Chapter 22

Generalized Disease Conditions of Bone

Soft Tissue and Osseous Overgrowth
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Soft Tissue and Osseous Overgrowth

1. Acromegaly: An acquired condition resulting in excess of growth hormone due to a pituitary eosinophilic adenoma. Radiographically, it is characterized by overgrowth of bone, cartilage, and soft tissue. Classically, it has enlarged ungual tufts of bone termed “spade-like” distal phalanges. With adult onset, the hands and feet demonstrate the most pronounced skeletal changes. There is usually a significant increase in heel pad thickness.

2. Hypertrophic Osteoarthropathy: A hereditary condition transmitted as an autosomal dominant inheritance. The primary form called Pachydermoperiostosis manifests itself in adolescence as overgrowth of the soft tissues, periostitis, and synovitis. Clinically, this is characterized by thickening of the skin, clubbing of the terminal digits, and painful swollen joints. It does resemble acromegaly except the ungual tufts tend to be reabsorbed rather than enlarged. The scalp demonstrates cutis verticis gyrata (longitudinal wrinkles). The secondary form called Pulmonary Hypertrophic Osteoarthropathy is associated with cardiopulmonary disease and malignancies.

3. Neurofibromatosis-1 (von Recklinghausen’s Disease): An autosomal dominant multisystem disease. Neurofibromas of the skin, bones, and soft tissues. Abnormalities can result in grotesque deformities (elephant man). Neurofibromas occur on the peripheral and cranial nerves and have the high potential for sarcomatous degeneration. “Cafe-au-lait” spots are often present on the skin. Half of these patients develop skeletal abnormalities, which include kyphoscoliosis, scalloping of the vertebral bodies, rib notching, and a characteristic defect of the orbit of the eye due to tumors of the optic nerve. The peripheral skeleton can develop overgrowth of the soft tissues and bones.

4. Macrodactyly: A localized enlargement of the soft tissues of a digit, which can be idiopathic or non-idiopathic. Can be static (once skeletal maturity is reached, the digit stops growing) or progressive (continues to grow after skeletal maturity).

5. Thyroid Acropachy: Rare disease seen in autoimmune thyroid disorders, particularly Grave’s disease. There is clubbing of the digits and sub-periosteal bone proliferation.

Connective Tissue Disorders

1. Ehlers-Danlos Syndrome: A group of inherited connective tissue disorders resulting in hyperelasticity of the skin and fragility of blood vessels. Ligamentous and capsular laxity as well as muscular weakness lead to subluxation and dislocation. In the feet pes planus is very common. Atrophic scarring commonly occurs. Clinical findings include: soft velvet-like skin, bruise easily, frequent dislocations, near-sighted, hypermobility of joints, curvature of spine. There are 9 clinical subtypes. Symptoms vary depending on the type. Types I, II, and III are the most common and are autosomal dominant types.

2. Marfan’s Syndrome: An inherited autosomal dominant connective tissue disorder resulting in abnormal elastic tissue and collagen production and excessive laxity. The deformity is located on Chromosome 15 of fibrillin. Hyperextensible joints and ligamentous laxity result in hallux valgus and pes planus, and kyphoscoliosis. The most serious complication of Marfan’s syndrome is a dissecting aneurysm of the aorta. Clinical findings include: mitral valve prolapse, scoliosis, tall stature, disproportionately long extremities, lens dislocation, hypermobility of joints, and chest wall abnormalities (pectus carinatum or excavatum). The radiographic hallmark of Marfan’s is exaggerated length of the bones. The lens of the eye is also displaced, usually upward.

General Appearance of Increased Bone Density

1. Osteopetrosis (Albers-Schonberg Disease): An inherited bone disease causing diffusely dense bones. The basic defect is a failure of osteoclasts to absorb primary spongiosa during enchondral bone formation. This leads to a “bone-within-a-bone” or “marble bone” appearance. However, the bone is actually structurally very weak.

2. Melorheostosis: An acquired condition causing abnormal cortical thickening. The etiology is still unknown. The cortical thickening is smooth and involves the periosteal surface or the endosteal surface, encroaching on the medullary canal. On X-ray, the cortical thickening is termed “melted candle wax.” There is a correlation between this disorder and scleroderma.
Osteopoikilosis: A hereditary “spotted” bone disorder transmitted as an autosomal dominant inheritance. There are multiple round or oval bone densities occurring in the spongiosa of bone. There is a predilection for the tarsus in the foot. There is no uptake with this on a bone scan (differential for blastic metastases). This disorder is completely asymptomatic.

Bone Islands/enostosis: Are histologically identical to osteopoikilosis but occur as single lesions.

Paget’s Disease of Bone: The destruction of bone with subsequent repair results in thickened, disorganized trabeculae and increased size of bone, giving the appearance of increased density. Usually the tibia is affected, but can involve the bones of the feet. The coarse trabeculae often have a different appearance from blastic metastases and melorheostosis. The skull is affected as well, and there can be loss of hearing and dental abnormalities. Malignant degeneration is a rare complication (malignant fibrous histiocytoma, osteosarcoma, chondrosarcoma, fibrosarcoma—all called “Paget’s sarcoma” if they occur in a setting of Paget’s Disease of Bone).

Osteopenic Conditions

1. Rickets and Osteomalacia: Due to deficient mineralization of bone specifically due to insufficient vitamin D from malabsorption, renal disease, lack of adequate sunlight, liver disease, and metabolic disorders. In the child this can cause widening of the growth plate, cupping of the epiphysis, and bowing of the legs. The pathognomonic sign of osteomalacia is the presence of Looser’s lines or pseudofractures. These lucent lines are perpendicular to the cortex, are often bilateral and symmetrical.

2. Osteoporosis (decreased bone mass): Loss of trabeculation and thinning of the cortex

3. Scurvy: Lack of vitamin C results in failure to produce intracellular substances, therefore, osteoporosis of the adjacent metaphysis, seen as transverse radiolucent bands. This is called the scurvy line. Fractures can occur through this zone with complete separation of the epiphyseal plate. The vascular endothelium is abnormal, which leads to hemorrhage. Subperiosteal bleeding causes wide separation of the periosteum, and healing manifests as a thin shell of peripheral periosteal new bone. Wimberger’s sign is noted around a growth center in a child with scurvy. It takes a minimum of 4 months of lack of vitamin C for the disease to become apparent. This is very rare today in developed countries.

Osteogenesis Imperfecta (Ekman-Lobstein disease): A generalized connective tissue disorder that is inherited as an autosomal dominant gene. A deficiency of osteoblasts and collagen formation resulting in severe generalized osteoporosis, the long bones are osteopenic, and protrusio acetabuli are frequently seen. Additionally there is abnormal dentition, blue sclerae and early deafness. These patients are very prone to pathological fractures.

Disuse Atrophy: Diffuse, severe osteoporosis accompanies disuse or prolonged immobilization, with changes resulting in thinning of the cortex and loss of trabeculation, giving the bone a spotty appearance.

Reflex Sympathetic Dystrophy Syndrome (Sudek’s Atrophy): It is now known as Complex Regional Pain Syndrome (CRPS). Generally follows trauma (usually minor); however surgery is another common etiology. It is associated with severe pain (pain out of proportion to the injury sustained), soft tissue swelling, and rapid demineralization. Rapid loss of mineral results in a patchy pattern of demineralization.

Renal Osteodystrophy: Seen in patients with End Stage Renal Disease (ESRD) termed “Renal Rickets”; increased levels of hyperparathyroid hormone released in the blood stimulate increased osteoclastic activity. This leads to bone resorption or Brown’s tumors in the digits and “Rugger-Jersey” osteosclerosis in the spine.

Marrow Abnormalities

NOTE* The basic radiological changes inherent to all the marrow affecting disorders includes expansion of the marrow cavity, thinning of the trabeculae, and the appearance of rectangular osteopenic bone.
1. **Anemias:**
   A. Thalassemia major: Arise from defects in either the alpha or beta chains of hemoglobin, which causes microcytic/hypochromic anemia. Generalized involvement of all the bones of the feet occurs. There is a striking "criss-cross" or "honeycomb" trabecular pattern. Beta thalassemia major is also called Cooley’s anemia.
   B. Sickle cell disease: Produces changes similar to thalassemia. Those changes can sometimes be mistaken for osteomyelitis. Can cause infarctions (avascular necrosis) in bone due to vascular blockage by abnormal RBCs, termed a vaso-occlusive crisis (VOC).

2. **Storage Diseases:**
   A. Glycogen storage diseases (Von Gierke’s disease)
   B. Cerebrosides (Gaucher’s disease and Niemann-Pick disease)
   C. Mucopolysaccharides (Hurler’s, Hunter’s, Sanfilippo’s, Morquio’s, Scheie’s, and Maroteaux-Lamy syndromes)

3. **Fibro-Osseous Dysplasia:**
   A. Fibrous dysplasia: A developmental anomaly that results in fibrous tissue replacement of the marrow cavity

4. **Granulomatous Diseases:**
   A. Sarcoidosis: A systemic granulomatous disease of unknown etiology that can affect the bones in a small percentage of cases, and when involved, almost always is seen in the phalanges causing small punched-out defects. Severe involvement may result in cortical destruction, fractures, and collapse of bone, giving an arthritis mutilans scenario
   B. Tuberculosis (TB): Granulomatous disease due to hematogenous spread of the TB bacillus. Acid fast stains show TB bacilli, which are not seen in Sarcoid

5. **Infarction:** Any type of vascular obstruction may result in marrow infarction. The radiographic changes are frequently those of bone destruction
   A. Pancreatic disease

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**The Dysplasias**

*NOTE* Dysplasia is a disturbance in the formation and modeling of bone; it is usually hereditary and most commonly occurs as a result of inborn errors in metabolism. Foot dysplasias are an expression of a generalized skeletal anomaly.

1. **Spondyloepiphyseal Dysplasia**—delays in bone ossification lead to a form of dwarfism
2. **Multiple Epiphyseal Dysplasia** (Fairbank’s disease)—mild form of dwarfism
3. **Chondrodysplasia punctata** (Conradi’s disease)—“stippled” appearance of growth centers at birth
4. **Occurrence of Cone Shaped Epiphyses**
   A. Normal variant
   B. Chondroectodermal dysplasia (Ellis-van Creveld syndrome)—shorten stature and malformation of heart and teeth
   C. Cleidocranial dysostosis—(CCD) hereditary abnormal formation of clavicles and delayed bone fusion
   D. Dyschondrosteosis (Leri-Weill)—rare form of dwarfism
   E. Hand-foot-uterus syndrome—rare genetic disease where there is significant shortening of the thumbs
   F. Oto-palato-digital syndrome (OPD) or Taybi’s syndrome—abnormal formation of facial structure and bones
   G. Osteopetrosis
   H. Pycnodysostosis—shortened stature very prone to fractures of the limbs and jaw
   I. Tricorhinophalangeal syndrome—genetic, craniofacial abnormalities with bulbous nose and sparse amounts of hair
5. **Occurrence of Tarsal Coalition**
   A. Isolated variant (usually in the hindfoot)
   B. Juvenile rheumatoid arthritis (Still’s disease)
   C. Apert’s syndrome (acrocephalosyndactyly)—premature closure of cranial structures and fusions of fingers and toes
   D. Arthrogryphosis multiplex congenita (AMC)—congenital joint contractures, associated with clubfoot deformity. Can lead to blindness
   E. Hand-foot-uterus syndrome
   F. Oto-palato-digital syndrome (Taybi’s syndrome)
6. **Occurrence of Polydactyly**
   A. Arthrogryphosis
   B. Basal cell nevus syndrome—leads to basal carcinoma around puberty. Wide set eyes and broad noses with protruding forehead are common features
   C. Cleidocranial dyostosis
   D. Ellis-van Creveld syndrome
   E. Gorlin-Chaudhry-Moss syndrome (GCM)—rare premature joint closure, small eyes, and lack of teeth are features of this dysplasia
   F. Larsen’s syndrome—congenital dislocation of multiple joints
   G. Myositis ossificans progressiva
   H. Trisomy 13–15 (Perth’s syndrome)

7. **Occurrence of Syndactyly**
   A. Normal Variant
   B. Apert’s
   C. Down’s syndrome
   D. Taybi’s syndrome
   E. Prader-Willi syndrome
   F. Popliteal pterygium syndrome

8. **Occurrence of Short Metatarsals**
   A. Myositis ossificans progressiva
   B. Taybi’s syndrome
   C. Hand-foot-uterus syndrome
   D. Apert’s syndrome
   E. Larsen’s syndrome
   F. Popliteal pterygium syndrome
   G. Fanconi’s syndrome
   H. Normal variant
   I. Enchondromatosis
   J. Juvenile RA
   K. Osteochondromatosis
   L. Pseudohypoparathyroidism
   M. Pseudopseudohypoparathyroidism
   N. Trauma
   O. Turner’s syndrome—one of the more common chromosomal syndromes resulting in a sex chromosome abnormality that causes a XO pattern. Important clinical findings are coarctation of the aorta, horseshoe-shaped kidneys, short neck, and hypogonadism. Radiographically, a short 4th metatarsal is commonly found