**Secrets of the Experts: 5 Things I Learned the Hard Way**

**SPR US Categorical Course**

**May 2017**

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**Objectives**

- Describe 5 of my most difficult challenges in US
- Describe my approach & resolution

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**#1 Challenge:**
**Establishing US at CHOP**

- US for CHOP pts began at HUP
- Priority issues
- Invasive procedures (IVP, angiography, NM)
- Exploratory laparotomies
- Image quality of early US challenging

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**#1 Challenge:**
**Establishing US at CHOP**

image quality issues 1976

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**Ultrasound in the Diagnosis of Idiopathic Hypertrophic Pyloric Stenosis**
Rita Littlewood Teixe, M.D., and Edward H. Smith, M.D.
#1 Challenge: Establishing US at CHOP
image quality issues 1978

- Self education in preparation for establishing US
  - US courses
    - Ken Taylor, MD, Yale
    - Barry B. Goldberg, MD (Episcopal, Jefferson)
    - Observation at Jefferson
    - Literature searches, textbooks

#1 Challenge: Establishing US at CHOP
image quality issues 1981

- Referring physician education to help gain acceptance & support for establishing US
  - educating referring physicians re efficacy of US for a wide gamut of pediatric problems
  - hypothesizing myriad of possible applications
  - no ionizing radiation, no punctures, no contrast, no sedation, no anesthesia

- Prepared proposal which included:
  - space requirements
  - sonographer
  - equipment requirements
    - 1 Siemen’s articulated arm scanner
    - 1 ATL real-time US unit (limited probe technology)
  - stretcher
  - supplies (mineral oil)
#1 Challenge: Establishing US at CHOP resolution & the beginning
- Worked with my chairman Spencer Borden, IV, MD
- Administration agreed at X-mas 1980 to review my proposal for establishment of US at CHOP
- Proposal approved shortly thereafter
- Project launched
- US opened April 21, 1981
- Lifelong challenge finding newer & newer applications of US

#2 Challenge: US assessment of Superficial Lumps & Bumps
- Understand when sonography may be used to evaluate superficial masses in order to
  - reduce radiation exposure
  - risk of iodinated contrast
  - need for preparation/sedation/anesthesia
  - reduce cost
- Determine when higher tech imaging is necessary!

Superficial Lumps and Bumps
- Most superficial masses in children are benign!
- Most common benign masses:
  - lymph node
  - post-traumatic (hematoma)
  - infectious/inflammatory (abscess)
  - congenital vascular tumor (hemangioma)
  - cyst
  - lipoma
  - neurolithoma

Superficial Lumps and Bumps approach to challenge
- Open communication with referring physicians
- Explained advantages and limitations of US for evaluation of superficial masses
- Presented Pediatric Grand Rounds at Mount Sinai 2012 and at several other tri-state venues
- Referral volume escalated
- Obtain pertinent correlative and follow-up info
- Close vigilance on small # remaining diagnostic dilemmas
- Know & accept limitations!!!

?“Touch” or “Don’t Touch” lesion?
- Determine next best step:
  - watchful waiting
  - follow-up US
  - plain film radiography
  - higher tech imaging (NM/CT/MRI)
  - biopsy
  - surgical resection

Superficial lumps and bumps may arise in skin, fat, muscle!...and/or in the underlying bone
To maximize diagnostic accuracy & limit differential diagnosis, imager should have thorough knowledge of:

- clinical history
- physical findings
- laboratory findings
- other imaging findings

Differential Diagnosis

derived from

✓ Clinical history
  - congenital or acquired
  - presence of absence of fever
  - painful or painless
  - stable, growing, shrinking

Physical Examination

essential prior to scanning

✓ Location
✓ Consistency
  - firm, hard (solid)
  - compressible (cystic)
✓ Fixed, easily movable
✓ Surface - smooth, irregular
✓ Tender?, red?, hot?

Help referring providers understand why Duplex/color Doppler US is modality of choice for evaluation of superficial lumps and bumps!!!

✓ Rapid acquisition information
✓ Confirm presence & location mass
✓ Size & shape
✓ Borders (well defined, blends with surrounding tissue, spiculated)
✓ Internal consistency (cystic, solid, mixed, calcifications, acoustic enhancement, shadowing, twinkling)
✓ Vascularity
✓ Vascular encasement/displacement
✓ US guided biopsy/interventional procedure

# 2 Challenge:
US assessment of Superficial Lumps & Bumps

…some examples

2 mo M with bluish mass upper lt chest

pilomatricoma

✓ Hard (often contain calcium), uncommon, harmless, hair follicle tumor derived from hair matrix cells
✓ Single skin-colored or purplish lesions mainly head and neck
✓ Dx: darkly stained ‘basophilic’ cells and ‘shadow’ cells with missing nuclei
15 yo F with rapidly growing hard rt buttocks mass

**myxoid liposarcoma**

- Large well-defined heterogeneous hypoechoic non-compressible hard mass in region of clinical interest

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10 yr M with pain & STS sole of foot after stepping on something that hurt

**Foreign Body**

- Splinter

- Sagittal projection confirmed presence of 2.39 cm long splinter surrounded by hypoechoic edematous tissue

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**Help referring providers become comfortable w your recommendation to use US for evaluation of superficial lumps & bumps:**

- US is sufficient if:
  - entire lesion is in FOV
  - boundaries of lesion clearly defined
- CT/MRI/NM, biopsy, surgical excision may be required:
  - in equivocal cases
  - if FOV is insufficient for complete visualization of an obvious lesion
  - if lesion too dense to adequately penetrate, or if there is high suspicion of malignancy

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**#3 Challenge:**

Sonographic Evaluation of Pediatric Skeletal Lesions: is it worthwhile?

Rosenberg HK, Patel A, Lester N. Sonographic Evaluation of Pediatric Skeletal Lesions: is it worthwhile?

Approach

✔ Retrospectively reviewed clinical & imaging findings in 44 patients seen during a 2 year time frame in whom
✔ US demonstrated abnormalities related to skeletal system, excluding patients with hip effusion or DDH

US is useful for evaluation of a wide gamut of skeletal lesions!!!

✔ Provides information regarding
  - size of lesion
  - shape
  - borders
  - location
  - internal consistency
  - vascularity

To maximize diagnostic accuracy & limit differential diagnosis:

✔ Imager should have thorough knowledge of
  - clinical history
  - physical findings
  - laboratory findings
  - other imaging findings

Results

US proved useful in following situations:

✔ ABC clavicle (1)
✔ Exclude underlying bony component of ST mass (1)
✔ Dx and F/U fx infant (4)
✔ Dx osteomyelitis in pts w cellulitis (4)
✔ ? fx underlying cephalohematoma/subgaleal hematoma (4)
✔ Rib mass (osteochondroma) (1)
✔ Contour deformities costochondral cartilage (8)
✔ Ganglion cyst (4)
✔ Posterior knee mass (Baker’s cyst) (4)
✔ Anterior knee mass (septated cyst rheumatoid disease) (1)
✔ Epidermoid cranial vault (4)
✔ Langerhan’s histiocytosis skull (1)
✔ Indeterminate clavicle mass post trauma, resolved (1)
✔ Assessment craniosynostosis (5)
✔ Differentiate al structure from pathology, e.g. lump on back = spinous process (3)

# 3 Challenge: Sonographic Evaluation of Pediatric Skeletal Lesions

...some examples

Infant w compressible lump post auricular area of scalp noted at birth
dermoid cyst

✔ Well defined SQ avascular compressible cystic mass superficial to periosteum
✔ Strong back wall with good through transmission
✔ Unremarkable underlying skull
9 mo F w hard immobile right frontal mass

- small (0.4 x 0.6 x 0.8 cm) hypoechoic avascular well defined cystic mass
- apparent extension through right frontal bone
- periosteal draping over the mass

7 yo M with painful occipital mass
Langerhan’s histiocytosis

- 1.1 x 1.3 x 1.5 cm solid mass with minimal vascularity extends from diploic space through the inner and outer tables of skull with local periosteal spread
- MRI confirms US findings

5 ½ yo M with hard prominence right lower rib for several months

- osteochondroma

15 mo M w right clavicular trauma 2 mos prior & subsequent growing hard immobile mass medial right clavicle

- Medial aspect clavicle not visualized
- Expansion, splaying remaining most medial portion clavicle

- Well defined cystic structure in corresponding part of the skull
- MRI confirms convexity of mass intracranially & cystic nature of mass (T2 hyperintense)

- Multiple fluid/fluid levels within multiseptated mass replacing medial clavicle
aneurysmal bone cyst (ABC)

- expansile, benign, multilocular lesion, blood filled fibrous cyst
- fluid-fluid levels due to internal hemorrhage & debris
- can occur in virtually any bone

NB with hard “mass” left knee

displaced Salter 2 fracture

- Marked soft tissue swelling left knee
- Rt sided cartilaginous distal femoral epiphysis normally aligned with shaft
- Lt sided Salter 2 fracture with posterior displacement distal femoral epiphysis

4 yr M hard lump above left nipple

costochondral cartilage
contour deformity

7 yr M acute left thigh pain with STS x 3 days, fever 40° C, ↑ ESR, H/O trauma

- Deep soft tissue swelling left posterior thigh
- Normal right sided muscular structures

Sonographic Evaluation

Skeletal Lesions

approach to challenge

- Open communication with referring physicians
- Volume referrals escalated
- Obtain pertinent correlative and follow-up info
- Close vigilance on small # remaining diagnostic dilemmas
- Know & accept limitations!!!
**#4 Challenge: US Inguinal Hernia**

- Most pediatric inguinal hernias are obvious clinically
- For those that are equivocal, US is often employed
- Challenge is actual performance of sonogram
- Essential to understand:
  - normal anatomy
  - know the expected location of various inguinal hernias
  - perform exam in supine/upright positions w/ w/o Valsalva
  - learn & accept limitations
  - recommend higher tech imaging as needed


**Inguinal “masses”**

- Nodes (benign/malignant)
- Hernia (may contain gonads)
- Undescended testes
- Pseudoaneurysm
- Hydrocele (simple/funicular)
- Hydrocele of cord

**Groin Hernias**

- Protrusion of an organ or tissue via abnl body opening
- Examine in supine/upright positions w/ w/o Valsalva
- Location (type: indirect, direct, femoral)
- Size of neck ≤ 4 mm
- Content of sac (fluid, fat, mesentery) &/or bowel [peristalsis]
- Reducibility (dynamic maneuvers)
- Incarcerated (cannot be reduced)
- Strangulation (? Ischemia)

**Inguinal Hernia in Pediatrics**

- Indirect more common in children than direct
- Almost always associated w/patent processus vaginalis
- Incidence up to 4.4%
- Increased in premature infants
- Increased intra-abdominal pressure (positive-pressure ventilation, VP shunt)

**Inguinal Hernia**

- Identify internal inguinal ring
- Identify inferior epigastric a (IEA)
- IEA arises from external iliac a (EIA)
- Origin of IEA marks the deep inguinal ring
- May prefer to assess AIIS to symphysis pubis

- Inguinal canal width >4 mm at level of inguinal canal reliable indicator of IH
- Peristalsis of hernia content helps differentiate from complex hydroceles, hematoceles, scrotal abscesses, and urinomas
**Inguinal Hernia**

**indirect**
- Arises in internal inguinal ring
- From AIIS to symphysis
- Superficial (anterolateral) to IEA
- Anterior to spermatic cord (round ligament)
- May communicate with scrotum
- May strangulate

**direct**
- AKA “old man’s hernia”
- Usually wide, broad neck
- Poor coverage conjoined tendon (IOM, TA)
- May be tear transversalis fascia
- From medial & behind cord
- Moves post to ant
- Does not strangulate
- Usually reducible

**femoral hernia**
- Just above saphenous merger w FV
- Medial to FV
- Moves from sup to inf
- Extends into medial thigh
- Contains fat &/or bowel
- F>M
- Risk of strangulation

**scanning guideline for detection**
- Femoral - med to FV
- Indirect - AIIS to symphysis, ant to cord
- Direct - med & behind cord

**#4 Challenge:**
US Inguinal Hernia

…some unusual cases
5 yo F with BIH
androgen insensitivity syndrome

- At surgery structures within inguinal hernia sacs felt firmer than expected
- Pelvic US following bilateral herniorrhaphies showed no internal gynecological structures

4 mo F with left groin mass & vomiting
torsed left ovary in left inguinal hernia

- Right ovary clearly identified in right adnexal region
- Left ovary not seen in left adnexal region
- Large oval shaped avascular structure identified within left groin contains multiple follicles

#5 Challenge:
US for evaluation Crohn’s Disease

- What are the ?s we need to answer:
  - Extent of disease (LB, SB, ICV, appendix)
  - Bowel wall thickening
  - Bowel wall hyperemia
  - Presence of stricture
  - Presence of dilatation
  - Peristalsis
  - Obstruction
  - Stool burden
  - Separation bowel loops (phlegmonous changes, creeping fat)
  - Lymphadenopathy
  - Localized/free fluid collection/Abscess
  - Fistulae

US for evaluation Crohn’s Disease

- Detection of disease activity through objective monitoring is key to changing long-term outcome and disability including post-op patients
- Monitoring clinical symptoms alone inadequate for assessment of disease activity
- Monitoring w endoscopy invasive
- CTE/ MRE
- US emerging as a useful modality for detection of Crohn’s & for detection of complications
- Increasing pt & family acceptance


US for evaluation Crohn’s Disease:
approach to the challenge

- Proper probe selection (L12-5 MHz, L9-3 MHz, C9-4 MHz, C5-2, 5-1 MHz, L17-5ioMHz)
- Strictly follow protocol:
  - Obtain static/video clips
  - Image Gently reserving higher tech imaging only as needed for clarification
- Encourage GI docs to consider US as alternative
- Clinical/endoscopic/operative correlation
- Develop research protocols

US for evaluation Crohn’s Disease:
approach to the challenge

- 2014: Marla Dubinsky, MD, Co-Director IBD Center
- Research Project: “Use of Small Bowel Ultrasound to Predict Response to Remicade Induction”
- Strong patient acceptance & preference
- More referrals from GI docs
- Future: CEUS/elastography
17 yr M with Crohn’s presented with worsening pain

Take-home Points: approach to challenges

- Believe in your convictions based on fact & experience
- Persevere when you believe that what you are proposing is easier for children & advantageous too
- Listen carefully to criticism
- Never forget ALARA
- Continue to refine US techniques and develop more and more applications
- Accept the limitations of this magic wand.

Thank You!