Heterotopic Bone Formation

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Heterotopic Bone Formation (HBF)

- Abnormal formation of true bone within soft tissue
- Highly active tissue with high bone turnover & rapid bone formation
- Nomenclature
  - Paraosteoarthropathy
  - Mysositis ossificans
  - Periarticular new bone formation
  - Periarticular ectopic ossification
  - Neurogenic osteoma
  - Neurogenic ossifying fibromyopathy
  - Heterotopic calcification
  - Heterotopic ossification
Dystrophic

Metastatic

Heterotopic

Introduction
Osseous metaplasia
Inappropriate differentiation of stem mesenchymal cells in connective tissue ➔ osteogenic cell line

- Increased expression of
  - Bone morphogenetic protein-2 (BMP-2,4)
  - Transforming growth factors beta-2 and beta-3.
  - PGE₂

- Under-expression of
  Antagonists of BMP-2 (Leptin)

Toom et al: *Calcified Tissue International*; 80:259, 2007
Forms

- **Acquired form** (most common)
  - Relatively benign in 80% or more of cases
  - Remaining patients often develop
    - Significant loss of motion
    - Ankylosis in up to 10%

- **Hereditary form**
  - Myositis Ossificans Progressiva (rare)
    - Progression to severely impaired joint mobility
    - Death usually in 20’s
  - Progressive Osseous Heteroplasia (very rare)
    - Progressive and potentially debilitating disorder
Acquired Heterotopic Bone Formation

- Trauma
  - Fractures
  - Post orthopedic procedures
  - Post joint dislocation
  - Direct muscle trauma

- Other conditions
  - CNS injuries
  - Burns
  - Sickle cell disease
  - Hemophilia
  - Tetanus
  - Poliomyelitis
  - Multiple sclerosis
  - Toxic epidermal necrolysis
  - Cancer
  - Osteoarthritis

- Idiopathic
  No precipitating event or condition
Heterotopic Bone Formation

Most common around the joints or long bones

- **Para-articular**
  - Always extra-articular
  - Can be attached to capsule with or without disruption

- **Parosteal**
  - May attach to adjacent bone with or without disruption

Heterotopic Bone Formation

• Typically asymptomatic in acquired form
• Most commonly: incidental imaging finding
• When symptomatic: depends on phase
  
  ➢ Acute (immature)
    
    Pain, fever, local swelling, erythema, warmth, limited motion & stiffness

  ➢ Chronic & stable phase (mature)
    
    Pain & limited range of motion
Morphologic modalities

- Standard Radiograph
- CT
- MRI

Functional Modalities

- Multiphase bone scan
  - (Most sensitive)
  - To confirm the diagnosis of HBF
  - To differentiate HBF & other diagnostic possibilities
  - To evaluate the maturity of ossification
Multiphase Bone Scan

- Most sensitive modality for early detection of HBF

<table>
<thead>
<tr>
<th>Positive findings</th>
<th>Duration after injury</th>
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<tbody>
<tr>
<td>Blood flow and pool</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Delayed uptake</td>
<td>3 weeks</td>
</tr>
<tr>
<td>X ray</td>
<td>4-8 weeks</td>
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- In immature phase: ▲ Flow & BP
35 y/o male exposed to multiple trauma over a period of 3 weeks

Scintigraphic appearance mimics:

- Osteomyelitis
- Cellulitis
- Thrombophlebitis
- Deep vein thrombosis
- Tumor: Osteosarcoma
- Osteochondroma

Elgazzar 6/08
Tumoral Calcinosis

HBF with large amounts of bone resembling tumor

28 Y/O male with quadriplegia
49 y/o quadreplegic woman with fever & left hip pain for 4 weeks

• Ga-67 & rarely In-111WBC accumulate in immature HBF (infection!)

Shehab D, Elgazzar A, Collier D: JNM; 43: 346, 2002
Ga-67 uptake: explained by sharing properties of bone-imaging agents

Ga-67 uptake is proportional to Tc99m MDP uptake in osteomyelitis

Consider HBF in appropriate clinical setting with positive Ga-67 scan

32 y/o m.
Fever, swelling & tenderness of L. knee
Follow Up

- **Progressive reduction** in activity of all 3 phases
- **In mature phase**
  Flow & blood pool activity normalize or stabilize
- **Reversible:** Can be absorbed & disappear

Tc99m MDP

6 mo

18 mo

Hereditary Heterotopic Bone Formation

Myositis Ossificans Progressiva

- Autosomal dominant
- Associated with
  - Skeletal abnormalities: malformation of the great toe & shortening of digits
  - Other clinical features: deafness and baldness
- Symptoms develop prior to 4 years of age but diagnosis is frequently missed
- Soft tissue ossification may be mistaken for bruising or sarcoma

Kaplan, Pediatrics, 2008
**Radiologic Features**

- Soft tissue calcification of
  - Subcutaneous & fascial CT
  - Tendons
  - Ligaments
  - Skeletal muscles
- Exostoses
- Joint malformations
- Abnormal vertebral bodies
- Changes of the hands & feet

22 Y/O F with episodes of bone & muscle pains & deformities since early childhood

**Myositis Ossificans Progressiva**

**Bone Scintigraphy**

- Useful in diagnosis & follow up
- Soft tissue calcification around
  - Joints
  - Mandible
  - Maxilla
  - Ribs
  - Parasternal
  - Paraspinal regions

Management

Prophylaxis

- NSAIDs: reduce incidence by 1/2 to 2/3
- Rad. therapy: 7 Gy single fraction < 4 h pre- or < 72 h post-op
- Combined therapy: for patients at highest risk for HBF
  Associated with the lowest rate of HBF

Treatment of Symptomatic HBF

- Conservative: Intensive physiotherapy during maturation to limit the final stiffness
- Operative: Postpone until maturation (typically 12-24 W)

HBF is a common condition

Bone scanning is a sensitive and effective method of diagnosis. Awareness of:

- Phases of HBF and their appearance
- Conditions that can be confused scintigraphically with immature HBF

Bone scan is useful in follow up and guiding management
Thank You