

# SKELETAL SYSTEM

## Contents:

Introduction of skeletal dysplasia

Embryology

Nomenclature

Genetic cause

Scanning points

Anomalies: thanatophoric dysplasia, achondrogenesis, achondroplasia, osteogenesis imperfecta, short rib polydactyly syndrome, chondrodysplasia punctata, campomelic dysplasia, short radial ray syndrome

## Study target:

- 1.To examine the fetal skeletal disease systemically
- 2.To describe sono-findings correctly
- 3.To differentiate lethal conditions
- 4.To know how to handle skeletal disease.

## . INTRODUCTION OF SKELETAL DYSPLASIA

\*Dysostosis-malformation of bones either singly or in combinations

\*Osteochondrodystrophies-abnormalities of cartilage and bone

\*Osteolysis-disorders associated with multifocal resorption of bone

\*Skeletal abnormalities associated with chromosomal disorders

\*primary metabolic disorders

;abnormalities inf the skeletal system\_ 1 in 500 births( 1 per 4000)

\*Problem in prenatal diagnosis of skeletal abnormalities

- the majority occur in the low risk population
- the non lethal type appear normal at 20 weeks scan

\*Uncertainty of Gestation age;

- measure the foot length
- F/U interval minimum 2 weeks.

## .EMBRYOLOGY

Two ways: Membranous ossification in clavicle and mandible  
 Intracartilaginous-ossification occurs from pre-existing cartilage .

Fetal limb-develops between 4 and 8 weeks of gestation.

By 6<sup>th</sup> weeks, all skeletal structures are cartilaginous

By Sono: 8<sup>th</sup> week- limb buds are first seen

9<sup>th</sup> week- femur, humerus, body movement

10<sup>th</sup> week- tibia/fibula, ulna/radius

11<sup>th</sup> week- digits

## .NOMENCLATURE

Achiria:	absence of hands
Achiropody:	absence of hands and feet
Acromelia:	shortening of hands and feet
Adactyly:	absence of fingers and toes
Amelia(ectomelia):	absence of an extremity
Apodia:	absence of the foot
Barachydactyly:	abnormally short fingers
Camptomelia:	bent limb
Clinodactyly:	deviation of the finger
Diastrophic:	distorted
Ectrodactyly:	split hand
Equinus:	extension of the foot
Hemimelia:	absence of the distal limb below the elbow or knee
Oligodactyly:	partial loss of the fingers
Phocomelia:	deficient development of the middle segments with

normal development of the proximal and distal segments

Polydactyly

Pre-axial: extra digit on radial or tibial side

Post-axial: extra digit on ulnar or fibular side

Syndactyly: fused digits

Talipes: club foot

Valgus: bent outwards

Varus: bent inwards

## . GENETIC CAUSES

Human chondrodysplasias in which mutations are known

Achondrogenesis type 2 COL2A1 12q13.11

Hypochondrogenesis COL2A1 12q13.11

SED congenita COL2A1 12q13.11

Late onset SED COL2A1 12q13.11

Stickler`s dysplasia COL2A1 12q13.11

Thanatophoric dysplasia FGFR3 4p16.3

Achondroplasia FGFR3 4p16.3

## . SCANNING POINTS

1. Image and measure all the long bone.

Length

Width

Structure

Texture

Ossification-posterior acoustic shadowing, falx, compression of

skull

Clarity of brain image

Fracture

2. Cranial vault

3. Facial profile

4. Ribs-length, fracture

5. Spine

- 6. Hands and feet
- 7. Thorax
- 8. Movement
- 9. Associated anomaly-cardiac, renal, facial cleft

#### A. Skeletal measurements

##### Long bone

: correspond ossified diaphysis.

exclude nonossified cartilages portion of proximal and distal.

exclude epiphyseal cartilages.

\* Femur – included in routine measurement.

femur's abnormal finding - other long bone measurement.

;humerus, tibia, fibula, ulna, radius.

\* Tibia, Fibula - almost alike length

alike location of proximal and distal end

tibia; more thick.

\* Ulna – long proximal end(DDx point).

##### Decide degree and distribution of bone shortening

\* Rhizomelia:

achondroplasia(heterozygous)

\* Mesomelia:

Mesomelic dysplasia(Langer, Reinhardt, and Robinow types)

\* Micromelia:

asphyxiating thoracic dystrophy Severe

Osteogenesis imperfecta 2

Achondrogenesis

Campomelic dysplasia

Short-rib polydactyly syn.

Chondroectodermal dysplasia

Diastropic dysplasia

\* Acromelia

Ellis-van Creveld syndrome (Chondroectodermal dysplasia)  
 Identify bony deformity; bowing, fractures, thickened, angulation.

Dysplasia	Sonographic findings
Hypophosphatasia	Compressible and poorly echogenic calvar (diffuse hypomineralization)
Achondrogenesis	Poor calvarial ossification ; type I
Osteogenesis	Type IIA, III; decreased bone echogenicity
	*Bowling: Campomelic dysplasia thanatophoric dwarfism O.I Achondrogenesis Hypophosphatasia
	*Reduced echogenicity: O.I Hypophosphatasia Achondrogenesis(virtual absence of ossification of spine)

#### B. Calvarial configuration

Identify degree and distribution of ossification.

#### C. Thoracic cage size:

:TC at four chamber view level

Dysplasia associated with altered thoracic dimension

a) Long, narrow thorax

Asphyxiating thoracic dysplasia (June)

Chondroectodermal dysplasia

Campomelic dysplasia

Hypophosphatasia

Achondrogenesis

b) Short thorax

Osteogenesis imperfecta ( type II )

Kniest dysplasia

c) Hypoplastic thorax

Short-rib polydactyly syndrome

Thanatophoric dysplasia

Homozygous achondroplasia

D. Movement:

-Maternal perception of FM decreased in achondrogenesis, thanatophoric dysplasia

E. Evaluate the associated abnormalities

: polydactyly, cleft palate, congenital heart disease, renal abnormalities, hydrops

Dysplasia associated with other abnormalities

Associated abnormalities

Dysplasia

Heart

Short-rib polydactyly syndrome, II

Chondroectodermal dysplasia

Campomelic dysplasia

Kidney disease

Short-rib polydactyly syndrome, I, II

Asphyxiating thoracic dysplasia

Chondroectodermal dysplasia

Hydrocephalus

Thanatophoric dysplasia

Associated abnormalities	Dysplasia
Polydactyly	Short-rib polydactyly syndrome, I, II (100%)
Postaxial	Asphyxiating thoracic dysplasia (-15%) Chondroectodermal dysplasia
Preaxial	Short-rib polydactyly syndrome, II Chondroectodermal dysplasia

	Achondroplasia
	Achondrogenesis
	Osteogenesis imperfecta II
	Campomelic dysplasia
Cleft palate	Campomelic dysplasia
	Asphyxiating thoracic dysplasia
	Short-rib polydactyly syndrome, II
	Kniest dysplasia
	Diastrophic dysplasia
	Spondyloepiphyseal dysplasia congenita
Congenital cataracts	Chondrodysplasia punctata

\* Investigate the family and previous obstetrical history

## . INDIVIDUAL SKELETAL DYSTPLASIA

= lethal dysplasia

Big four: Thanatophoric dysplasia (0.24-0.6 in 10,000)

Achondrogenesis (0.09-0.28 in 10,000)

Achondroplasia (0.37-0.64 in 10,000)

Osteogenesis imperfecta 2 (0.18-0.64 in 10,000)

### A. Thanatophoric dysplasia

- Incidence ; most common lethal skeletal dysplasia

- 2 types ; Sporadic , type 1, 85%

- without cloverleaf skull, telephone receiver femur)

Autosomal recessive, type 2, 15%

- with cloverleaf skull, straight long bones  
agenesis of corpus callosum (25%)

- Prenatal Dx. earliest wks ; 16wks

# Sonographic findings

1. Severe rhizomelic micromelia
2. Cloverleaf skull in AR type
3. Bowed long bones in sporadic type
4. Flattened vertebral bodies(platyspondyly)
5. Forehead prominent, saddle nose, ventriculomegaly frequently

present

6. Polyhydroamniosis(70%)
7. Narrow thorax
8. No hypomineralization of bone

DDx: Homogenous achondroplasia

B. Achondrogenesis (anosteogenesis)

- AR type
- Extreme micromelia, short trunk, macrocrania
- Associated with hydrocephalis, cystic hygroma, cleft lip and palate,

CHD,

renal disease

- 2 type;

Type I (Parenti-Fraccaro)

severe form, almost complete lack of ossification of the calvarium, spine, and pelvis

multiple rib fractures

Type II (Langer-Saldino)-80%

normal Calvarial ossification

no rib fracture.

# Sonographic findings

1. severe micromelia
2. retarded or absent ossification(two vertebral ossification centers)
3. narrow thorax
4. large head, normal calvarial ossification in type 2

5. hydrops fetalis, polyhydramnios

C. Achondroplasia

- 2 types

Homozygous achondroplasia ; rare, both parents are achondroplastic, early manifestate, lethal

Heterozygous type ; nonlethal, 1/30,000, 80% spontaneous mutation (20% AD)

D. Osteogenesis imperfecta

classification and sonographic features of osteogenesis imperfecta

Type	Inheritance	B.shortening	Fracture	Echogenecity	Outcome
I	AD	No	Isolate in 5%	Normal	Good
IIA	Sporadic>>AD	Severe	Innumerable	Decreased	Fetal
IIB	AR	Moderate femur only	Numerous	Normal	Fetal
IIC	AR	Moderate of all extrem	Nemerous	Normal	Fetal
III	AR	Moderate femur only	Nemerous	Decreased	Fetal
IV	AD	No	Occasional, isolated	Normal	Good

-OI; recurrence rate 6%  
thickened bones

E. Short-rib polydactyly syndrome

- Incidence ; rare

- AR, Three or four types

Type I (Saldino-Noonan); narrow metaphysis

Type II (Majewski); cleft lip/palate, disproportionately shortened tibia

Type III (Verma-Naumoff); wide metaphysis with spurs

Type IV (Beemer-Langer); midline cleft, extreme short ribs, umb. hernia, ambiguous genitalia

# Sonographic findings

1. Micromelia with metaphyseal spicules and spurs
2. Short rib with narrow thorax(horizontal hypoplastic rib)
3. Polydactyly; postaxial in type I, pre-and post in type II
4. Frequent cardiovascular or GU anomalies

F. Chondrodysplasia punctata

- Incidence ; 1/110,000
- AR
- Postnatal radiograph ; typical bone stippling

# Sonographic findings

1. Rhizomelic type(especially humerus)
2. Premature calcification of the proximal femoral epiphysis

G. Campomelic dysplasia(=bent bone)

- Incidence ; 1/150,000
- AR(most commonly sporadic)
- shortening and bowing of long bone of legs
- overall normal length
- die in neonatal period from pulmonary hypoplasia

H. Short radial ray:

- 18 trisomy
- Holt-Oram synddrome(A.D)
- Fanconi` Anemia(AR)
- VATER syndromee
- Robert syndrome

### I. Syndactyly

- familial
- Apert syndrome
- Triploidy
- Holt-Oram syndrome
- Smith Lemli Opitz syndrome(2,3 toes)
- Carpenter syndrome

### J. Hypophosphatasia

- Lethal, 1 in 100,000
- Severe shortening of long bone
- Small thorax
- Hypomineralization of skull, long bones
- Absence of liver and bone isoenzyme of alkaline phosphatase

### K. Achondroplasia

- 1 in 26,000
- mutation in the fibroblast growth factor receptor type 3 gene  
(Amniocentesis)
- heterogenous: short limb
  - lumbar lordosis
  - macrocephaly with frontal bossing
  - intelligence and life expectancy- normal
- homozygous: lethal, narrow thorax
  - resemble thanatophoric dwarfism
  - at least one parent affected.

### Differential diagnosis in lethal skeletal disease

Thanatophoric dwarfism-clover leaf or telephone receiver

No hypomineralization

Achondrogenesis-retarded ossification center(two VB)

Normal calvarium(80%)

0.1 – compressible skull

Thick long bone  
Achondroplasia(homogenous)-at least one parent