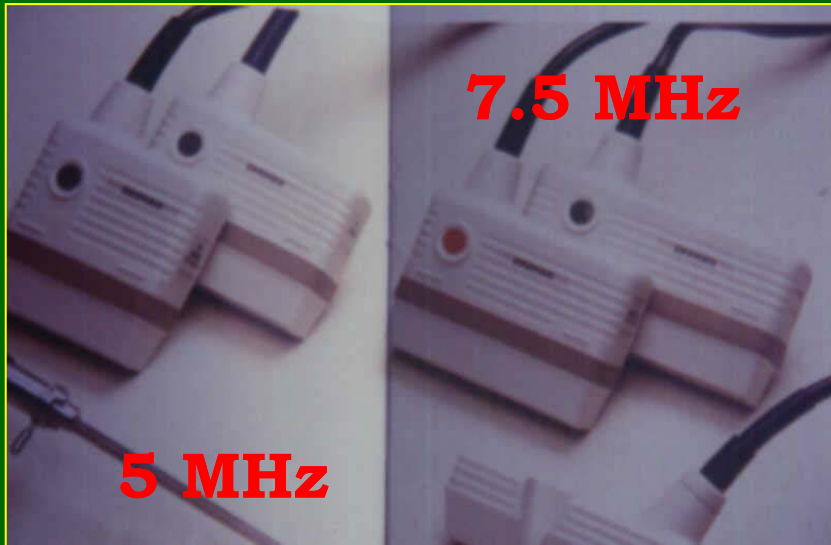
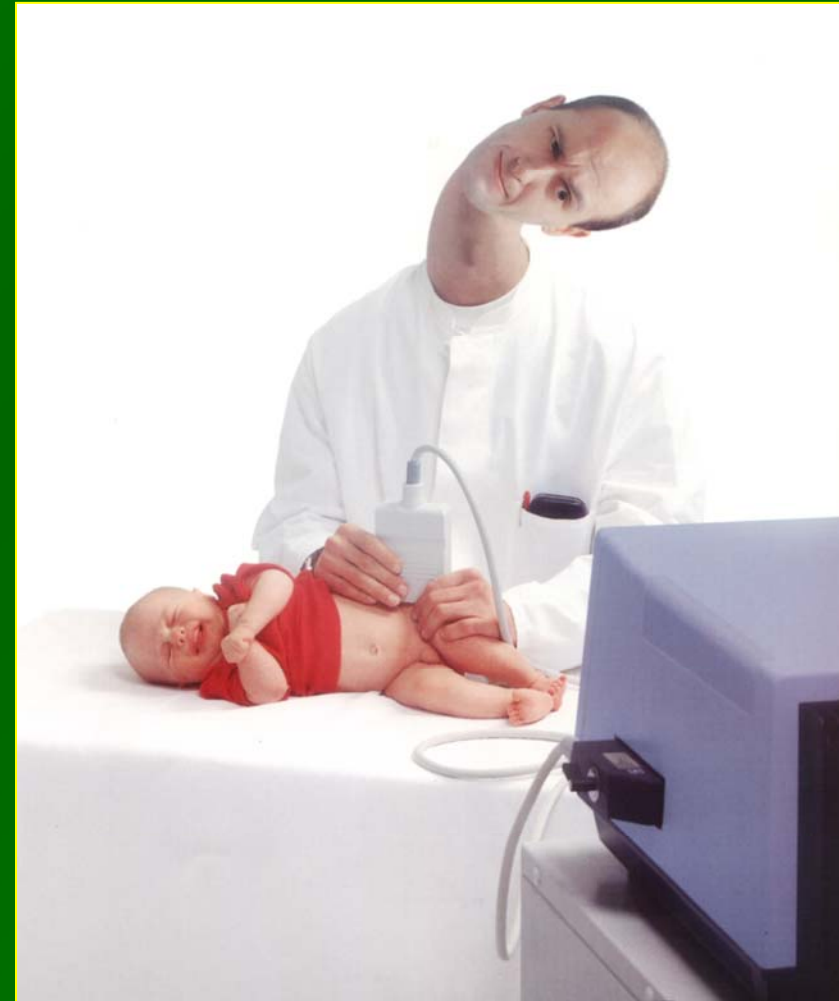
WHY ULTRASOUND ?

- **Early diagnosis**
- **Easy**
- **Not expensive**
- **Differential diagnosis with other hip diseases (synovitis, coxa vara ...)**

Who should perform ultrasound examination ?

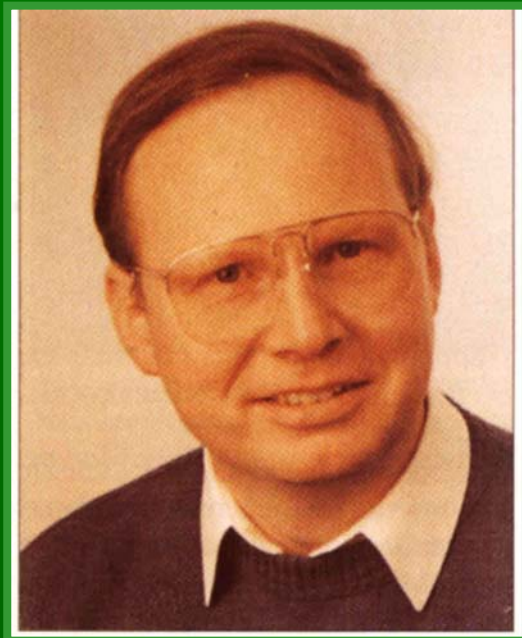
- **Orthopaedic surgeon**
 - **Pediatrician**
 - **Radiologist**

ULTRASOUND EQUIPMENT



*Different
US techniques*

Reinhard GRAF



1978

Austria

Graf in Austria

Gomes in France

Dalström in Sweden

Terjesen in Norway

Harcke in the USA

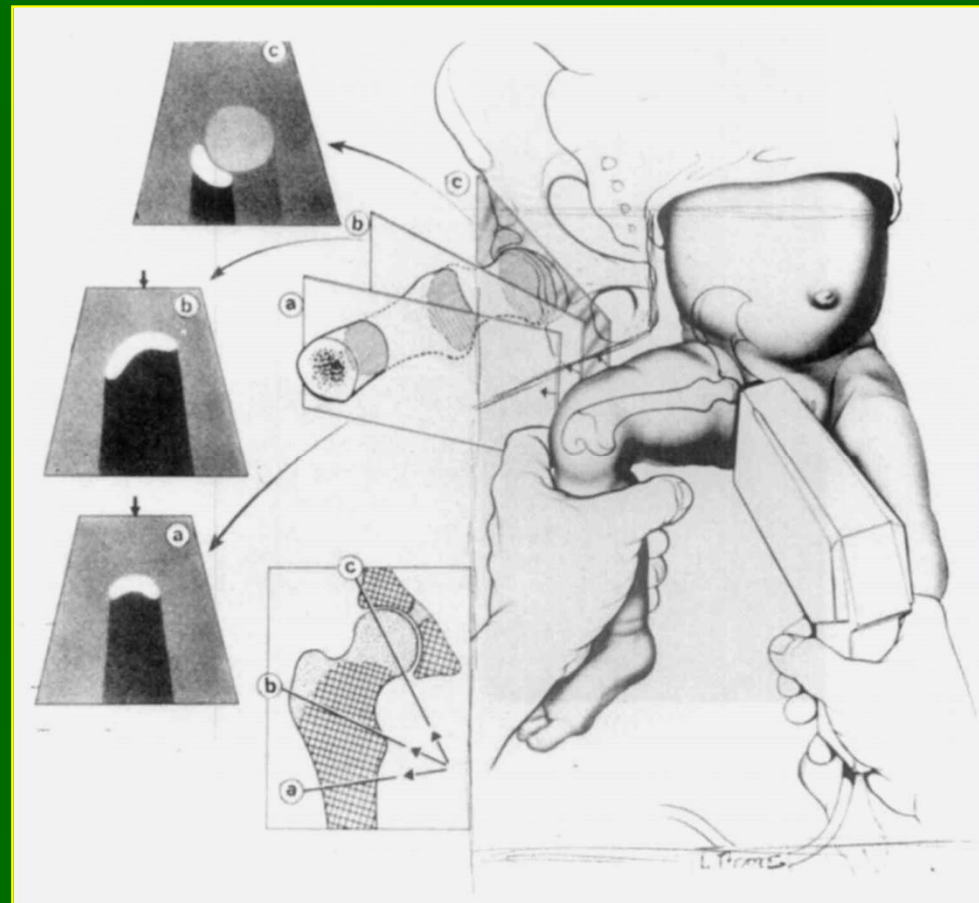
Novick in the USA

Suzuki in Japan

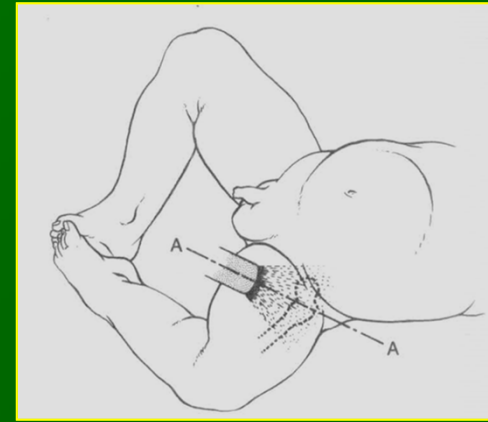
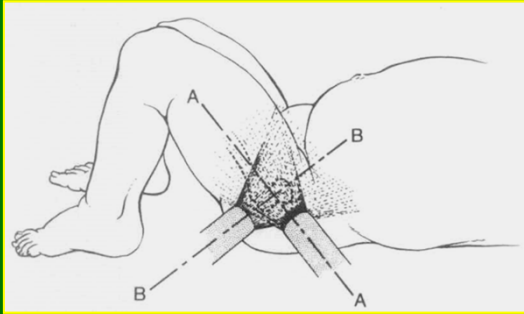
US technique



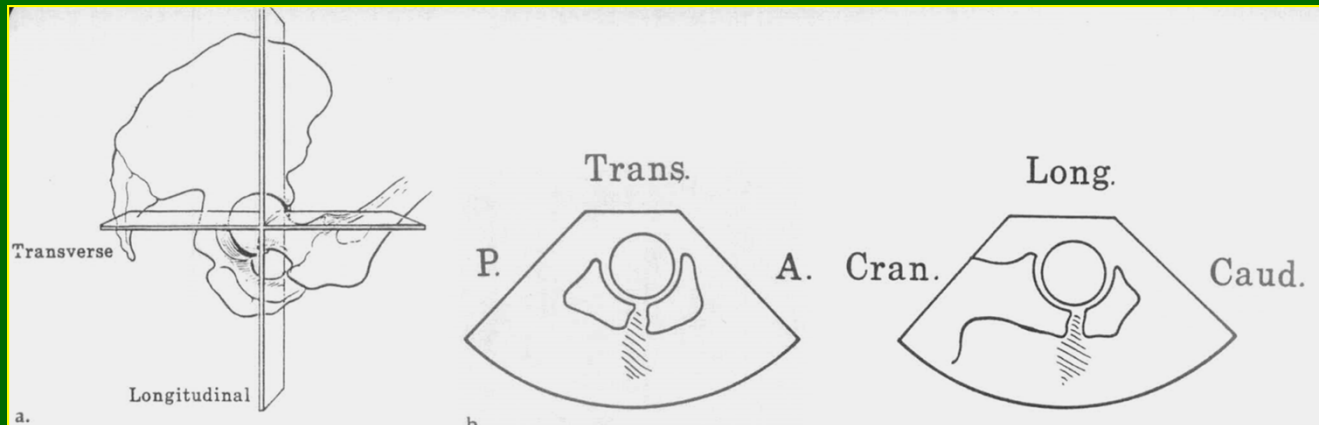
Gary Novick New Haven, CT



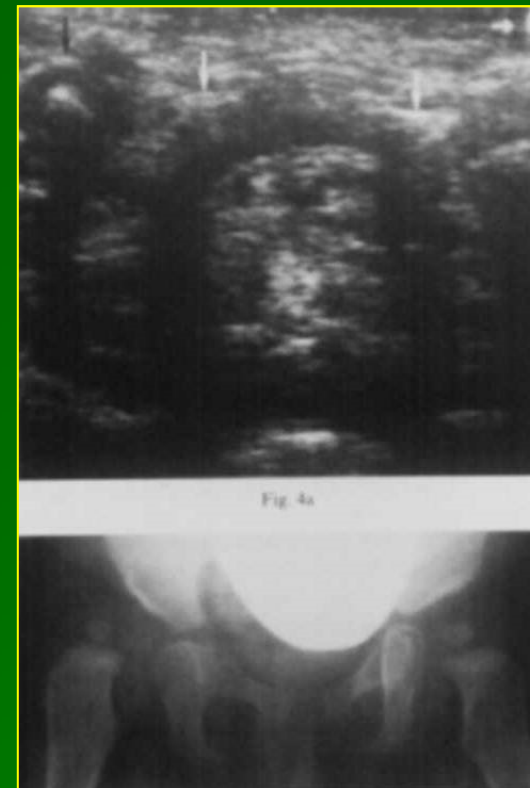
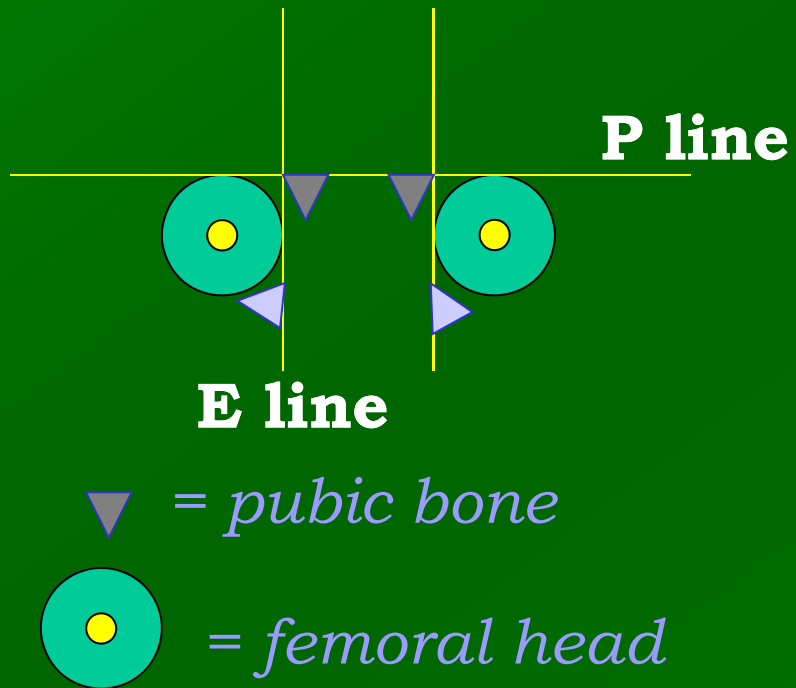
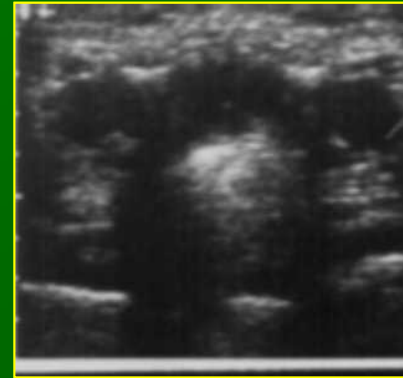
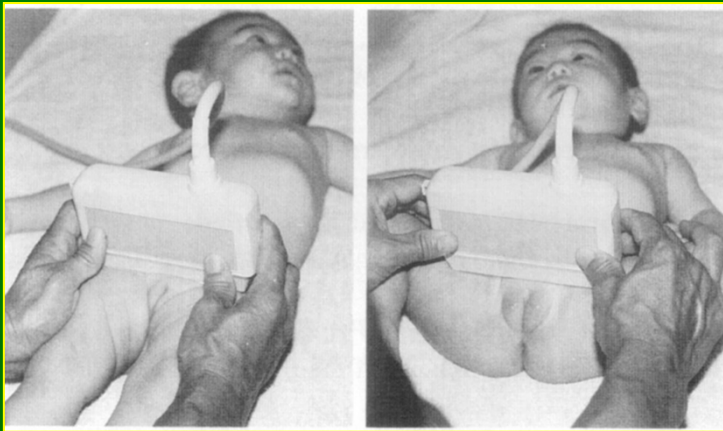
US technique



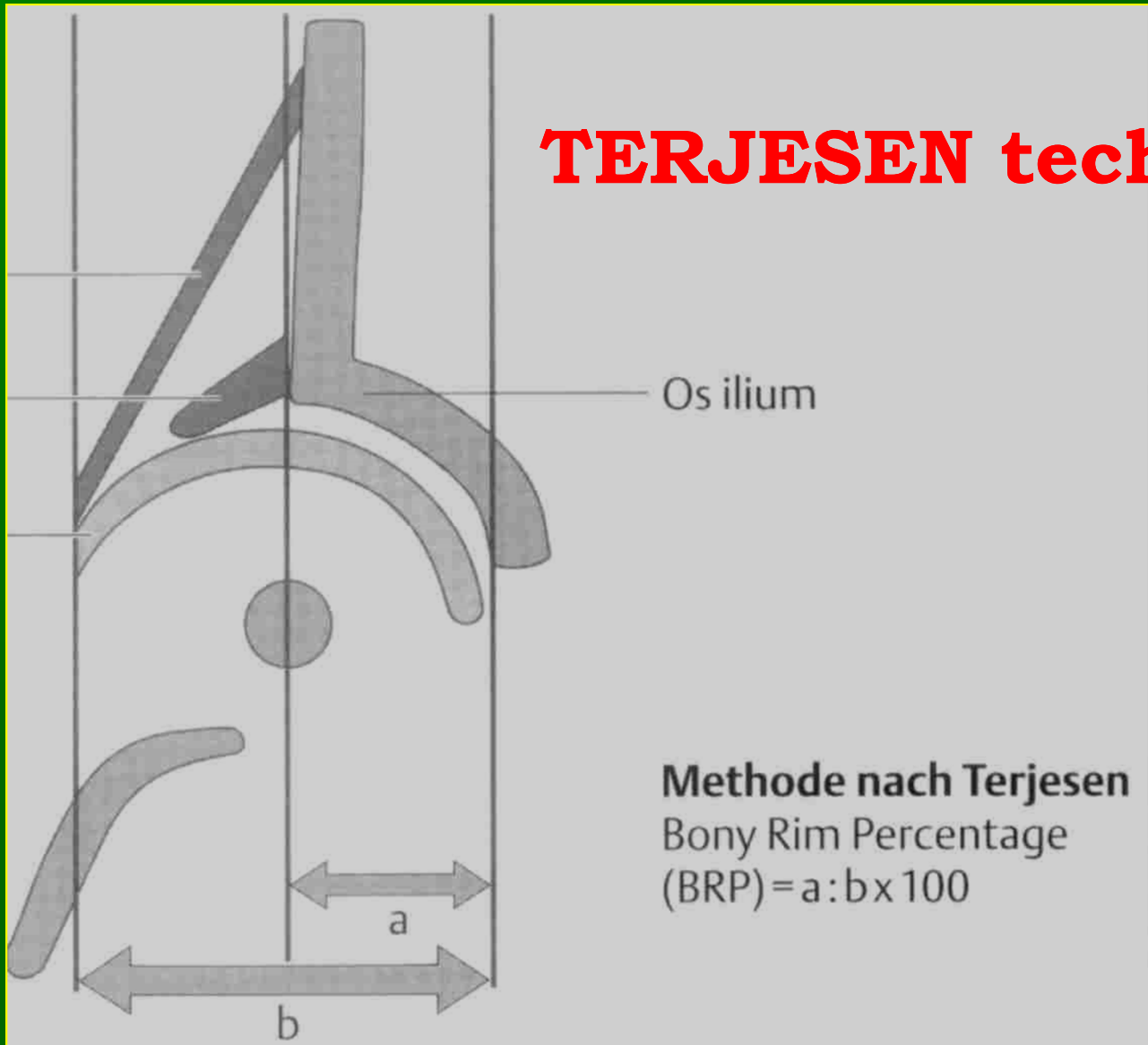
Schwenkter - PA



US technique

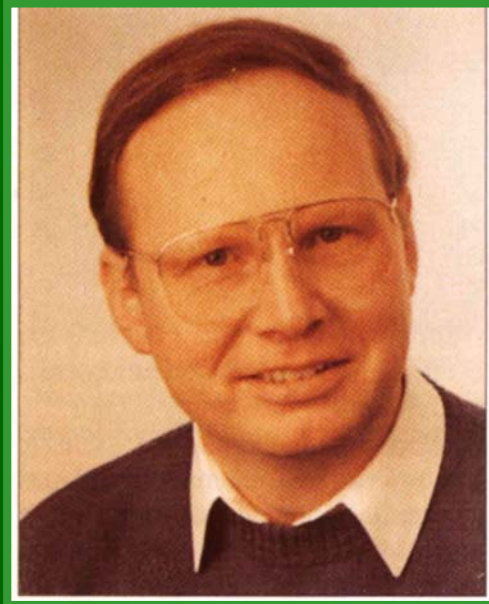


TERJESEN technique



ULTRASOUND TECHNIQUES

- **GRAF**

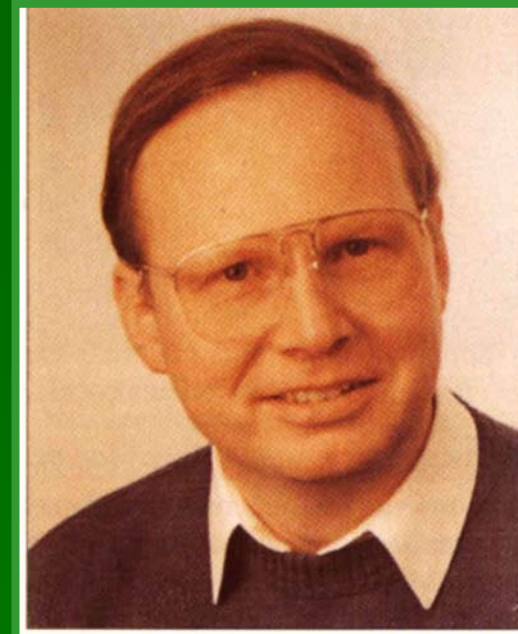


- **HARCKE**

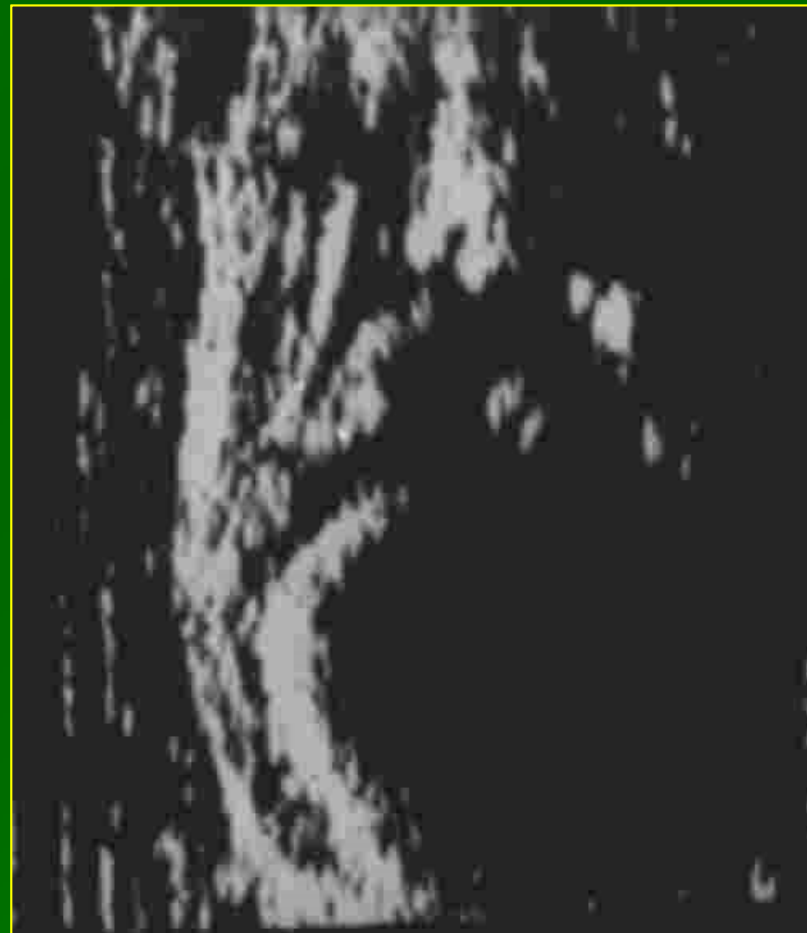


GRAF'S METHOD

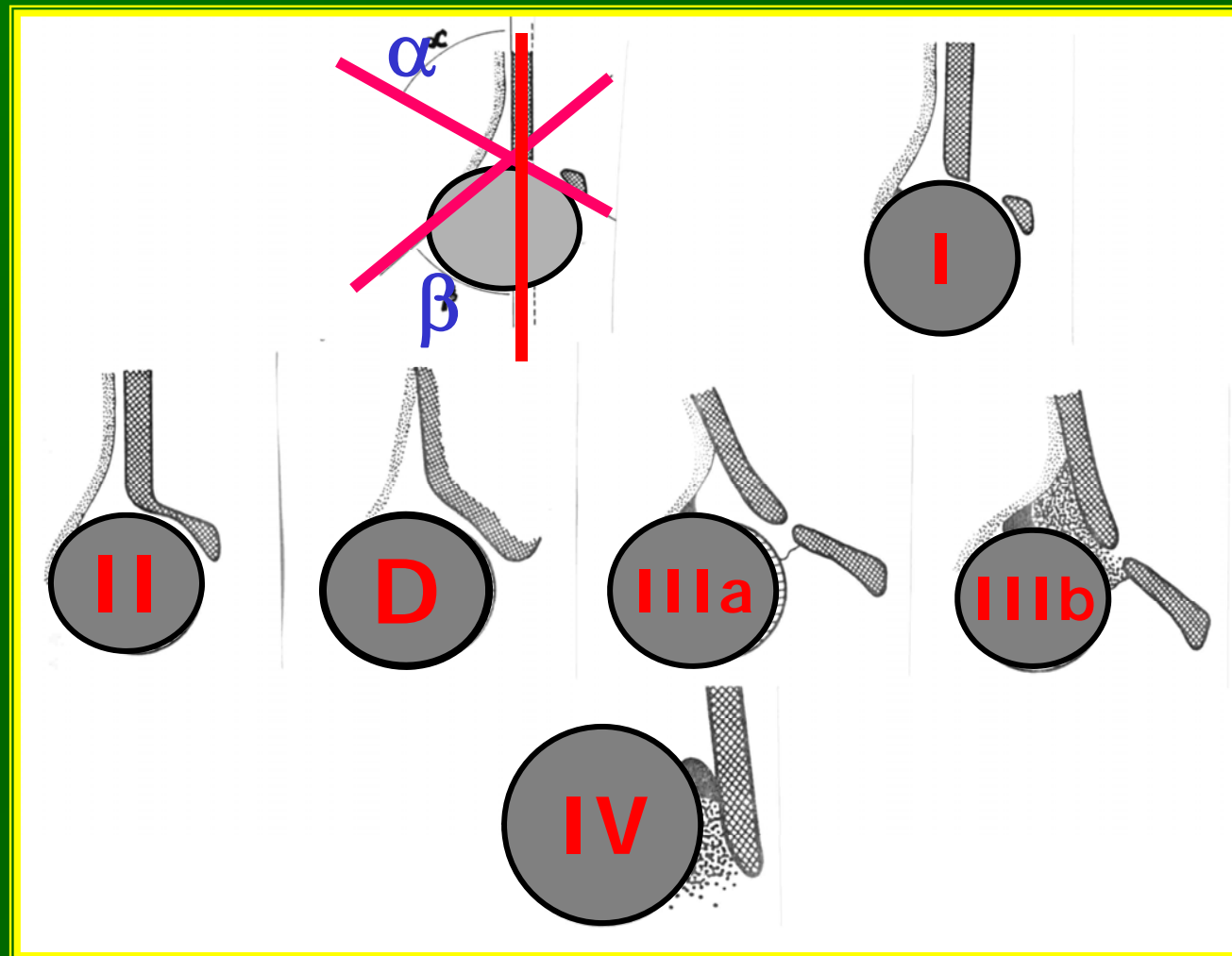
- **BASED ON α AND β ANGLES**
- **4 MAIN TYPES OF HIP DEVELOPMENT**
 - I a, I b
 - II a, II b
 - D
 - III a, III b
 - IV



GRAF'S METHOD



GRAF'S METHOD

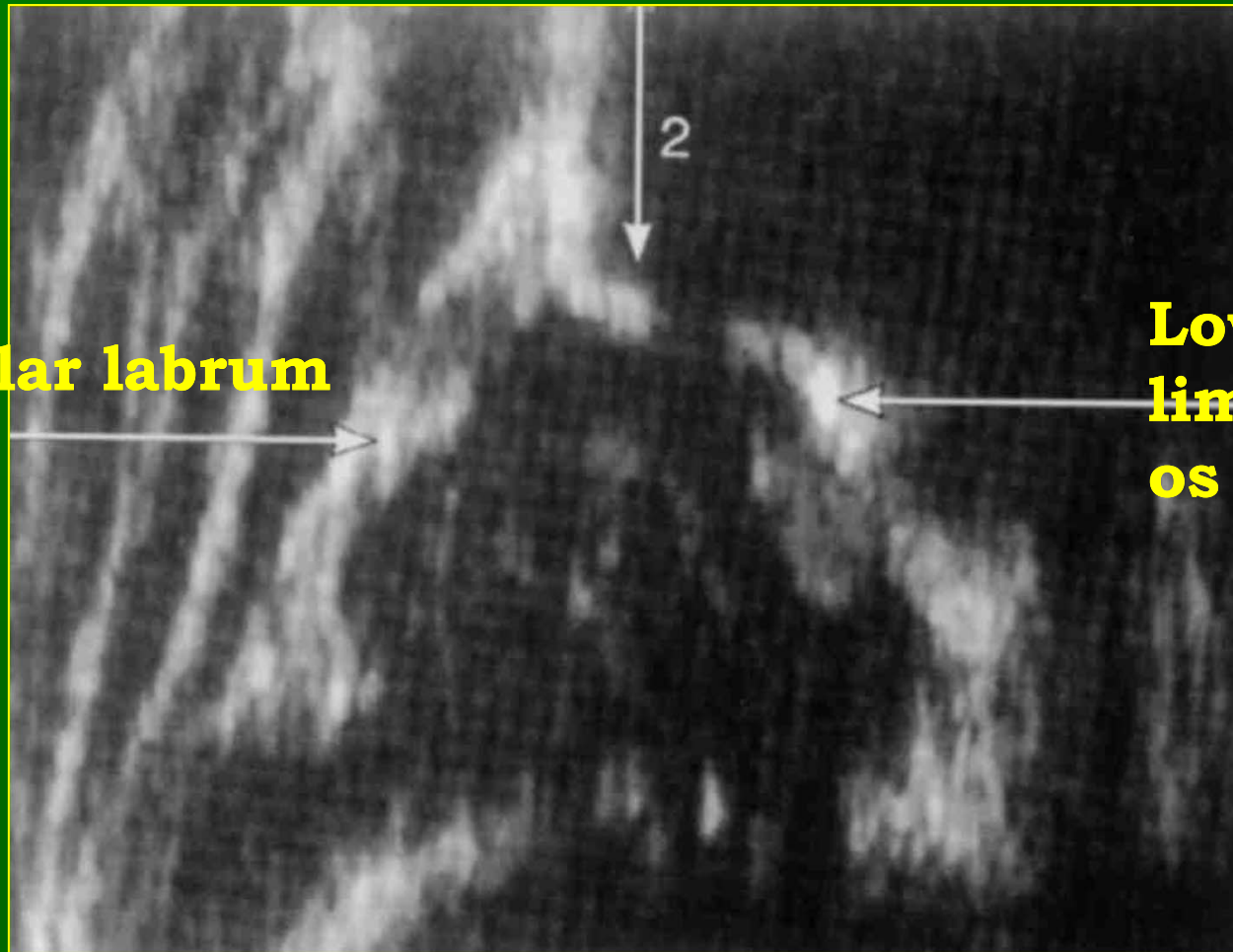


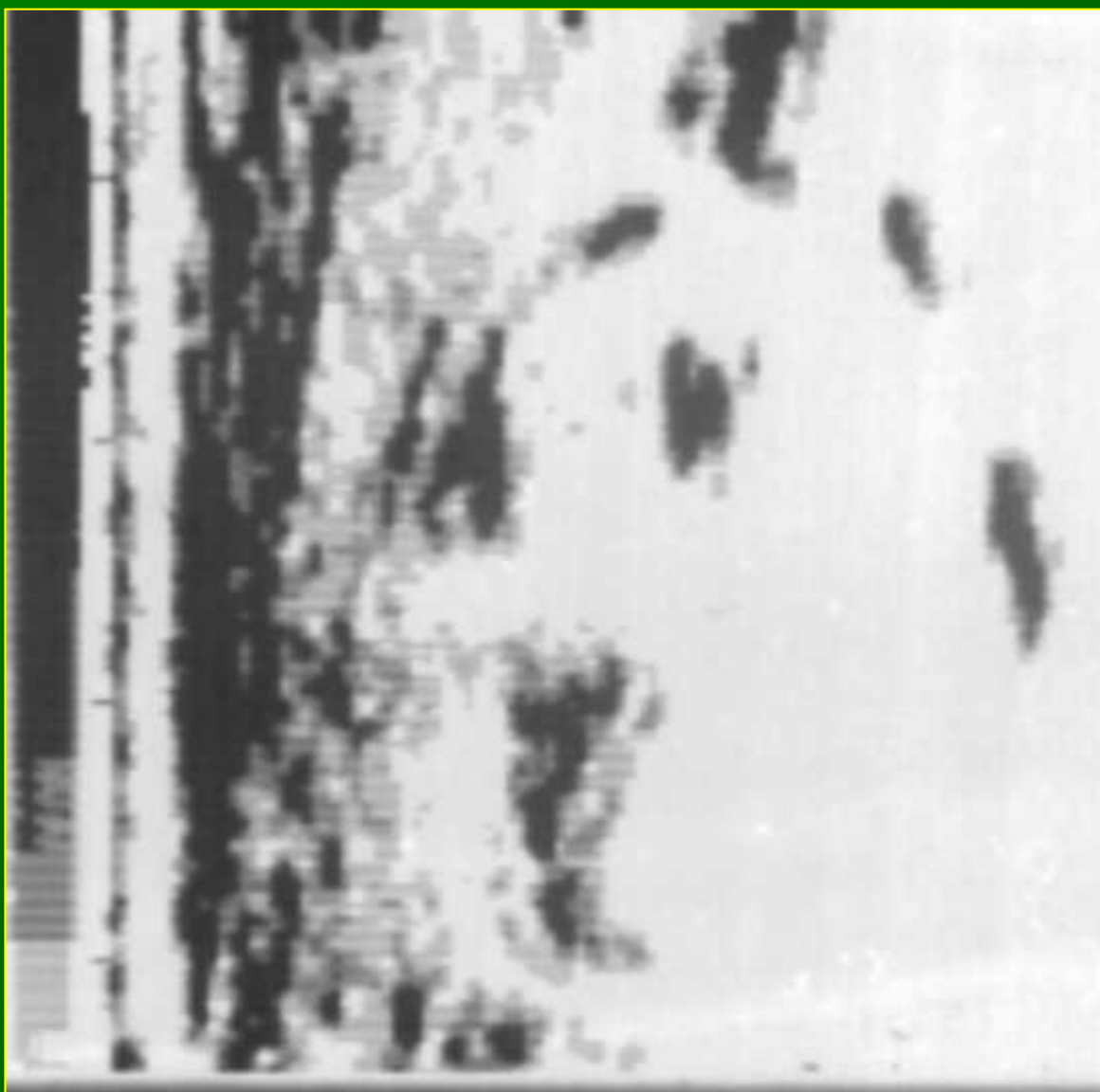
KEY POINTS

Bony acetabular roof

Acetabular labrum

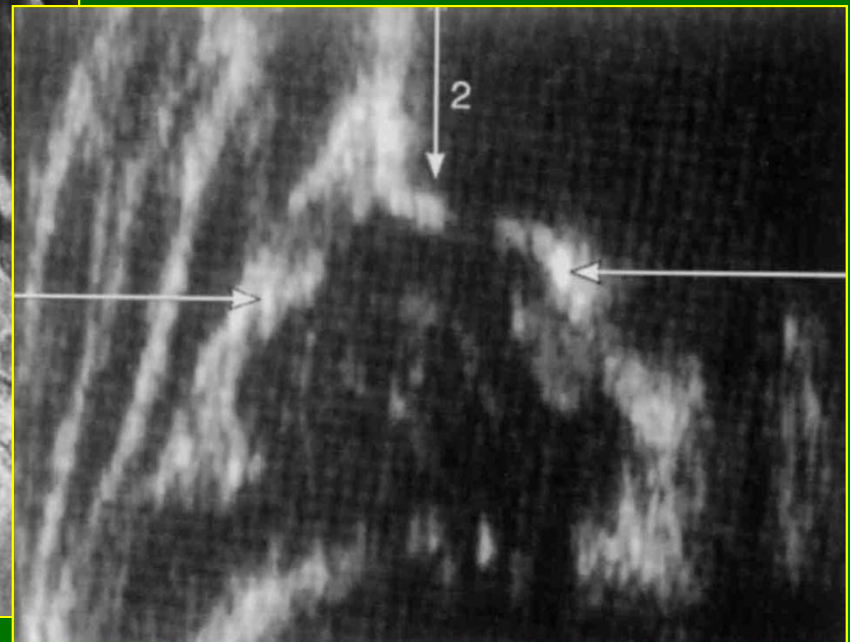
Lower limb of the os ilium







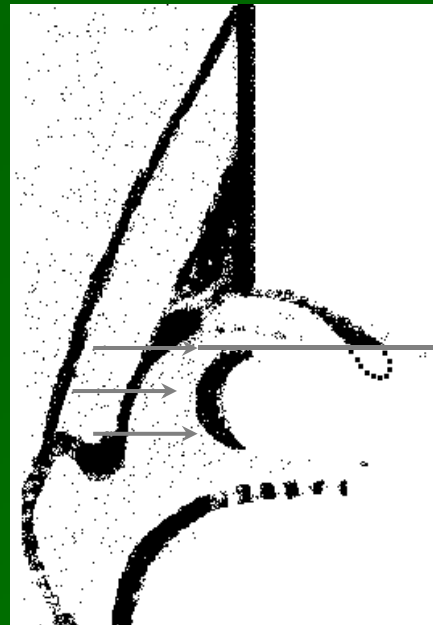
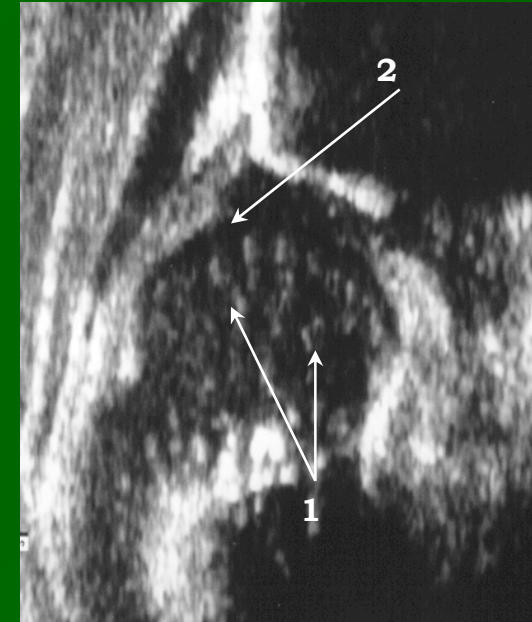
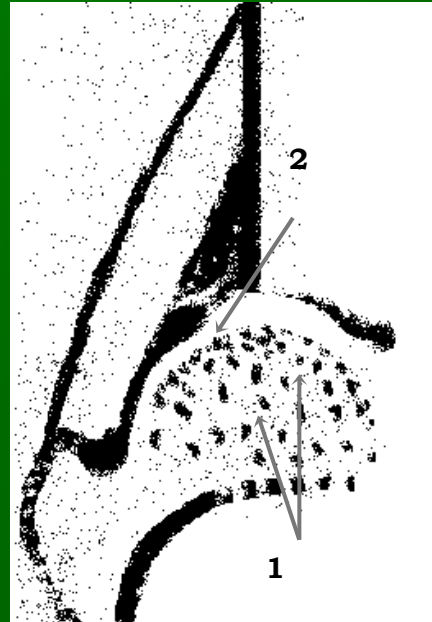
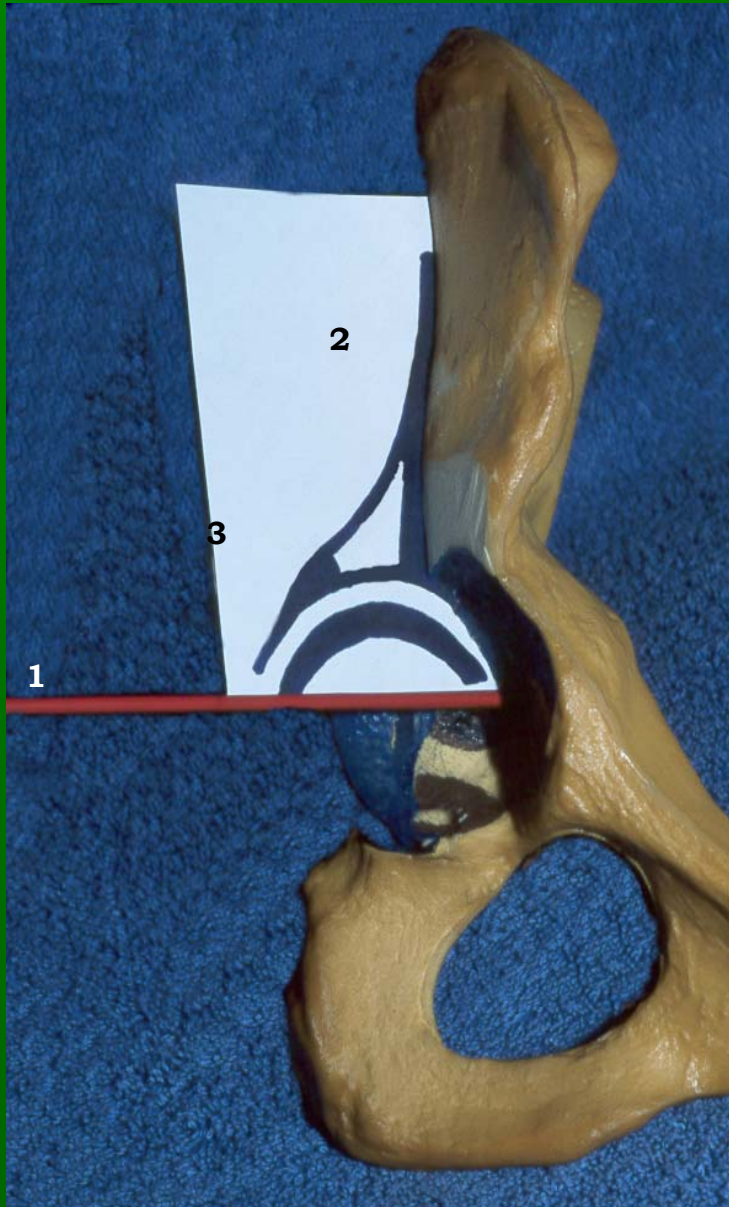
KEY POINTS

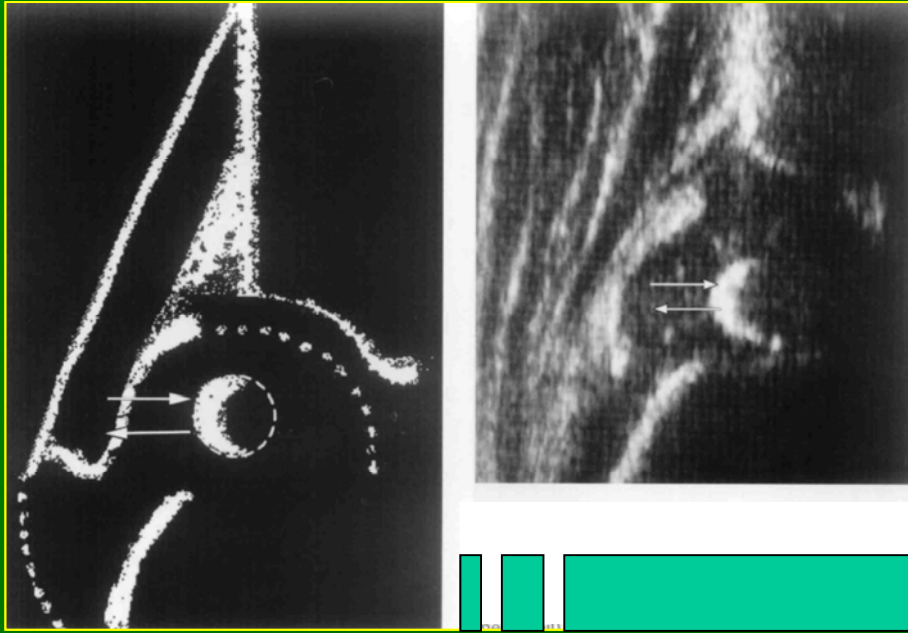




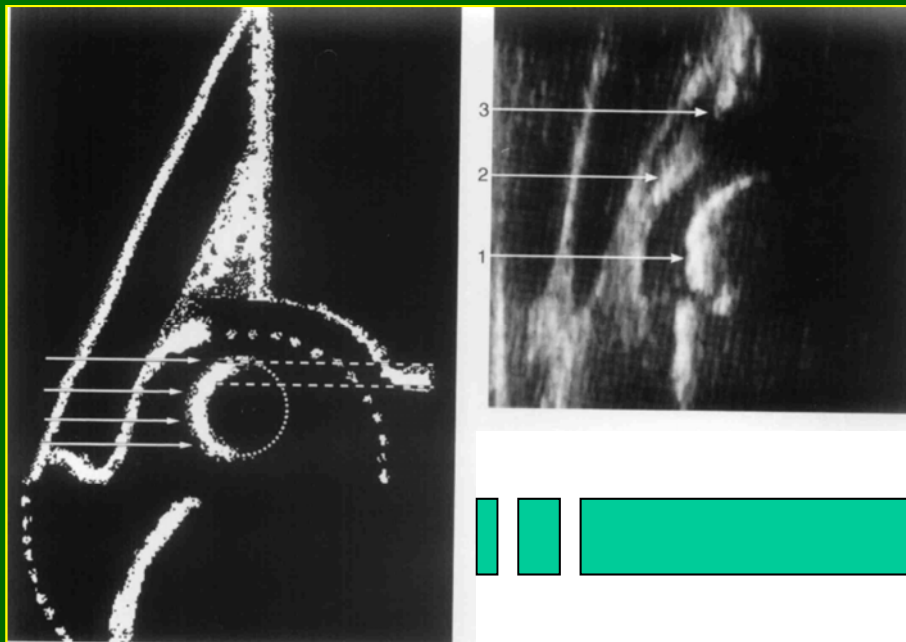
Chondro-osseous junction



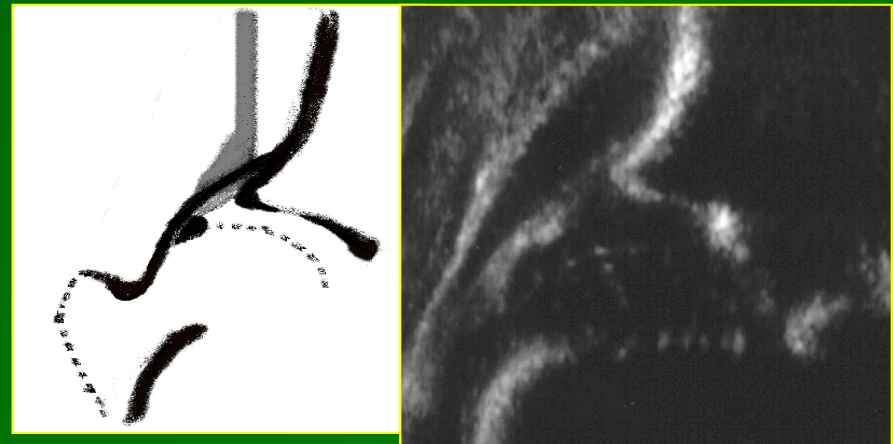
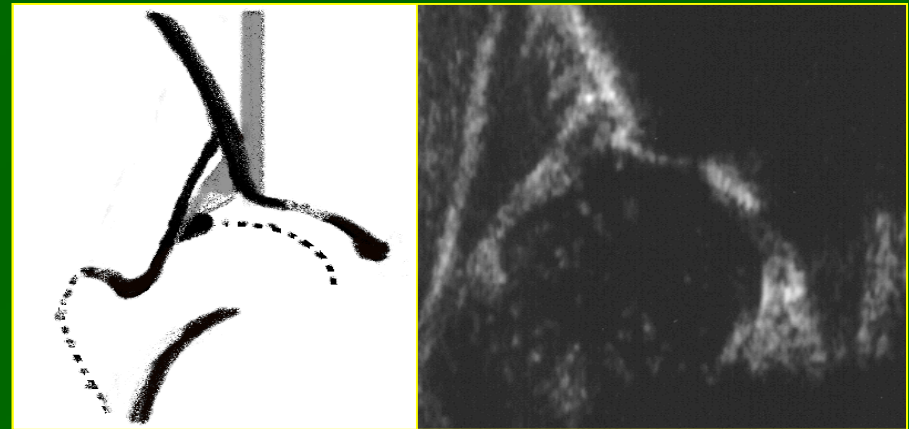
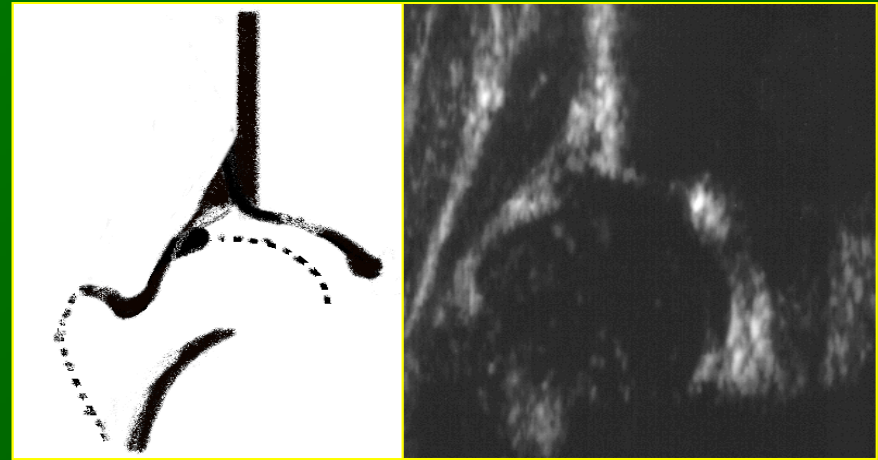


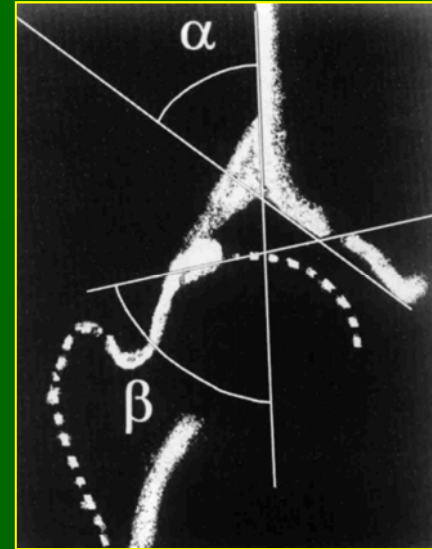
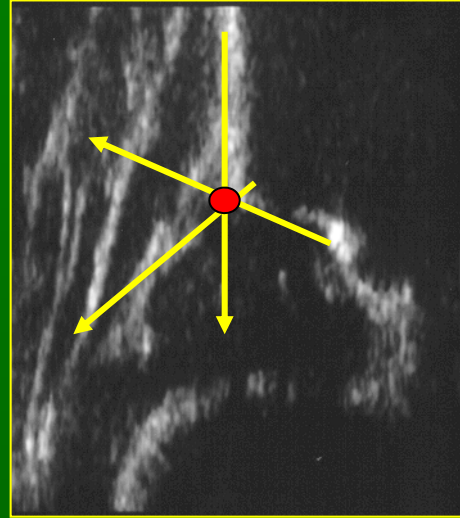


Half-moon Phenomenon

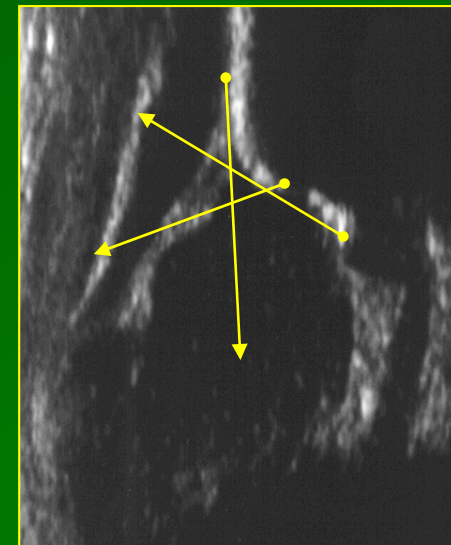
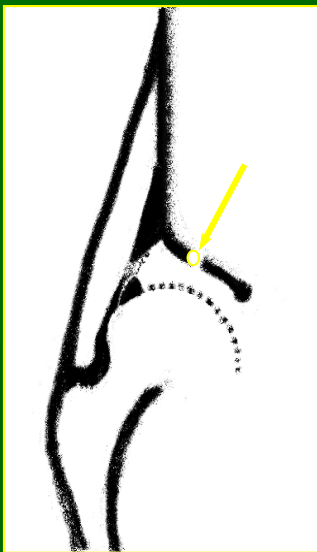


*Appears when
the femoral head
is partly ossified.*



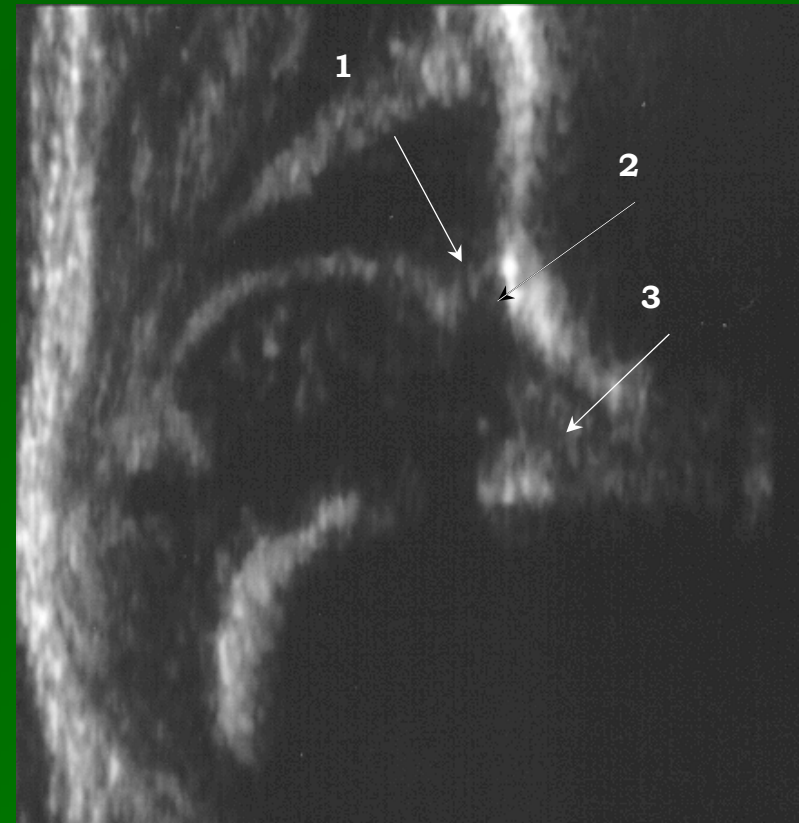
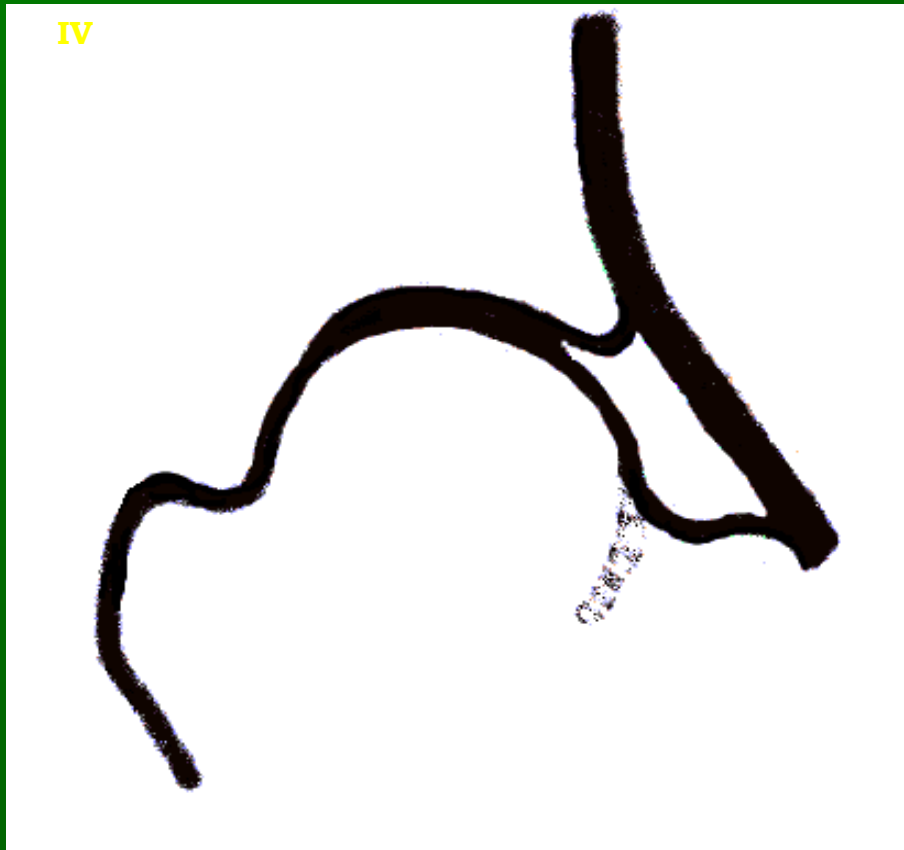


Measurements of the α and β angles

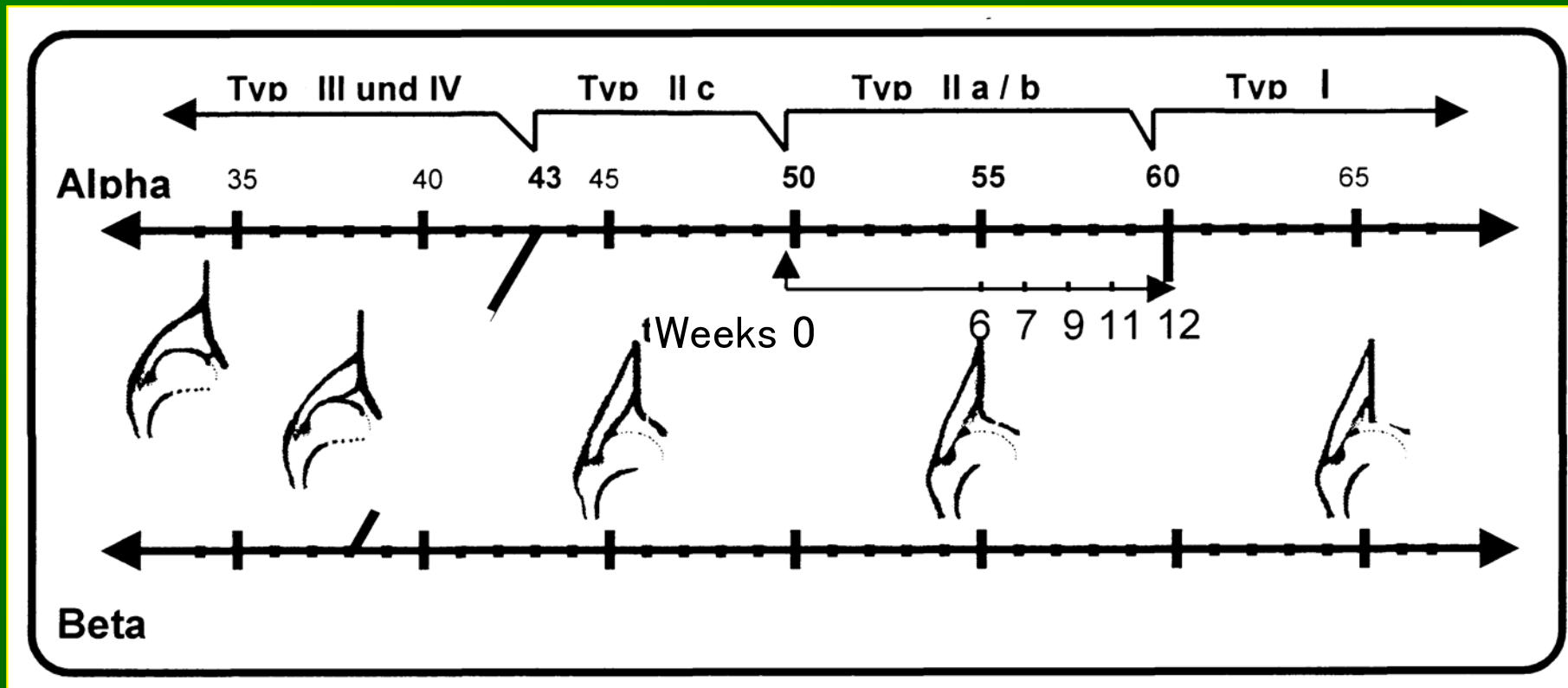


Bony roof line, baseline and cartilaginous roof line not always intersects at the same point

TYPE IV *dislocation*



SONOMETER



bony roof

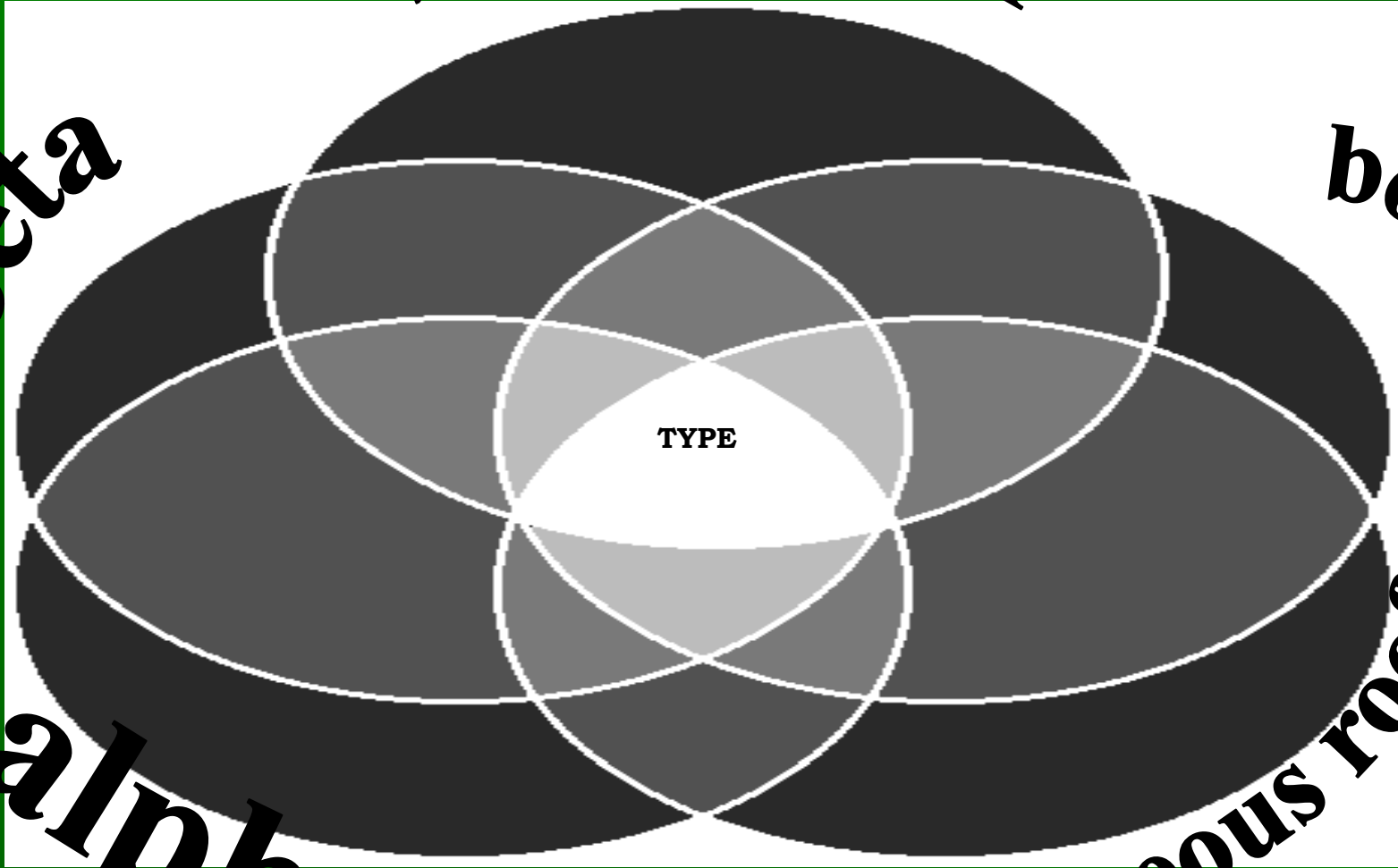
beta

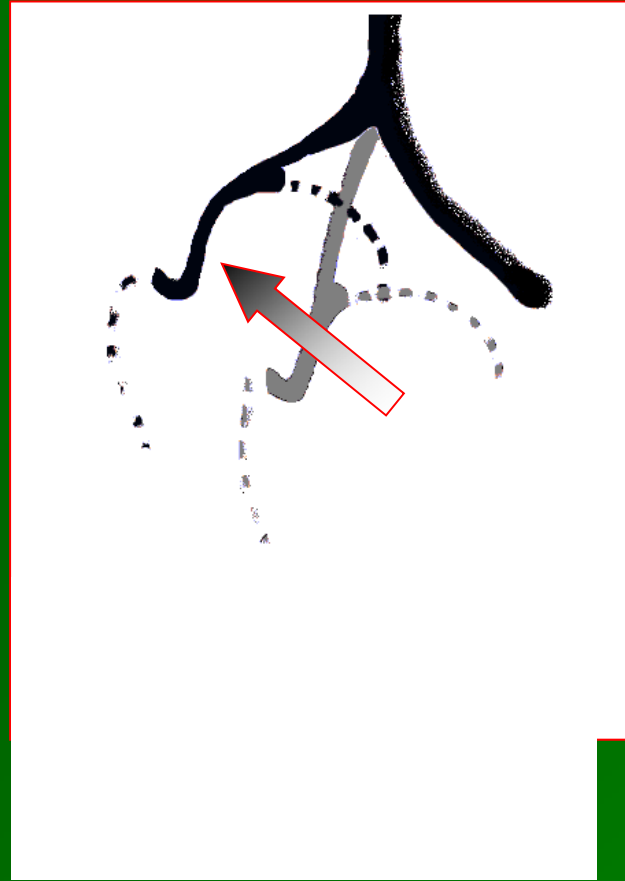
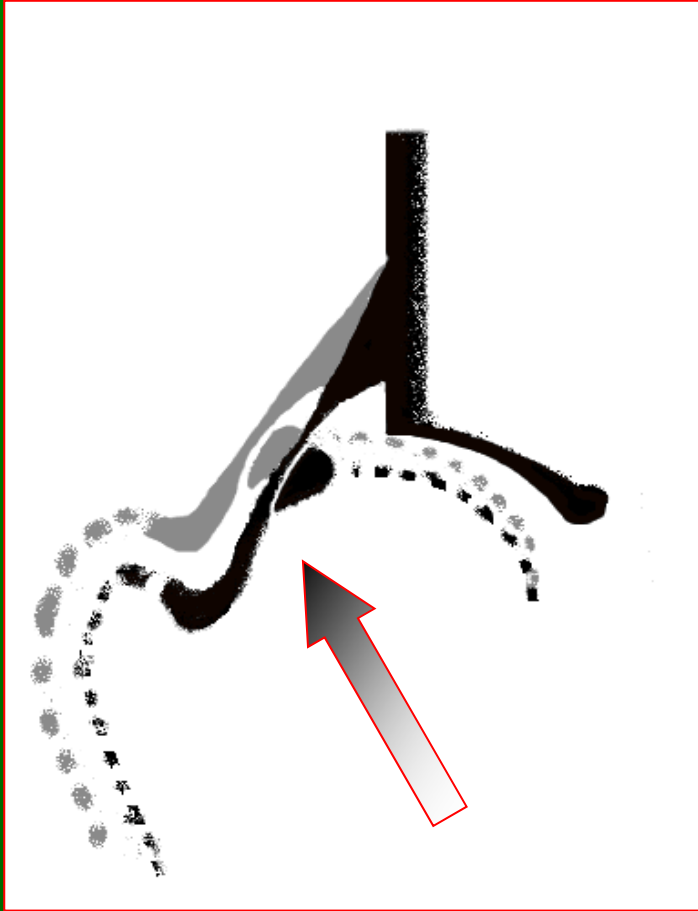
bony rim

TYPE

alpha

cartilagineous roof





EXAMINATION TECHNIQUE



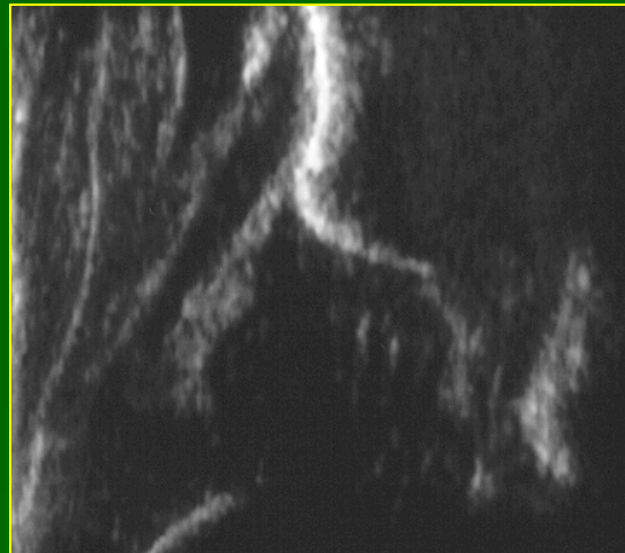
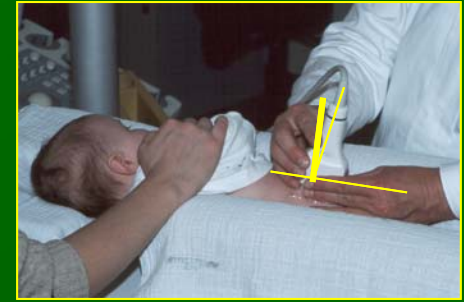
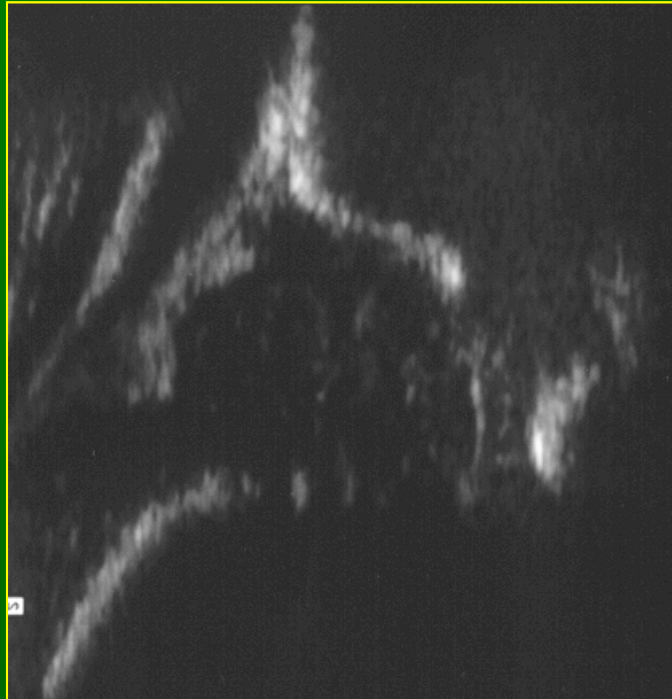
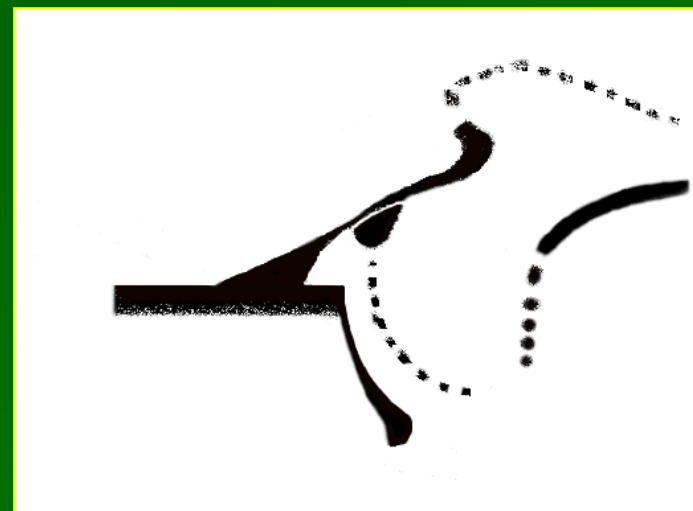
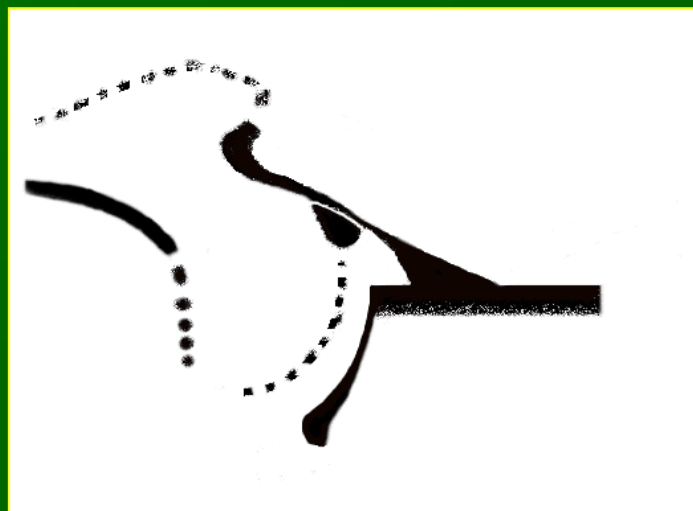
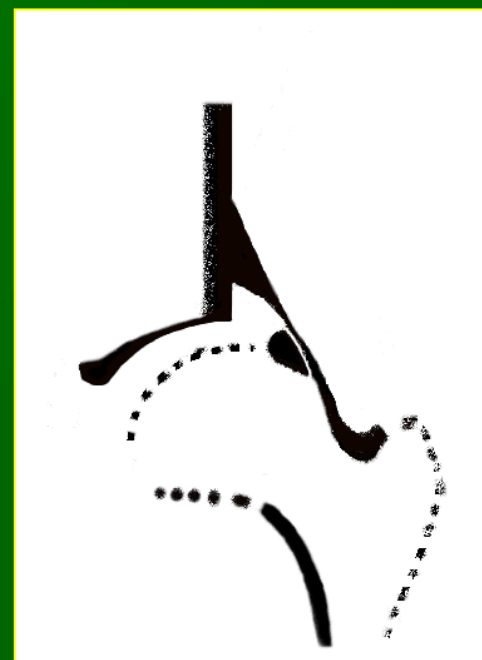
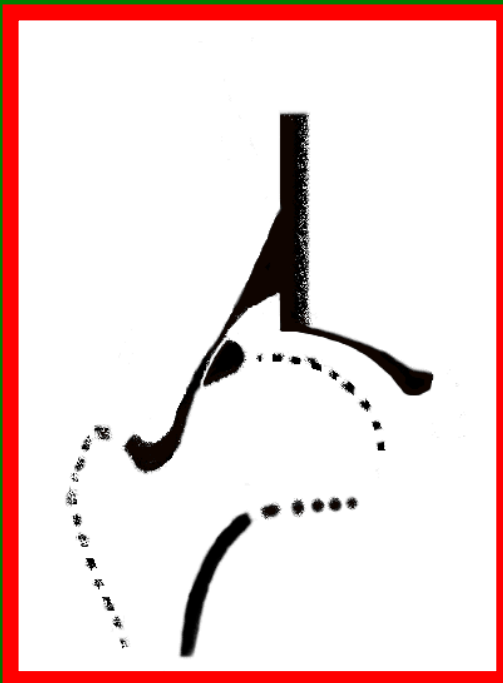
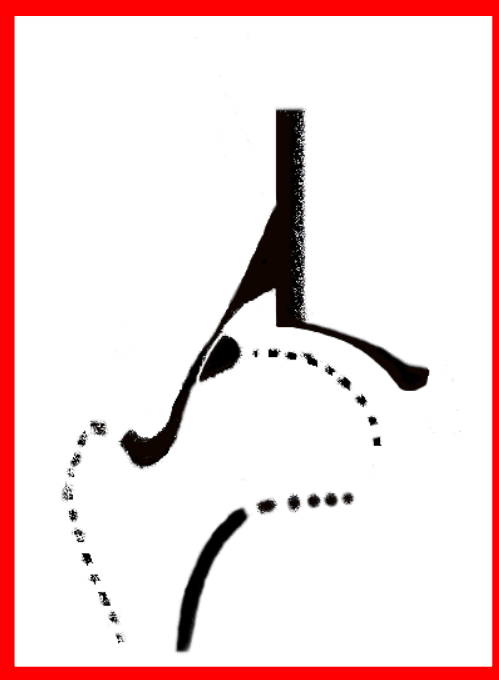


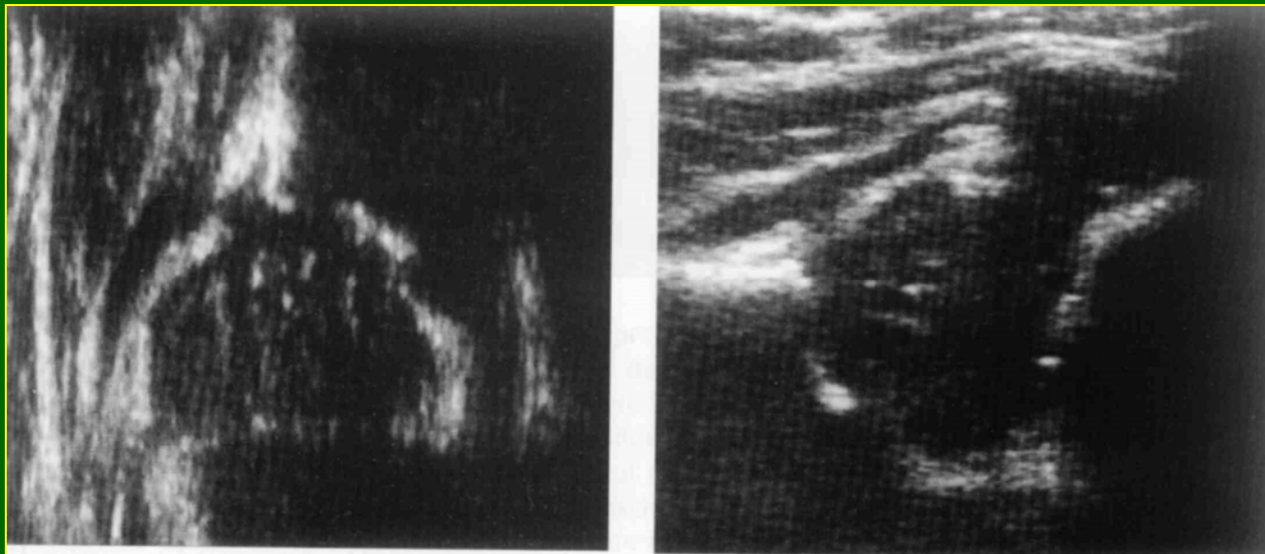
Image projection





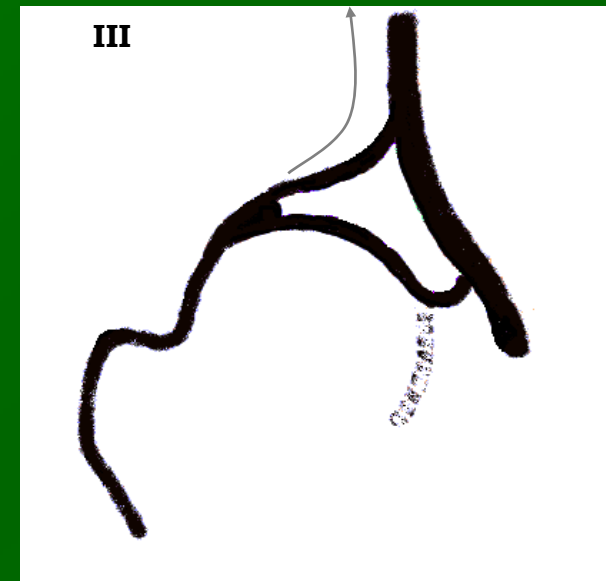
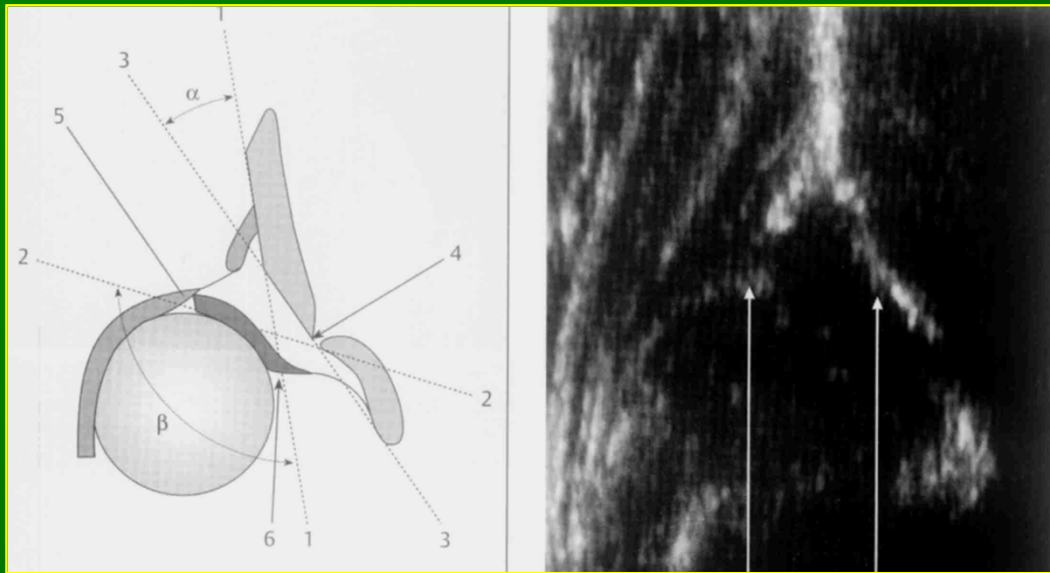
Researchers have shown that this projection is most easily interpreted by brain.

AP view of the right hip.

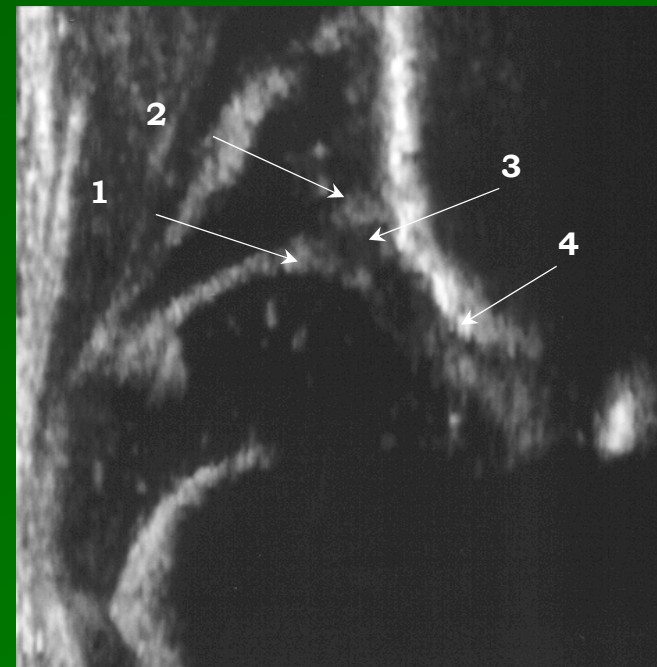
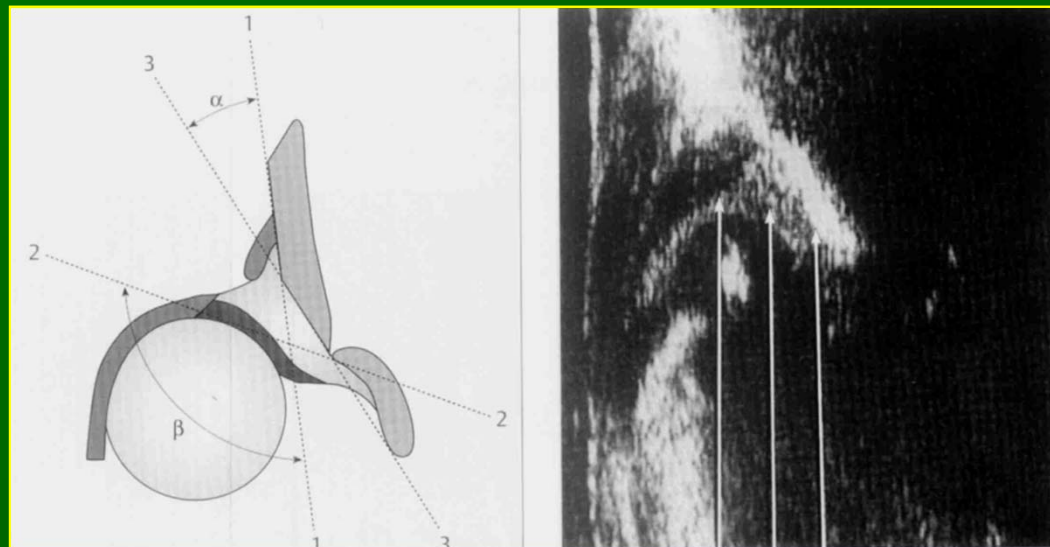


Anatomic projection

Sonographic projection



TYPE III



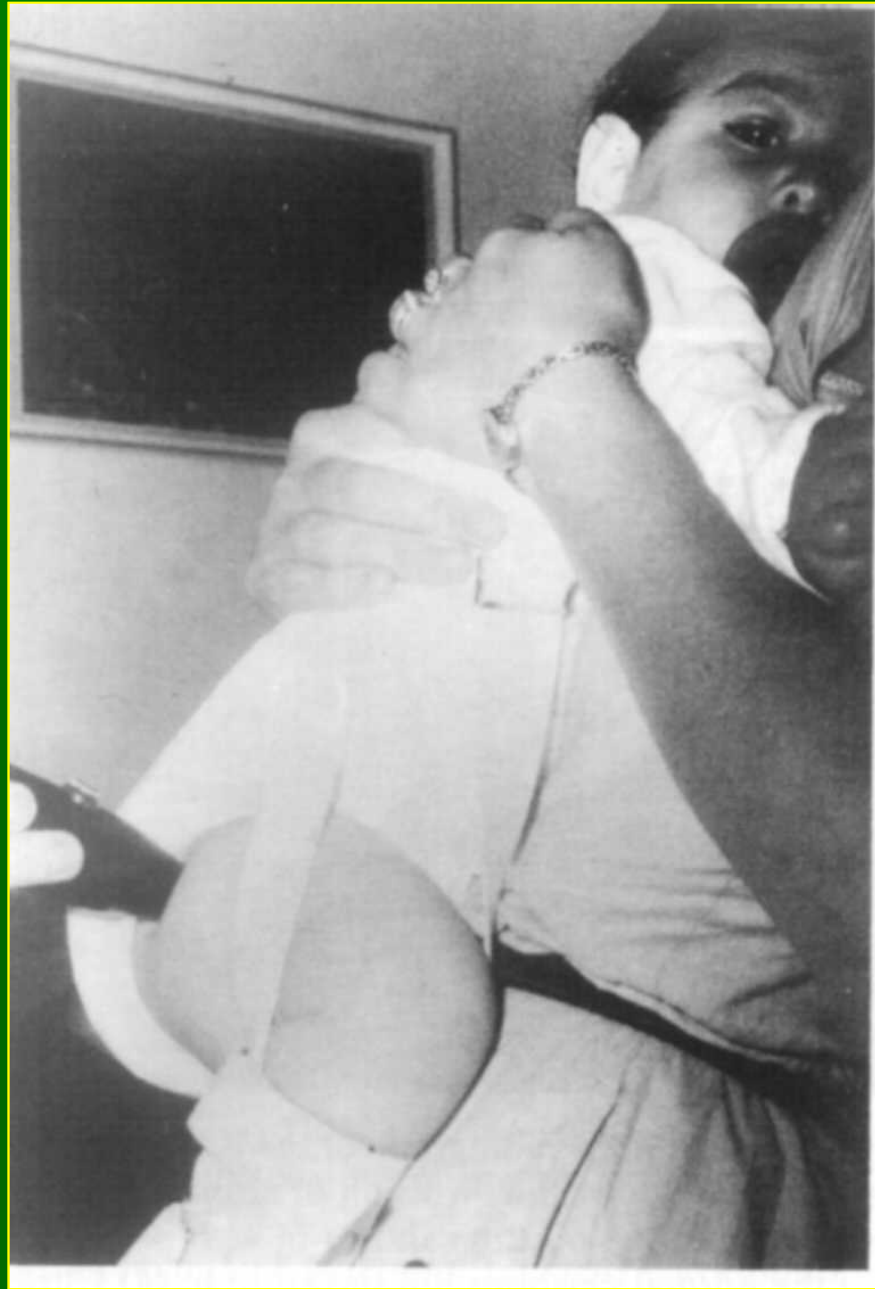
NAME: CHARLES, BRADLEY
I. # 61030
STUDY: HIPS 3MHz
RT. LAT
POST
FLEX 90
INF

APR 16 84
TIME 14: 3:29
SECTOR
DEPTH 7.7 CM
FRAME

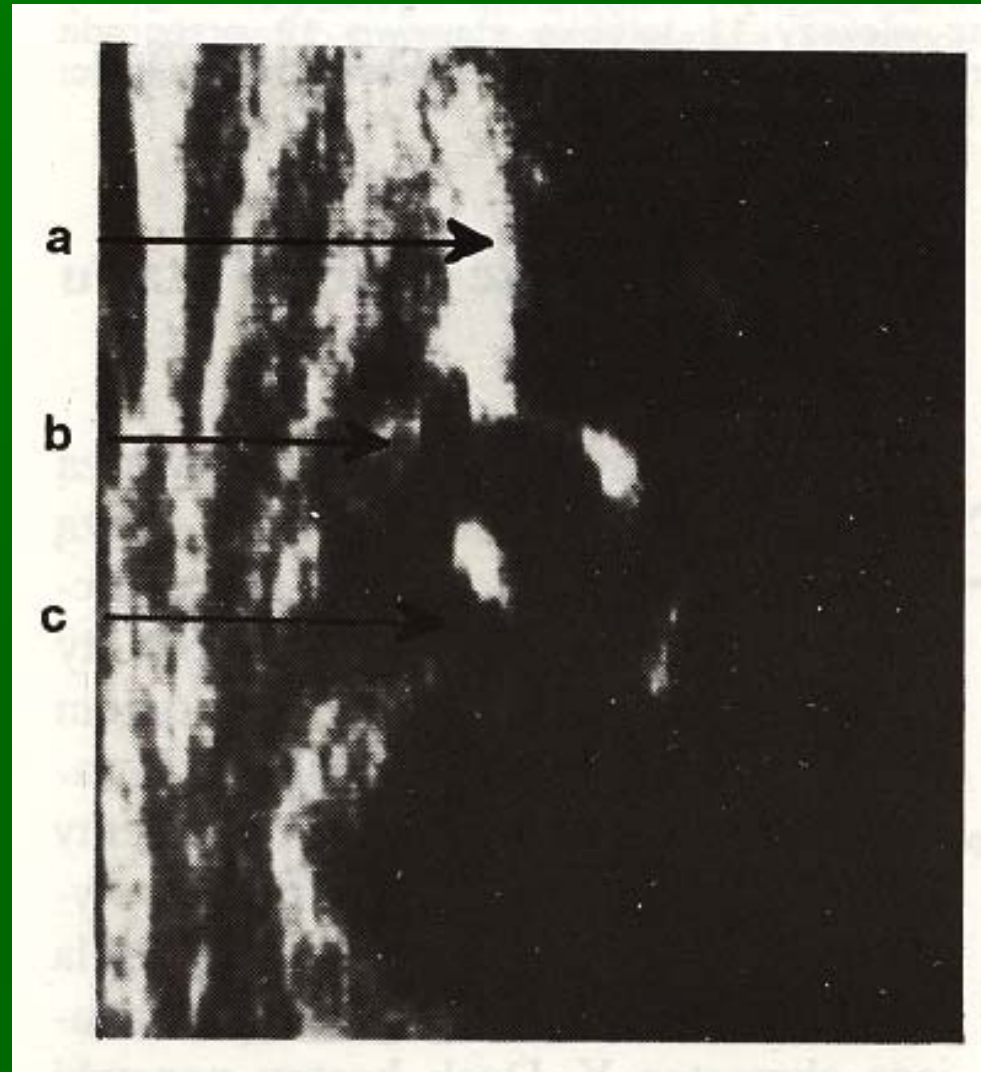


59%

90°

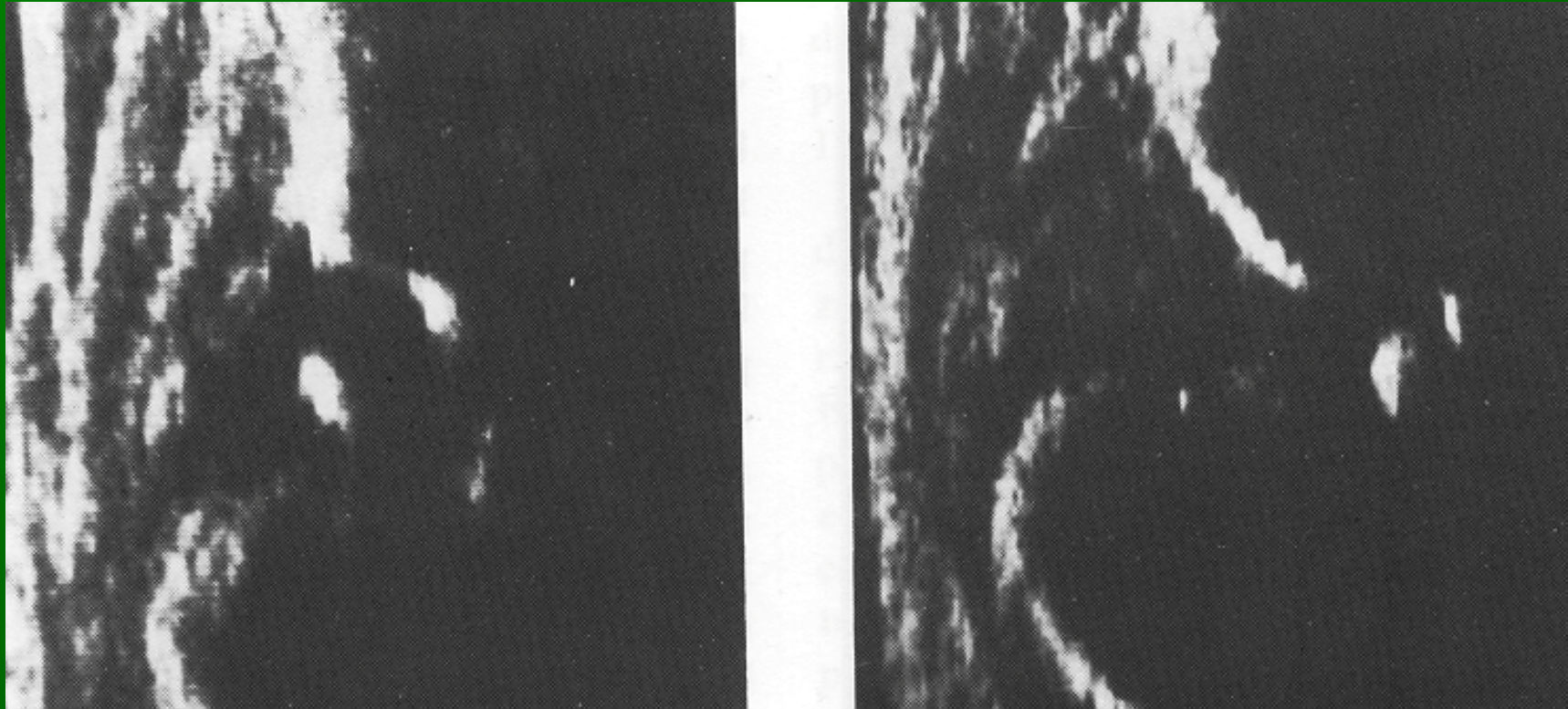


NORMAL SONOGRAM

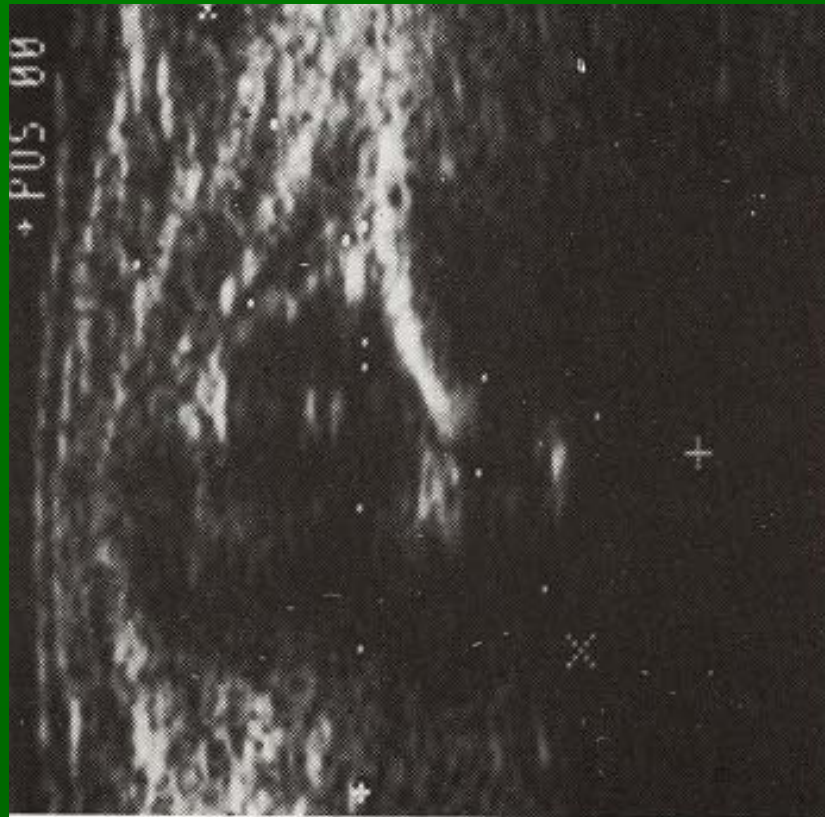


**NORMAL SONOGRAM WITH
OSSIFIC NUCLEUS OF THE
FEMORAL HEAD**

**DYSPLASTIC HIP
TYPE III**

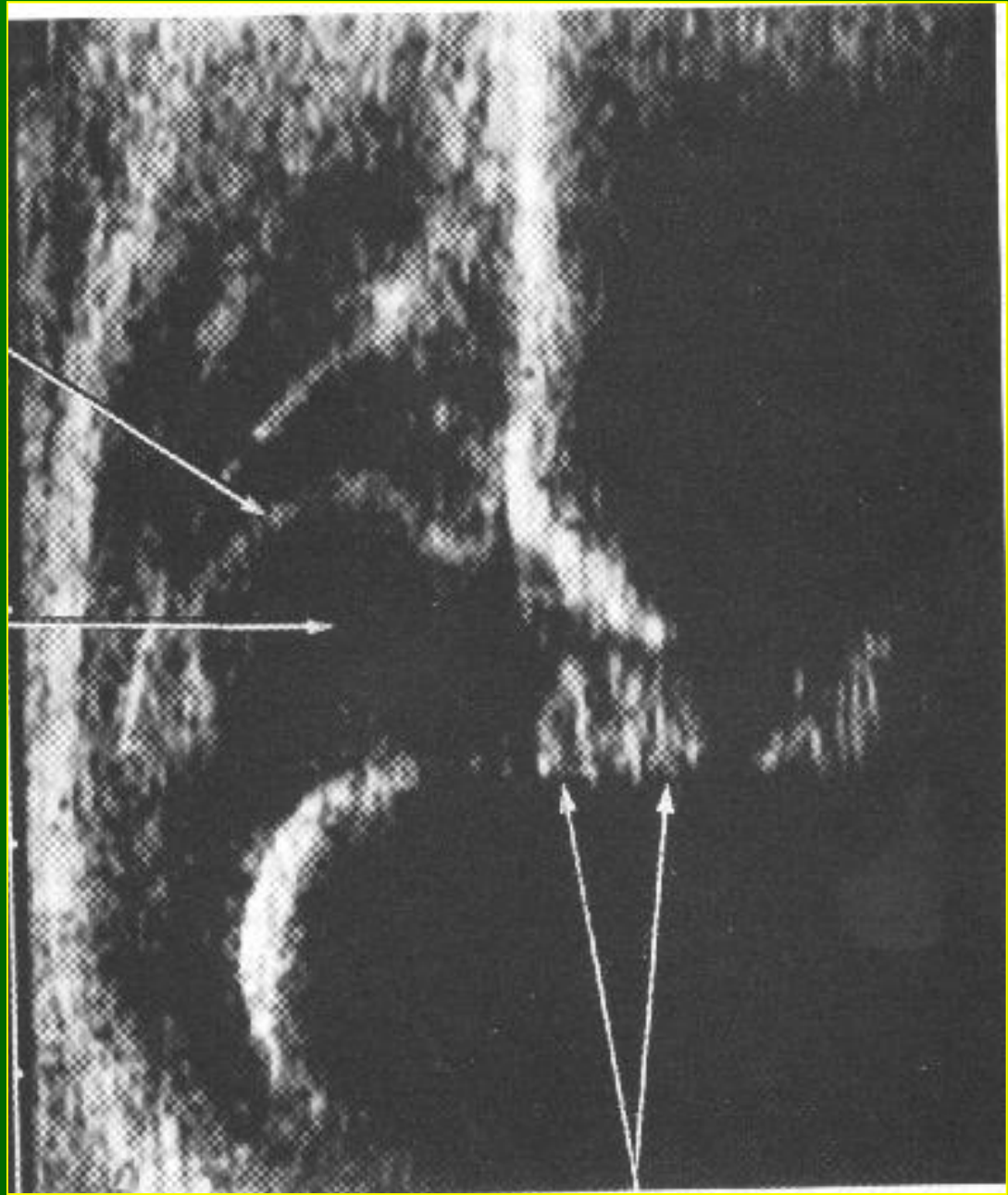


DYSPLASTIC HIP TYPE III



DYSPLASTIC HIP

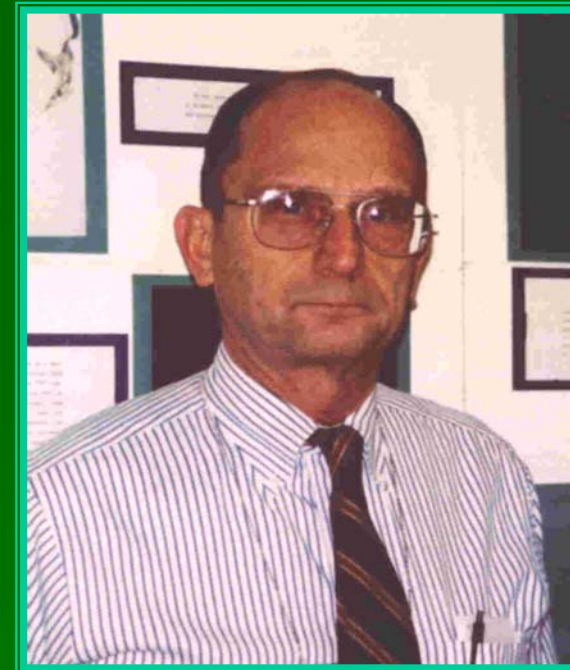




HARCKE'S METHOD

DYNAMIC

- **EXAMINATION IN TWO PLANES**
 - TRANSVERSE
 - CORONAL
- **4 TYPES OF HIP DEVELOPMENT**
 - * NORMAL
 - * LAXITY WITH STRESS
 - * SUBLUXATED
 - * DISLOCATED



Sonographie der Säuglingshüfte und therapeutische Konsequenzen

Ein Kompendium

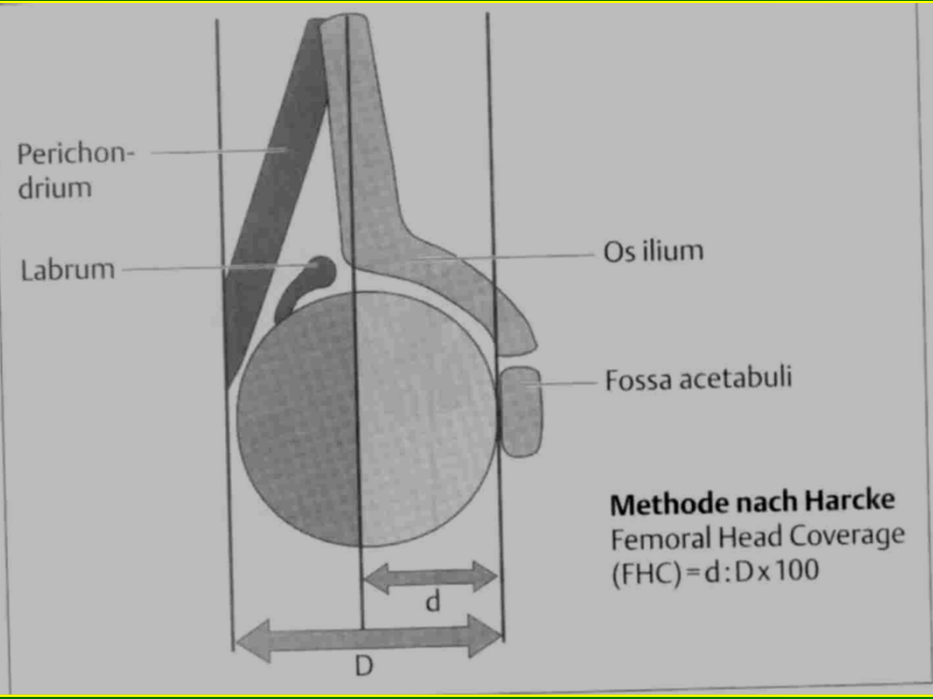
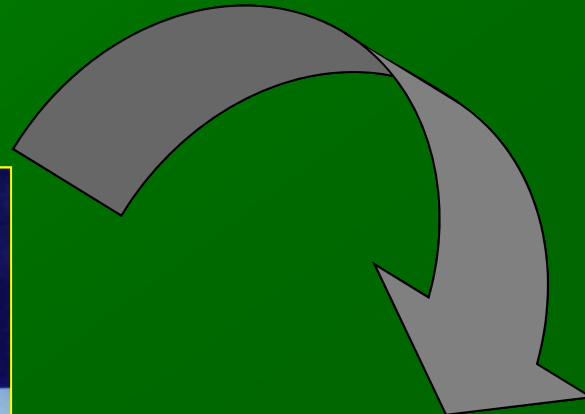
Reinhard Graf

Unter Mitarbeit von
Christian Tschauner, Peter Farkas
und Kurt Lercher

5. überarbeitete und erweiterte Auflage



Thieme



HARCKE'S METHOD

DYNAMIC



**TRANSVERSE
NEUTRAL**



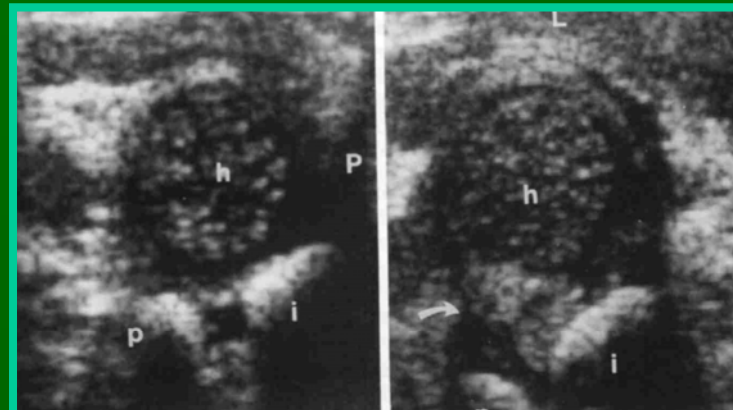
**TRANSVERSE
FLEXION**



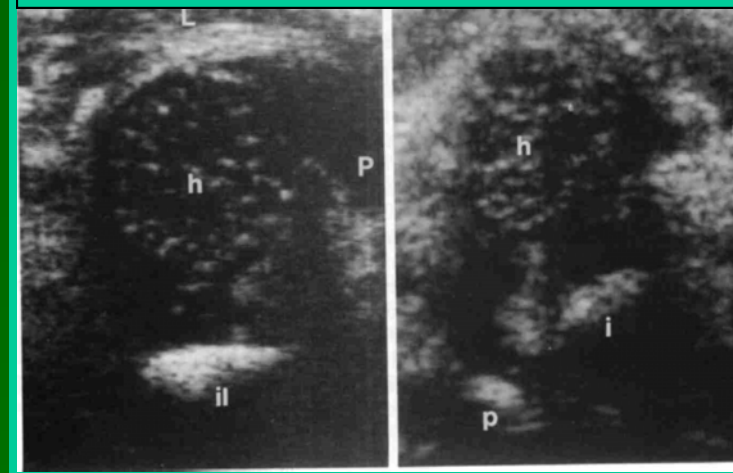
**CORONAL
FLEXION**

HARCKE'S METHOD

DYNAMIC

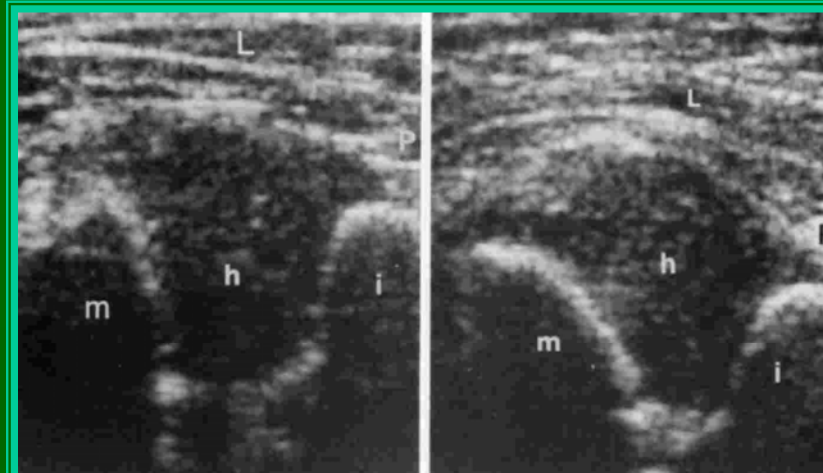
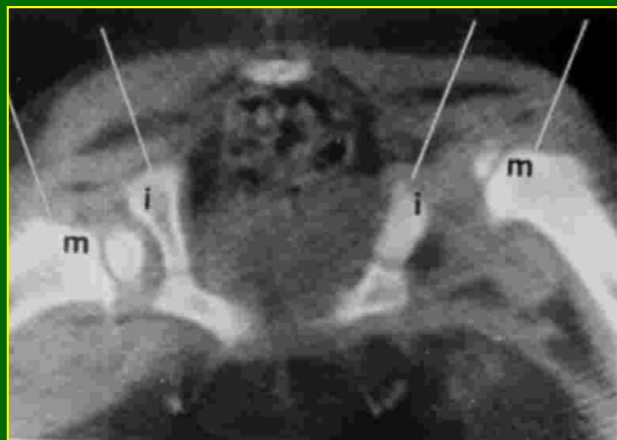


TRANSVERSE NEUTRAL

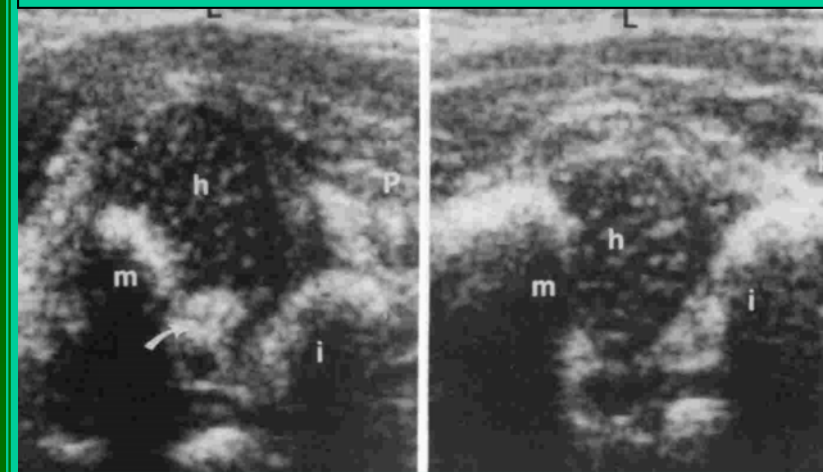


HARCKE'S METHOD

DYNAMIC

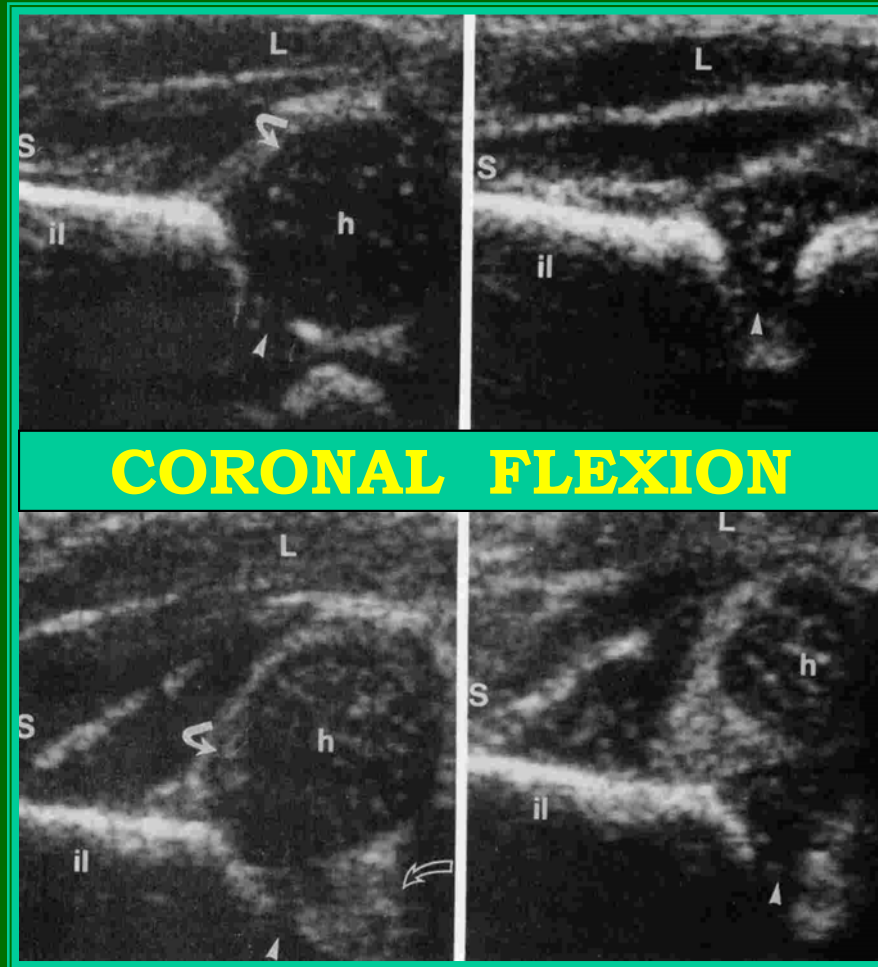
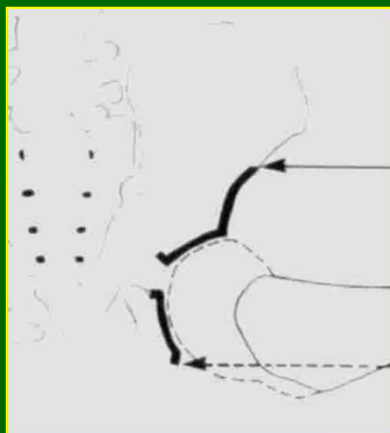


TRANSVERSE FLEXION



HARCKE'S METHOD

DYNAMIC



CORONAL FLEXION

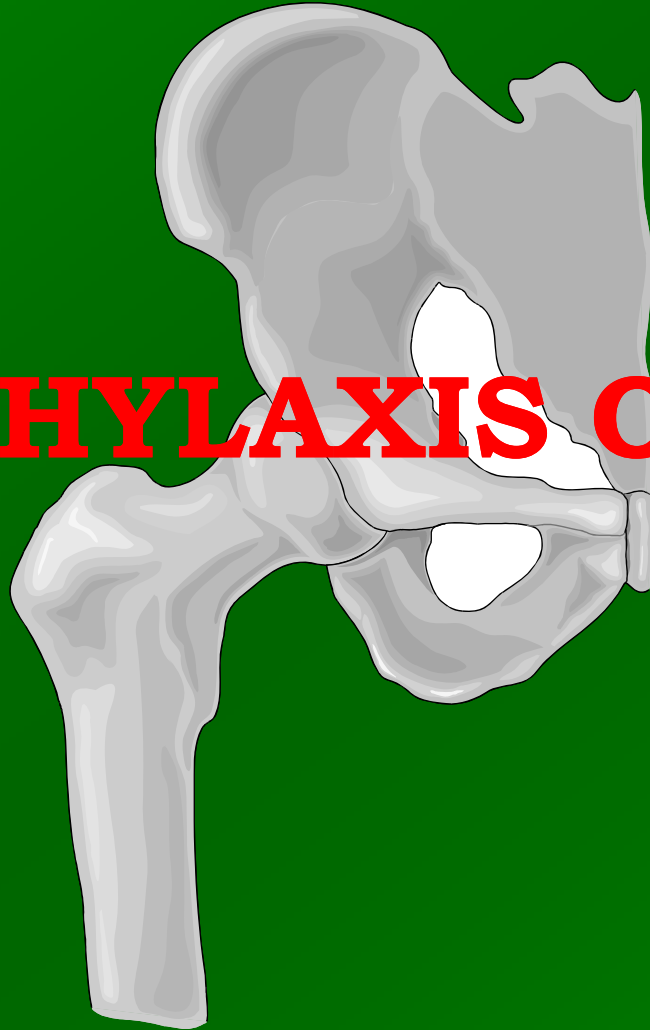
1993 Graf & Harcke proposed combined examination

Dynamic Standard Minimum Examination

Principles :

- 1. Hip should be examined at rest and when stressed** (*in the coronal plane at rest and in the transverse plane with stress*)
- 2. Assessment should include views in orthogonal planes**
- 3. Assessment should include both stability and morphology**

PROPHYLAXIS OF DDH

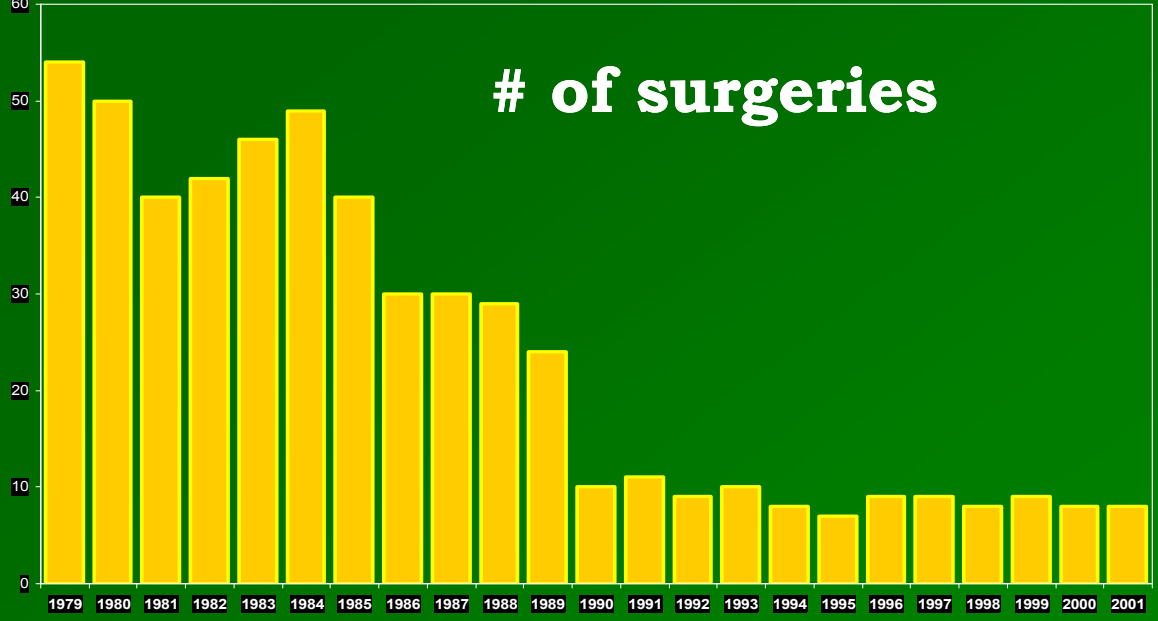
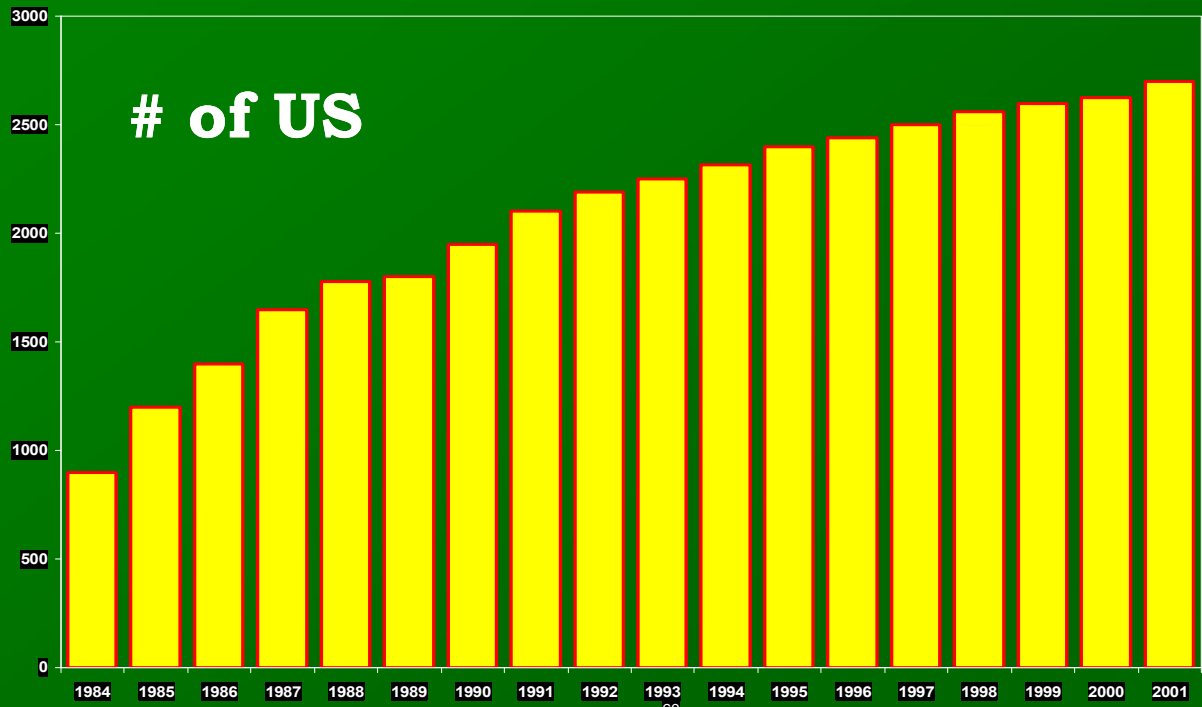


PROPHYLAXIS

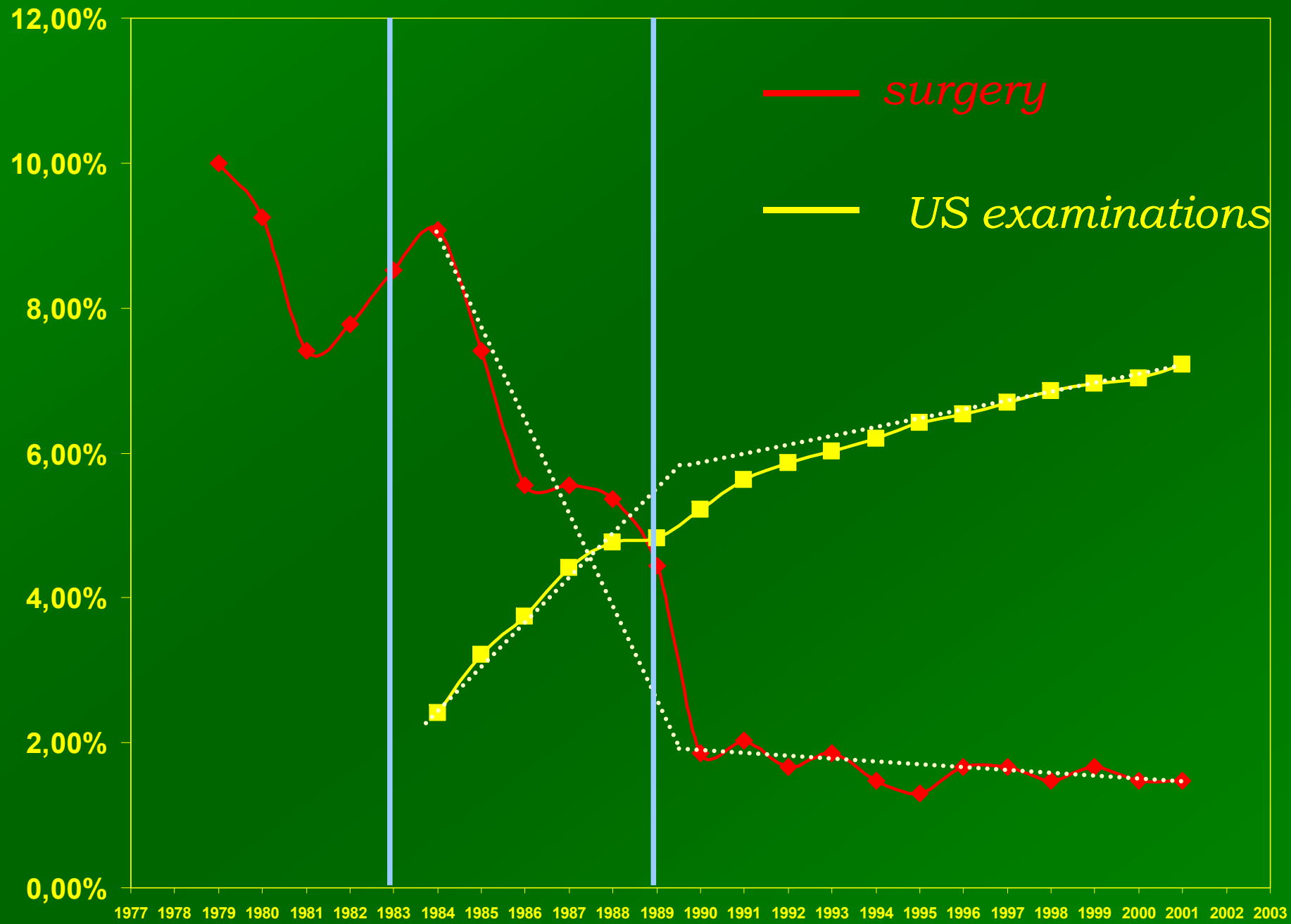
- * **Every child**
- * **Training for US technique**
- * **Information about DDH**

EARLY DIAGNOSIS :

- * **Early treatment**
- * **Easy treatment**
- * **Treatment more friendly for child and family**
- * **Decrease # of surgical cases**



1984-2001
40 000 US
examinations of the
hip joints



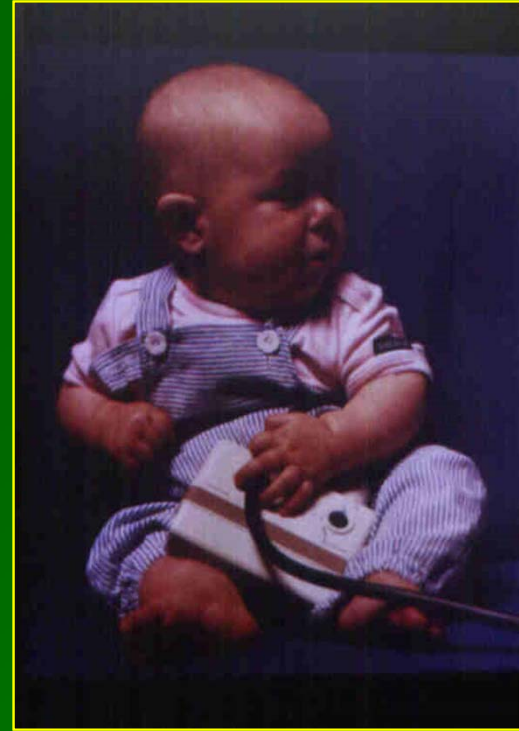
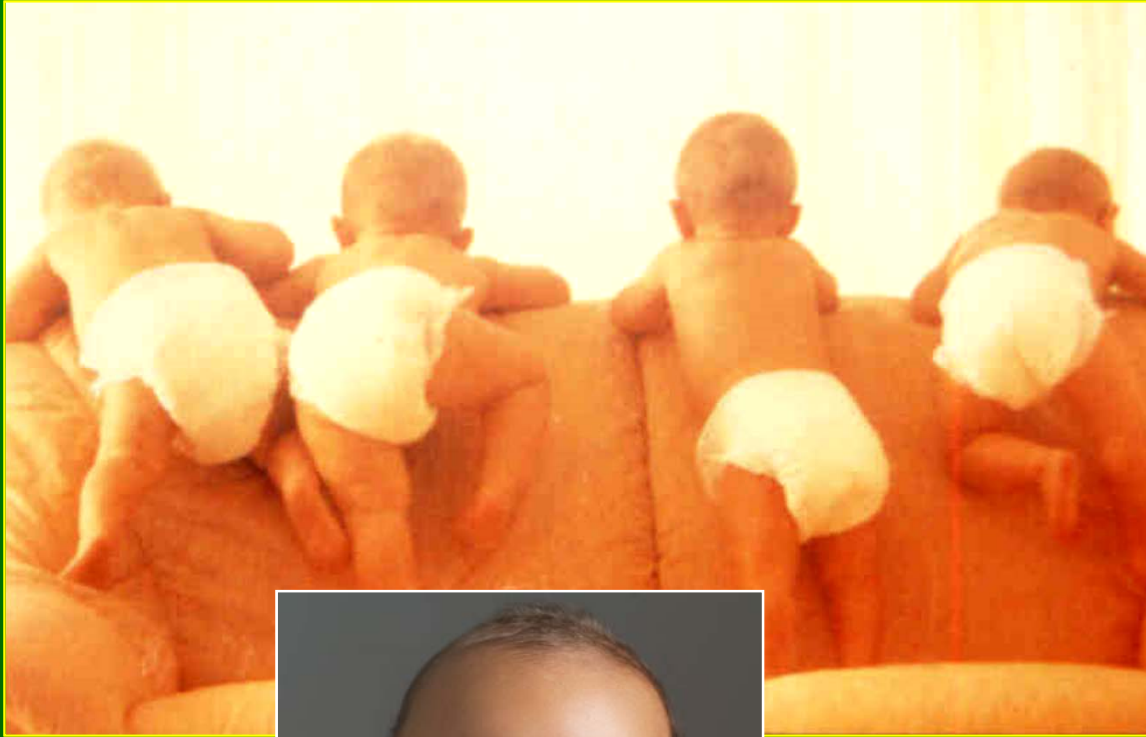
PROPHYLAXIS







PROPHYLAXIS



DIAGNOSIS

CLINICAL EXAMINATION

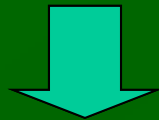


ULTRASOUND = 1 - 3 WEEK



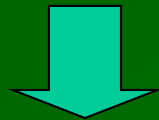
DYSPLASIA

NORMAL



TREATMENT

US AT 4 MONTHS



US MONITORING EVERY 3-4 WEEKS

MATERIAL

- **45 000** NEWOBURNS AND INFANTS
- 1984 - 2003
- FEMALE : MALE = 3 : 2
- **US TECHNIQUES :**
 - GRAF'S & HARCCKE'S METHOD
 - SIEMENS SL 2
 - LINEAR TRANSDUCER - 7.5 & 5 MHz
 - DYNAMIC EXAMINATION FOR HIP STABILITY

MATERIAL

- ***SPECIAL ATTENTION TO :***
 - **FAMILY HISTORY OF DDH**
 - **BREECH DELIVERY**
 - **CLINICAL SIGNS OF DDH**
 - **MOTHER DISEASES DURING PREGNANCY**

MATERIAL

- **THE DDH WAS
DIAGNOSED IN 5% OF
ALL EXAMINED
CHILDREN**

MATERIAL

- **GRAF'S TYPE OF DYSPLASYIC HIP:**

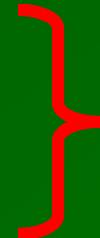
– **II** = **75%**

– **D** = **8%**

– **IIIa** = **6%**

– **IIIb** = **4%**

– **IV** = **7%**



children outside the city

MATERIAL

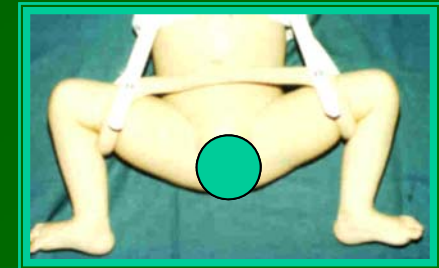
- **80% girls**
- **20% boys**

TIME OF HIP REBUILDING

- **TYPE II** = 4- 6 WEEKS
- **TYPE D** = 6-12 WEEKS
- **TYPE IIIa** = 8-14 WEEKS
- **TYPE IIIb** = 10-16 WEEKS
- **TYPE IV** = 12-24 WEEKS

MATERIAL

- **TREATMENT OPTIONS :**
 - PILLOWS
 - PAVLIK HARNESS
 - ABDUCTION-FLEXION DEVICES
 - OVERHEAD EXTENSION
 - CLOSED REDUCTION



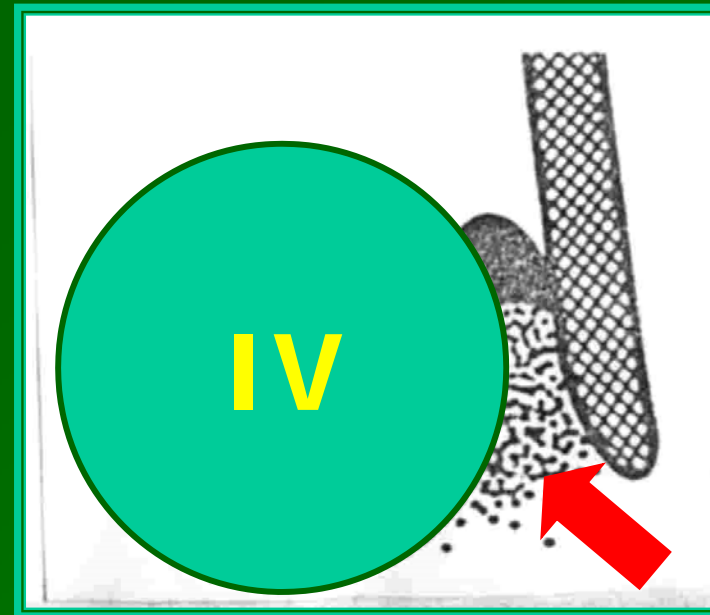
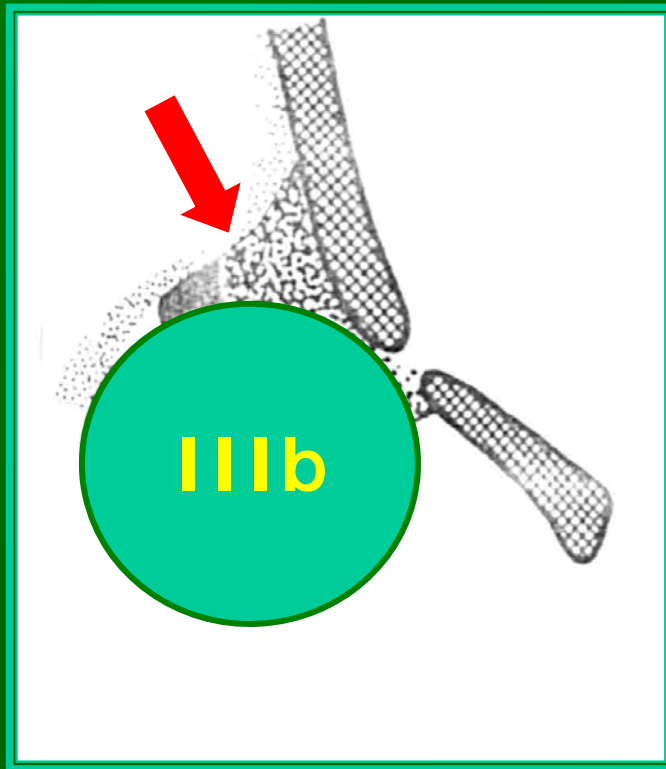
TIME OF HIP REBUILDING

TYPE IIIb = 10-16 WEEKS
TYPE IV = 12-24 WEEKS

**5% OF CHILDREN FROM THESE
GROUPS
REQUIRED SURGERY**

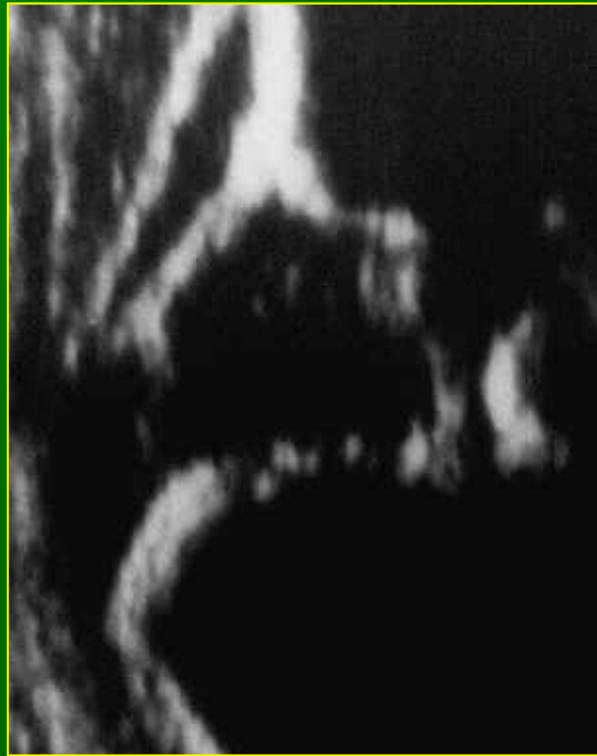
TIME OF HIP REBUILDING

PROBLEMS WITH HIP REDUCTION



HIP REBUILDING

Type IIa



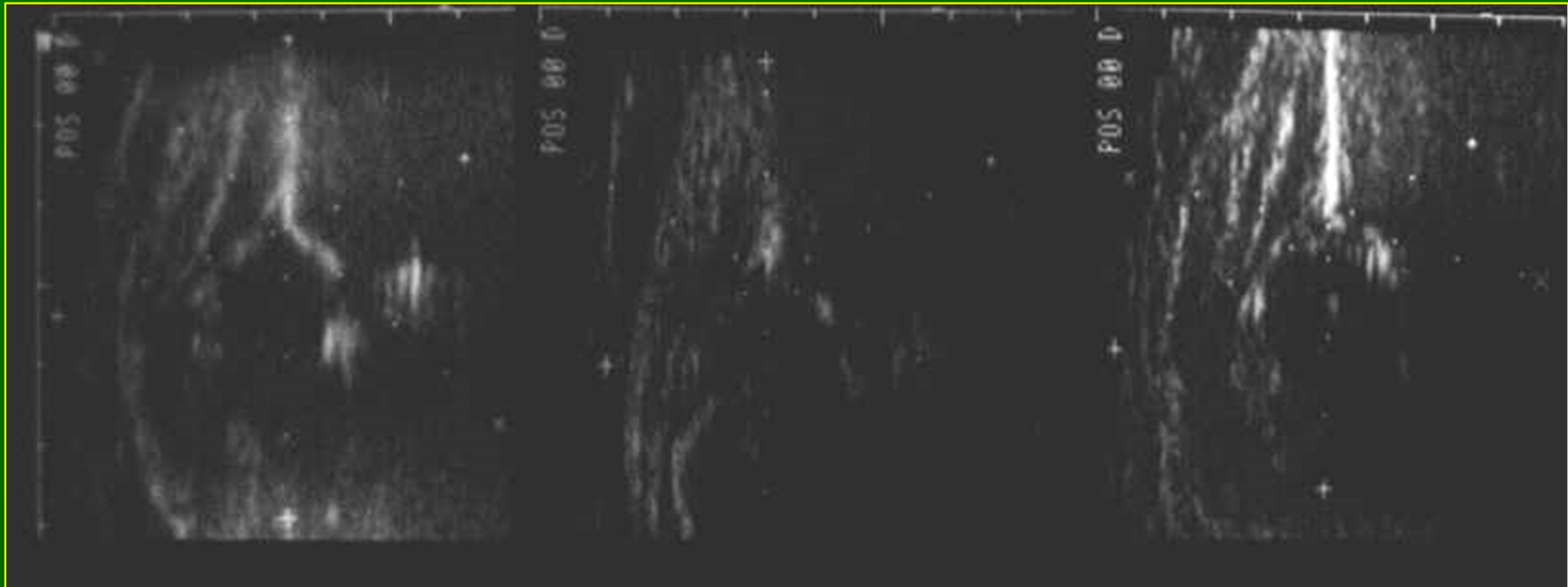
3 weeks



7 weeks

HIP REBUILDING

Type IIb



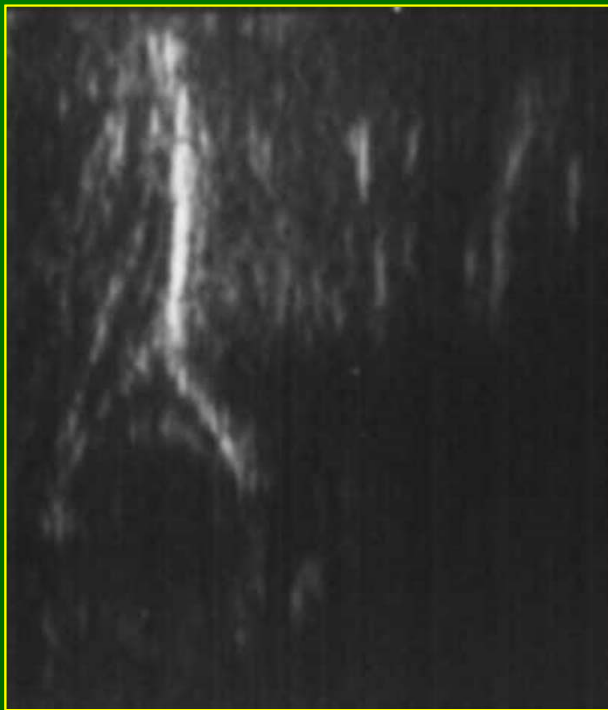
3 months

4 months

6 months

HIP REBUILDING

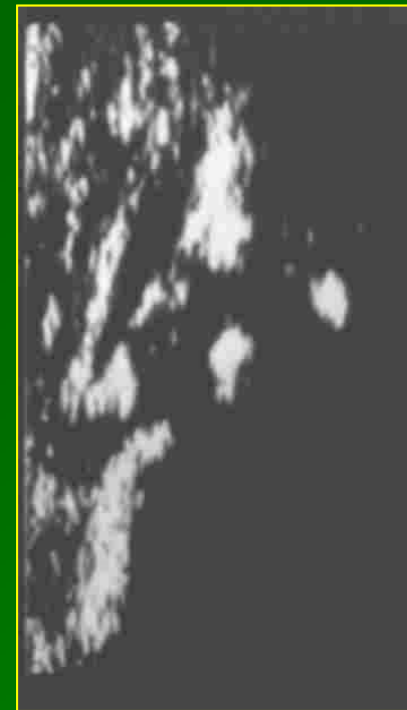
Type D



2 months



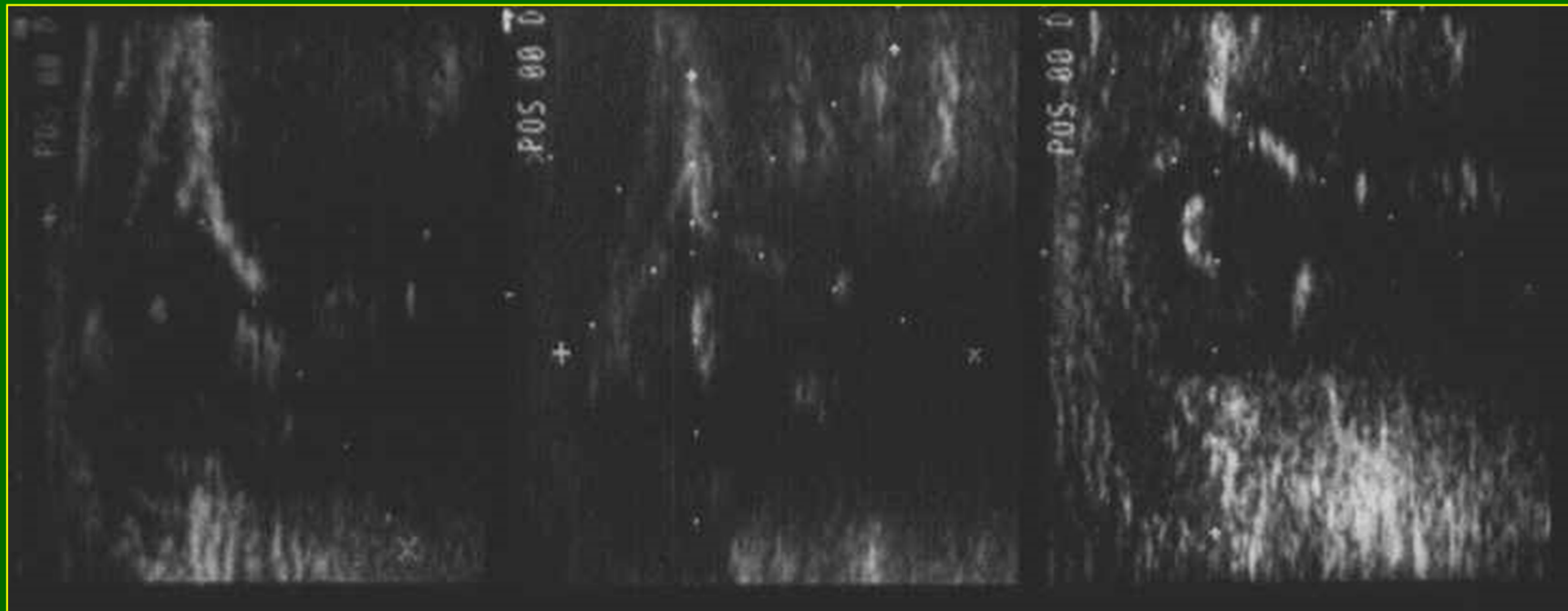
4 months



7 months

HIP REBUILDING

Type IIIa



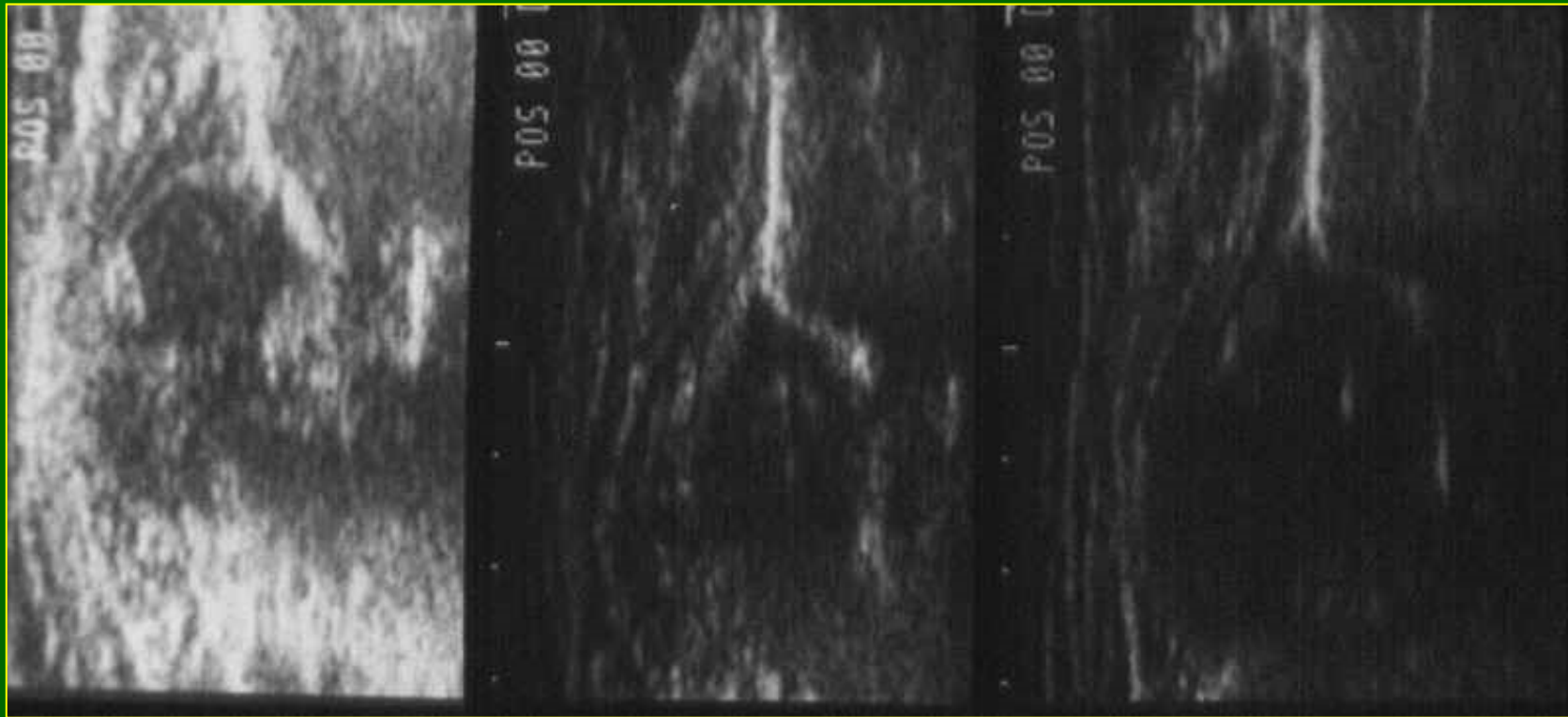
4 months

6 months

9 months

HIP REBUILDING

Type IIIa



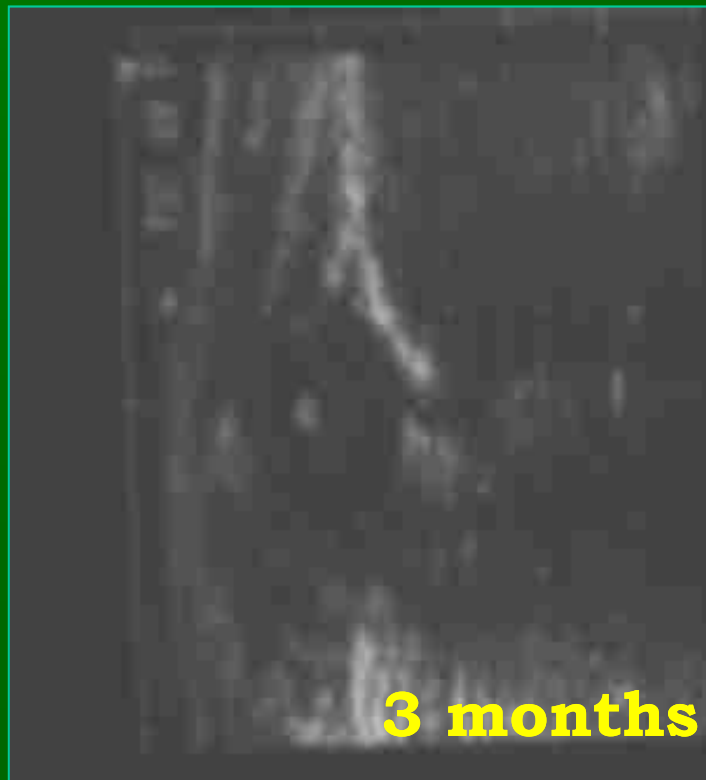
3 months

5 months

7 months

HIP REBUILDING

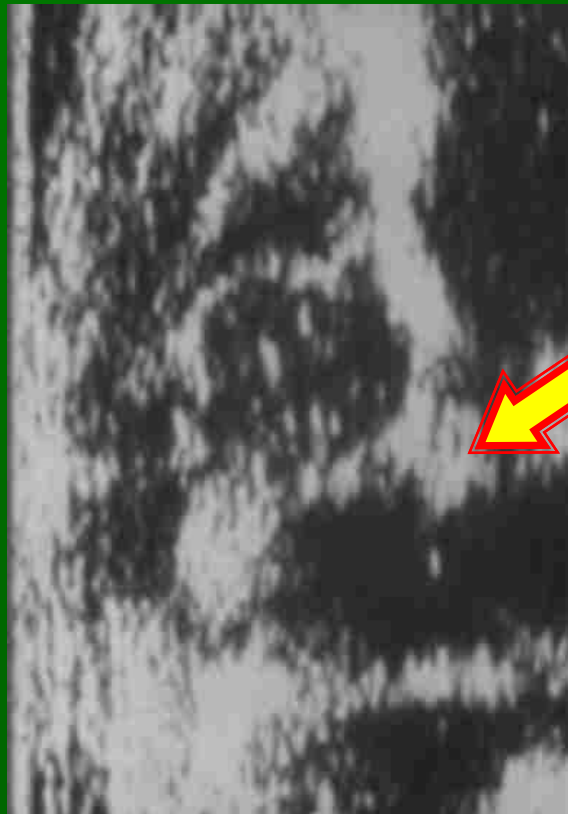
Type IIIb



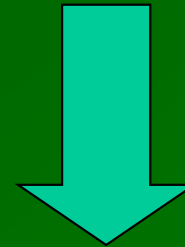
Scheduled for surgery

HIP REBUILDING

Type IV



No reduction obtained



Scheduled for surgery

3 months

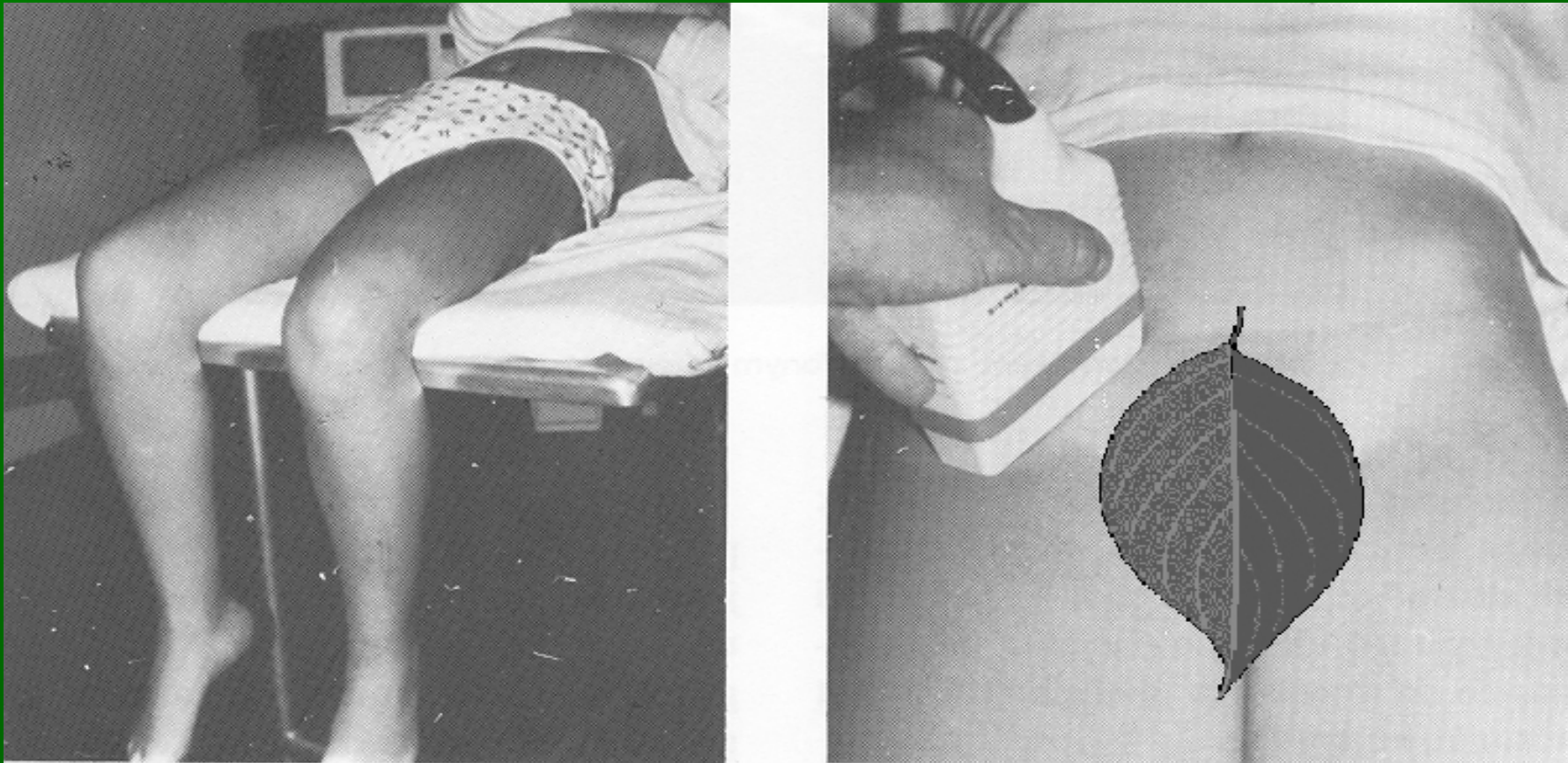
CONCLUSIONS

- **US EXAMINATION IS VERY USEFUL IN THE EARLY DIAGNOSIS OF DDH**
- **US MONITORING ENABLED PROPER TREATMENT**
- **THANKS US DIAGNOSIS THE NUMBER OF CASES WHICH REQUIRED SURGERY SIGNIFICANTLY DECREASED**

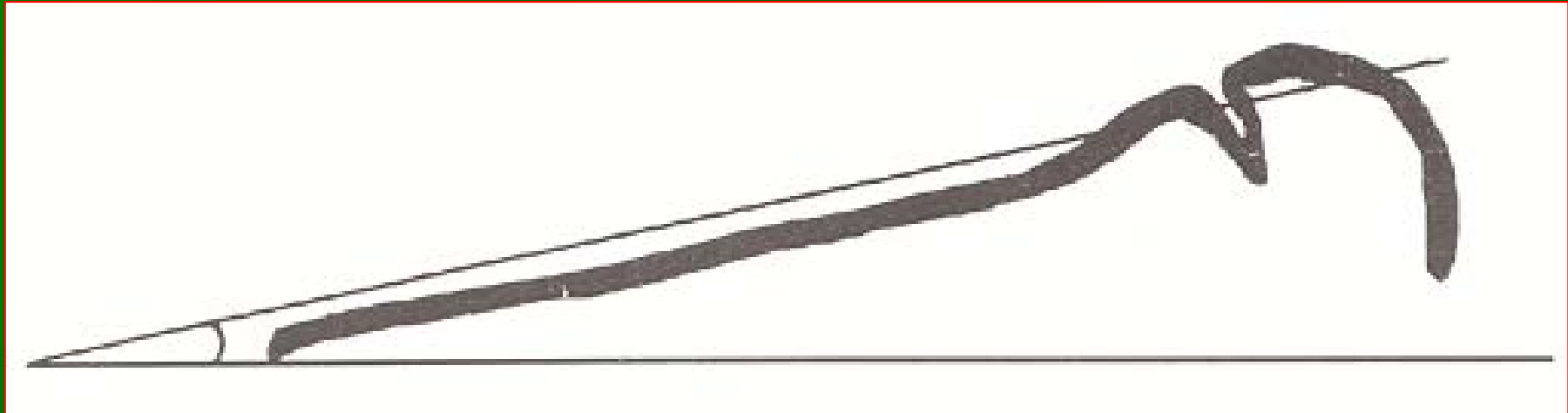
MOTTO :

**Better Ultrasound today
than a limp tomorrow !**

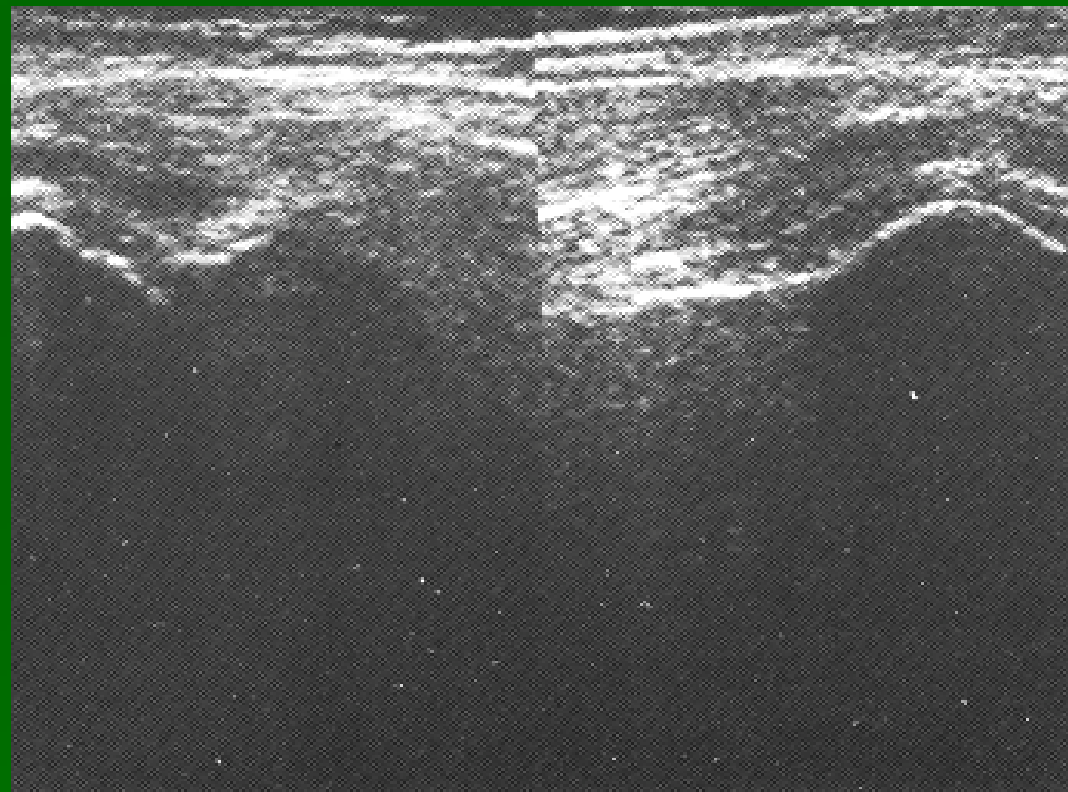
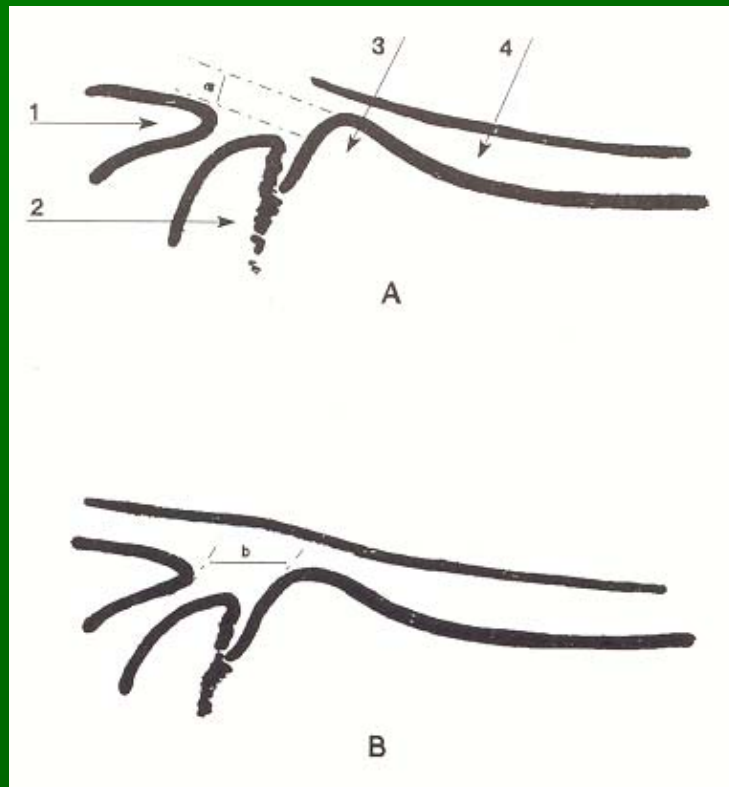
Evaluation of the hip joint in measuring of the antetorsion angle



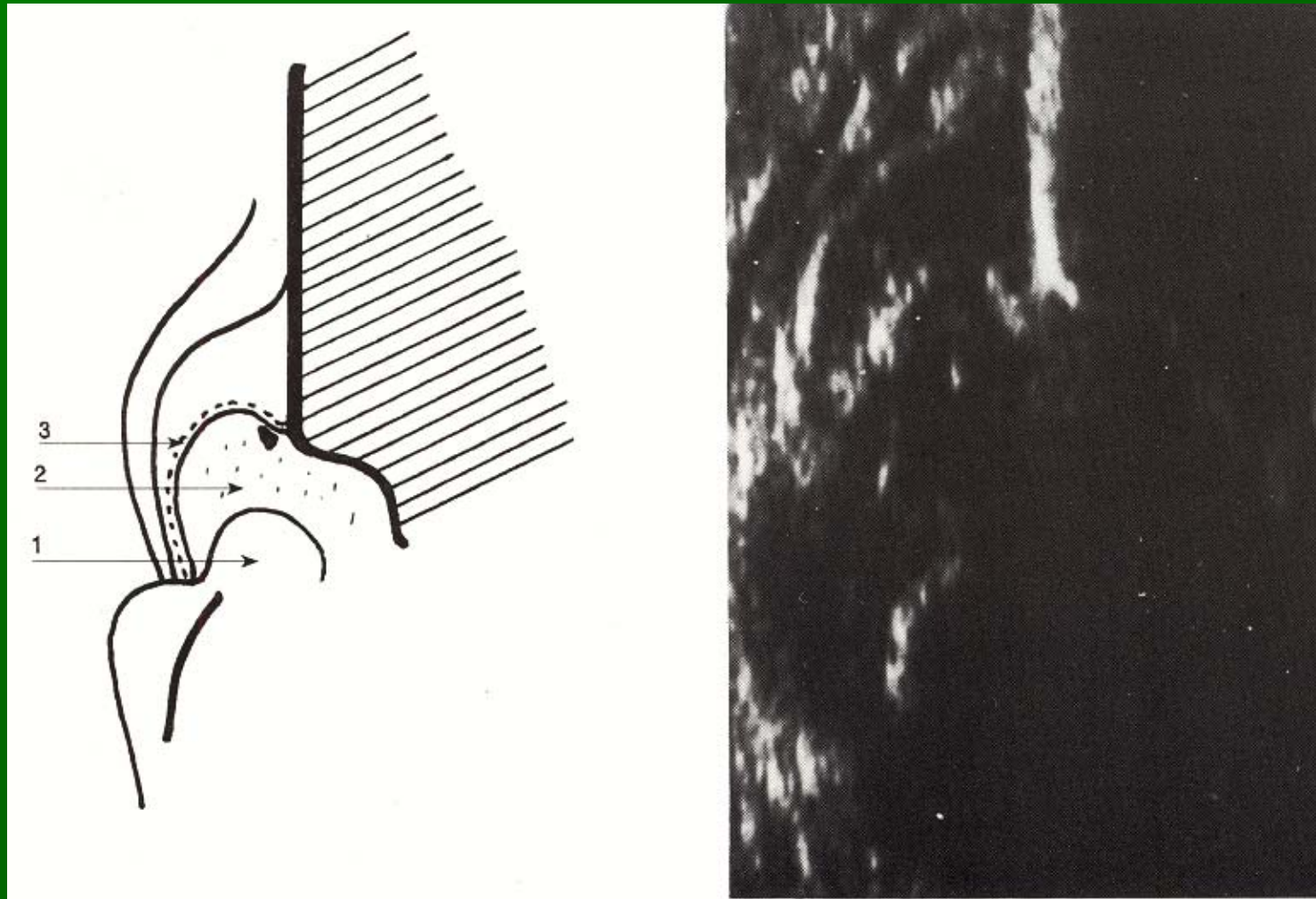
Evaluation of the hip joint in measuring of the antetorsion angle



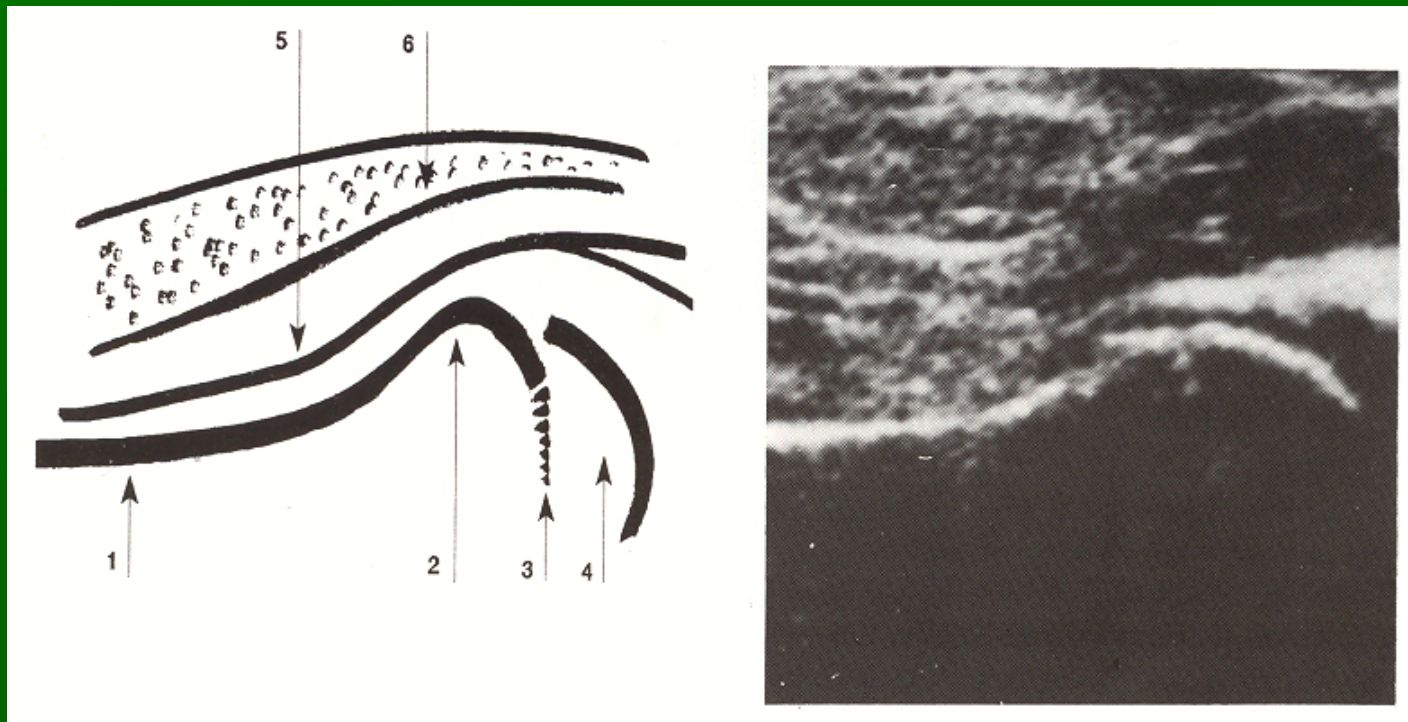
Ultrasound application in evaluation of SCFE



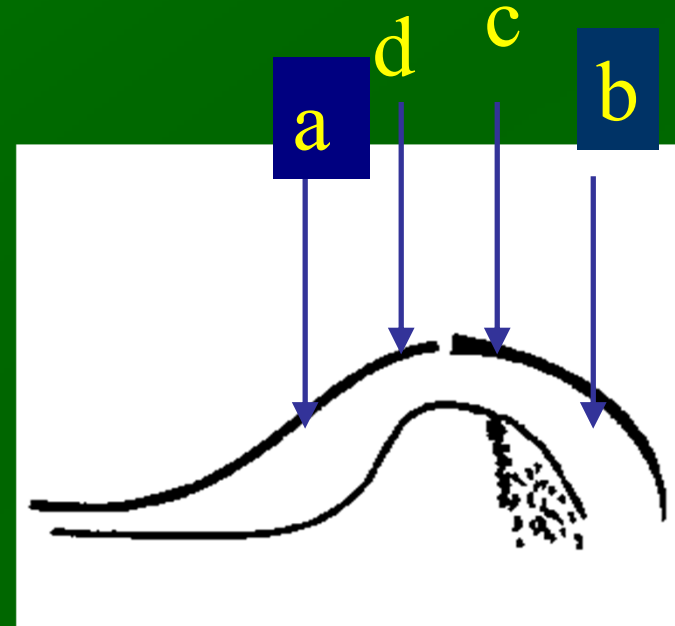
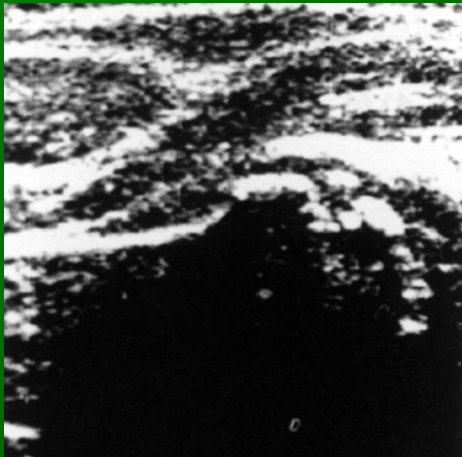
SEPTIC ARTHRITIS



ULTRASOUND APPLICATION IN EVALUATION OF *Coxitis fugax*

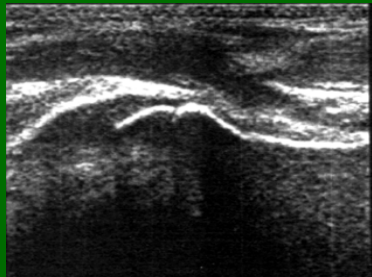


ULTRASOUND APPLICATION IN THE DIAGNOSIS OF PERTHES DISEASE

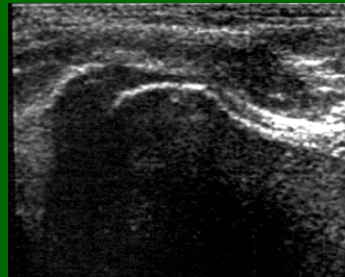


- a) Elevation of capsule
- b) Flattening of femoral head
- c) Irregularity in femoral head
- d) Methaphyseal changes

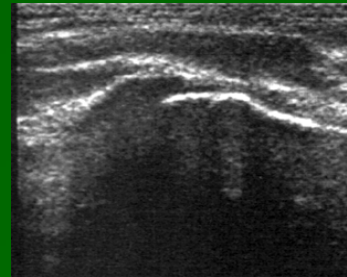
Position of the transducer



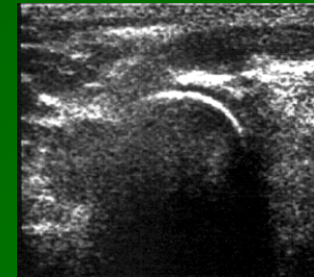
pozycja
pośrednia



rotacja
zewnętrzna



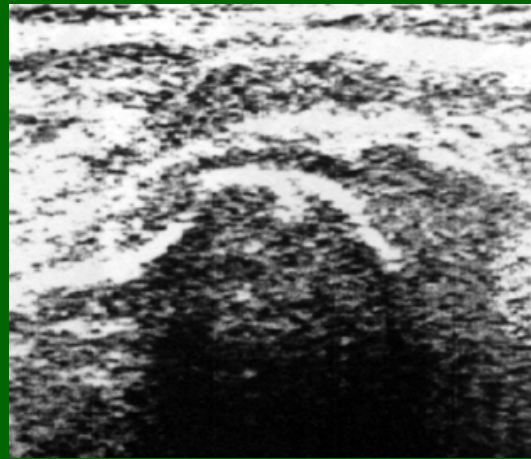
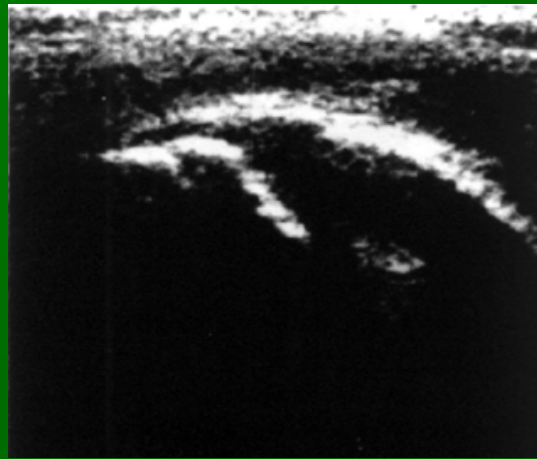
rotacja
wewnętrzna.



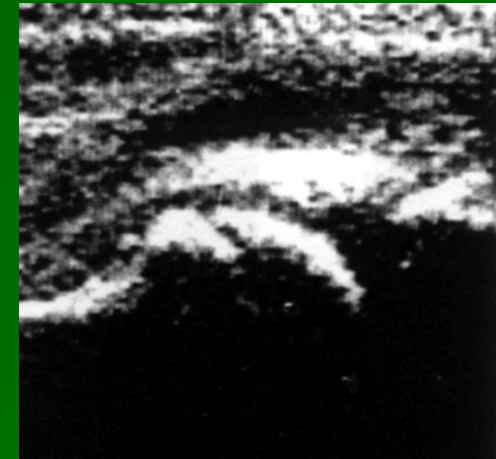
ustawienie
poprzeczne

US monitoring of Perthes disease

6-year-old boy



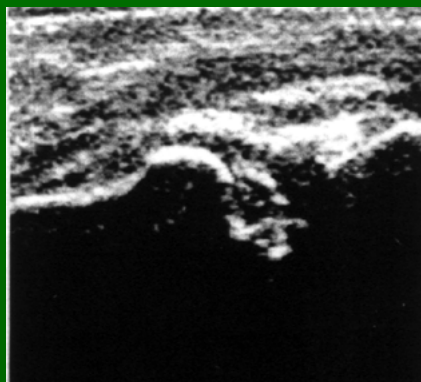
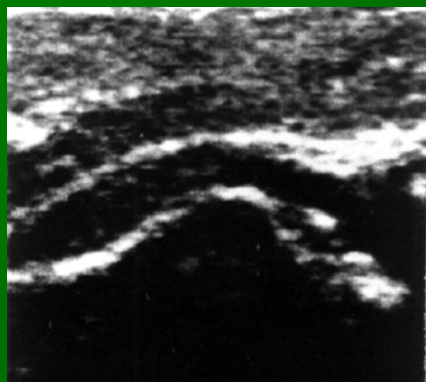
6 m.



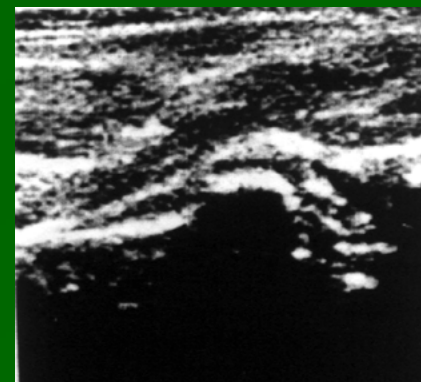
18m

US monitoring of Perthes disease

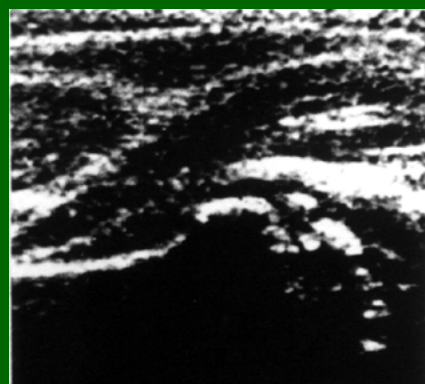
9 year-old girl



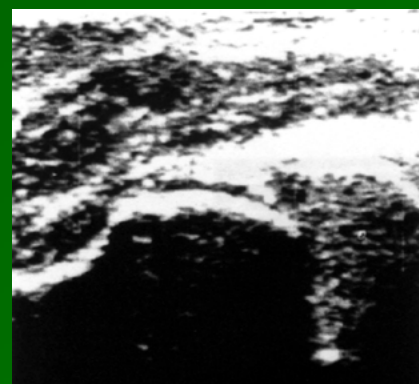
3m



9m

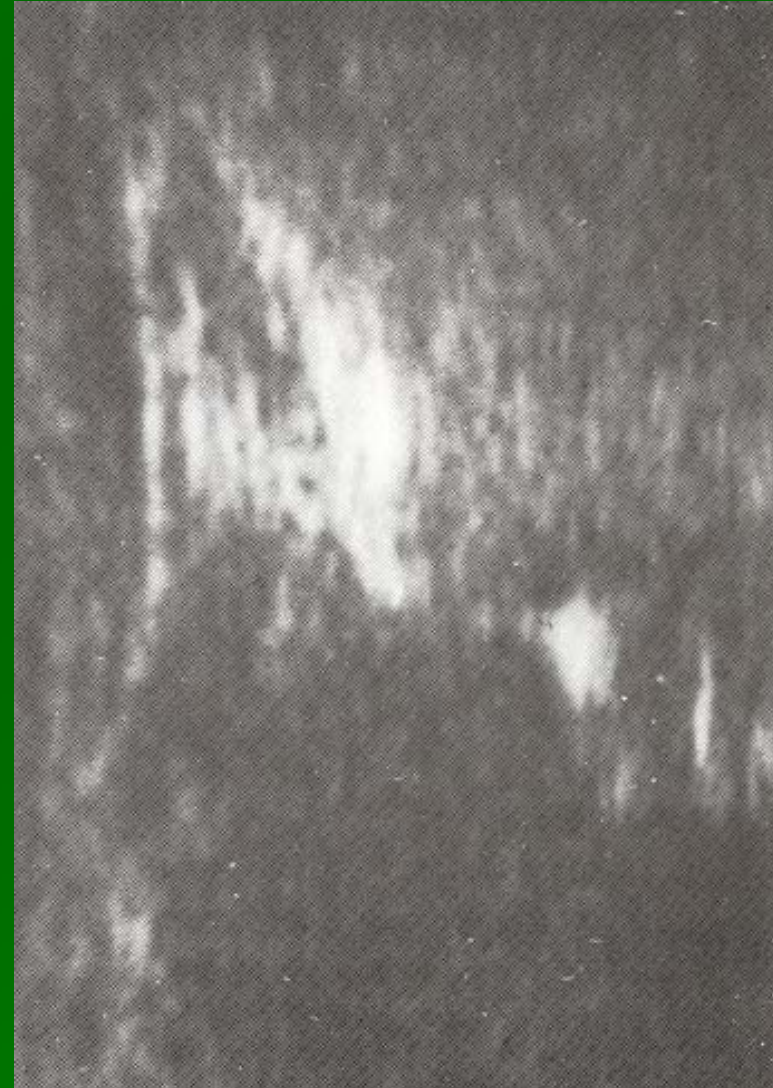
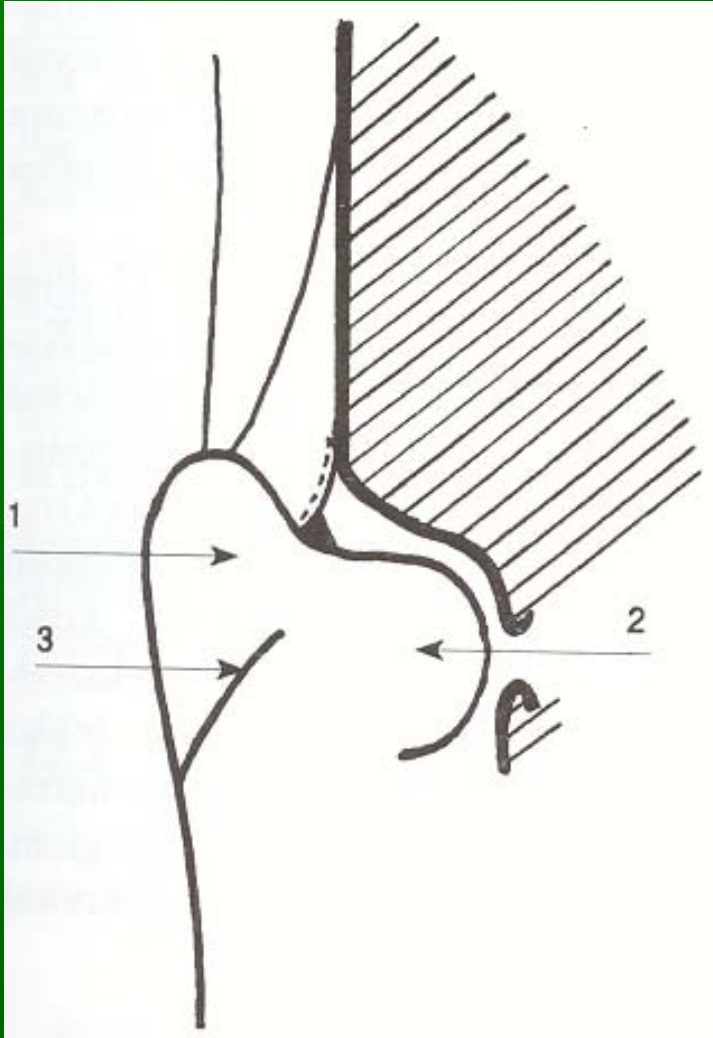


15m

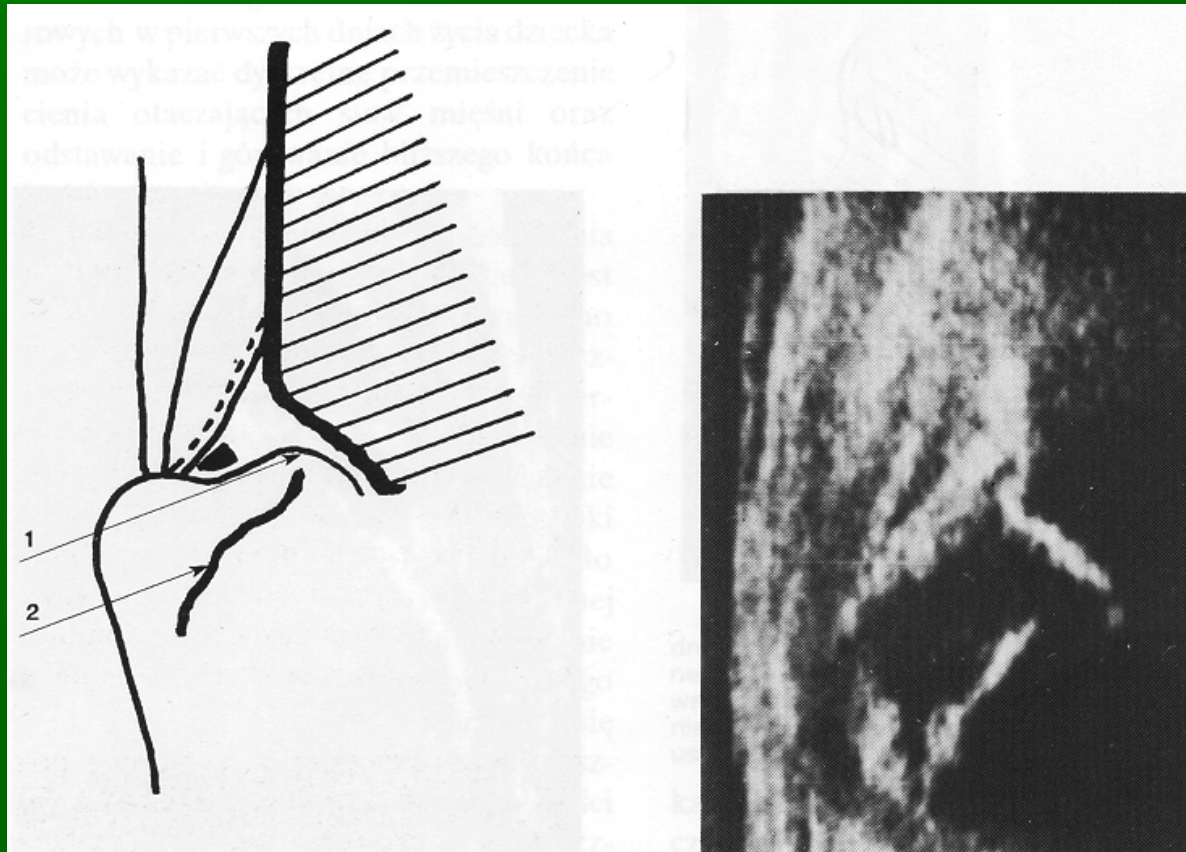


21m

COXA VARA



SEPTIC ARTHRITIS WITHOUT DISLOCATION



PATHOLOGIC DISLOCATION OF THE HIP





Thank you