Developing a Shoulder Ultrasound Program in Rural Uganda

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Disclosures

- Consultant: Bioclinica
- Contractor: POCUS PRO
- Advisory Board: Philips
- Book Royalties: Elsevier
- Board of Directors: Imaging the World

Syllabus PDF

See www.jacobsonmskus.com for syllabus other educational material

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Background

- Unmet medical musculoskeletal imaging needs:
  - Rural and underserved populations
  - Especially populations that rely on manual labor (i.e. agriculture)
- Limited access:
  - Technology
  - Training and education
  - Supervision and peer-review

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Uganda

- Country in East Africa
- Bordered by South Sudan, Kenya, Tanzania, Rwanda, and Democratic Republic of Congo
- Population: 44 million
  - 8.5 in capital of Kampala
  - 76% rural
- Language: English and Swahili
- Agriculture: coffee

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Uganda: health issues

- 8 physicians / 100,000 people (in early 2000)
  - Supplemented by extended care providers
- Only 10 MRI in entire country
- Only 23 Orthopaedic Surgeons in entire country
- 50 radiologists in entire country
- Predominant rural population
- 5 – 12 hours to travel to Kampala by car/motor bike

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Imaging the World

- Non-profit organization
  - Kristen DeStigter, MD: University of Vermont Chair
- Established ultrasound clinics throughout rural Uganda
- Trained personnel with ongoing peer-review
- Initial focus: obstetrical ultrasound
  - Now gynecologic and abdomen
- Expand to musculoskeletal ultrasound
  - Goal: create local centers of excellence

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Start up

- RSNA International Education Grant
  - To fund travel
  - Equipment: Philips Lumify, laptop computer, monitor
  - IT support (Imaging the World): image, data transfer
- Gulu:
  - Rural city, 5 hour drive from Kampala
  - Population: 120,000

Boda boda

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Equipment: Philips Lumify

- Hand-held portable ultrasound
- Connects to tablet or phone
  - 12-5 Mhz linear transducer
- Published study comparing Lumify to conventional cart-based Philips Epiq
  - 100 consecutive musculoskeletal patients
  - Concordant or clinically insignificant discordant: 96%

Falkowski AL et al. Ortho J Sports Med 2020

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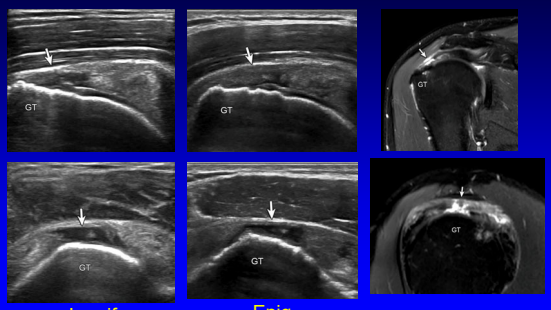
Philips Lumify vs. Epiq



Lumify Epiq

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Visit 1: July 2019

- 3-day educational course
  - Shoulder ultrasound
  - Radiologists, technologists, surgeon, physiatrist
- Identified a technologist to champion the shoulder ultrasound program in Gulu
- 2-day free shoulder ultrasound clinic:
  - 2 radiologists, 1 physiatrist
  - Assessed overall patient pathology

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Shoulder Ultrasound Protocol: 5 steps

1. Biceps Brachii: 2 images (short and long axis)
2. Subscapularis: 2 images (long and short axis)
3. Supraspinatus and infraspinatus: 6 images (long and short axis)
4. AC joint: 2 images
5. Posterior shoulder: 4 images
   A. Joint recess and spinoglenoid notch
   B. Infraspinatus and teres minor muscles

*All steps included video cine sweeps

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Results: free shoulder clinic

- Radio announcement prior to visit
- 111 subjects presented with shoulder pain over 2 days
- 64% female, 36% male
- Average age: 52 years (range 12 – 92)
- Occupation: 54% farming, 14% business
- Etiology: accident 32%, fall 29%, trauma 11%
- Other joint symptoms: ankle 63%, hip 55%, knee 54%
- Common shoulder pathology: impingement, cuff tear

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Issues

- Need to manage results of shoulder ultrasound
  - No arthroscopist in Gulu
  - Only 1 general surgeon and 1 physiatrist
  - Need teach ultrasound-guided steroid injections
- Need to manage conservative management
  - Develop basic home exercise program
  - Teach nurses and other health care providers

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Visit 2: December 2019

- Set up the ultrasound and computer equipment in Lacore Health Center in Gulu
- Reviewed the shoulder ultrasound protocol with the technologist
- Tested the remote peer-review system and data collection (REDCap or Research Electronic Data Capture)
- Demonstrated ultrasound-guided steroid injection
- Taught home exercises to health care workers at 2 rural health centers

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Visit 3: canceled

- Both July and December 2020 visits canceled
- July 2021 postponed
- COVID vaccination rates in Uganda (2020):
  - 1 dose: 2.5%
  - 2 doses: 0%
- Continue peer-review of the Gulu site

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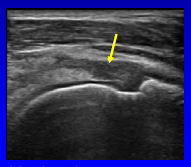
Results: peer review (Gulu)

- 56 shoulder ultrasound cases
  - 28 male, 28 female; avg age 44 years (12 – 90)
- All cases were considered technically acceptable

BT Subluxation and Tear



SST: focal full-thickness tear

SST: massive tear

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Results: peer review (Gulu)

- Discrepancy rates by examination component:

Structure of Interest	Diagnosis Discrepancy Rate
Biceps brachii	23%
Subscapularis	9%
Supraspinatus	43%
Infraspinatus	0%
AC joint	2%
Subacromial-subdeltoid bursa	30%
Miscellaneous	5%

*Overall clinically significant changes in diagnosis: 9%

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Results: diagnosis changes

- Supraspinatus: n=24
  - Normal to tendinosis: 6 cases
  - Normal to partial tear: 1 case
  - Tendinosis to partial tear: 4 cases
  - Upgrade extent of tear: 7 cases
- Subacromial-subdeltoid: n=17
  - Under called mild synovial thickening: 11 cases
- Discrepancy rate decreasing over time

Changed PTT to osis

Under call bursal fluid

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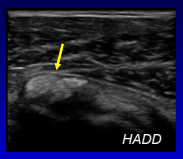
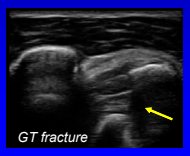
Interesting Cases: peer review (Gulu)





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Visit 4: July 2022

- Gulu:
  - New technologist: supervised 8 shoulder ultrasounds
  - Surgeon: plan for return to teach US-guided steroid injection
  - Continue peer review

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Visit 4: July 2022

- Bwindi:
  - Southwest Uganda
  - Democratic Republic of Congo border
  - Impenetrable forest
  - Mountain gorilla trekking
- Goal:
  - Establish contact with personnel
  - Determine future focus:
    - Shoulder, ankle, ER

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Next Steps

- Gulu:
  - Educational session with technologist
  - Teach US-guided steroid injection to surgeon:
- Bwindi
  - Identify individual to champion ultrasound
  - Begin training and set up peer-review
- Kenya
  - Begin process in rural Kenya
- Alaska and Canada
  - Native Americans and First Nation

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How many ultrasound are needed for training?

- The purpose of the study was to determine the number of shoulder ultrasound examinations required for training of a musculoskeletal radiology fellow

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Materials and Methods:

- 15 musculoskeletal radiology fellows prospectively and independently recorded their sequential shoulder ultrasound impressions of clinical patients
- Compared to radiology faculty assessment

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Materials and Methods:

- For each patient, a fellow assessed 6 items:
  - Supraspinatus
  - Infraspinatus
  - Biceps brachii long head
  - Subscapularis
  - Joint effusion
  - Subacromial-subdeltoid bursal fluid or thickening

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Materials and Methods:

- Tendons were recorded as:
  - Normal
    - Hyperechoic, fibrillar
  - Tendinosis or partial-thickness tear
    - Swollen hypoechoic
    - Anechoic or hypoechoic partial cleft or defect
  - Full-thickness tear
    - Anechoic or hypoechoic defect, or non-visualization

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Materials and Methods:

- For each patient, a fellow also assessed:
  - Joint fluid surrounding biceps tendon:
    - Normal: no or sliver of fluid
    - Effusion: hypoechoic or anechoic distention of tendon sheath
  - Subacromial-subdeltoid bursa
    - Normal: < 2 mm distention of bursa
    - Abnormal: 2 mm or greater distention

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Materials and Methods:

- Subsequently, one of 12 musculoskeletal radiology faculty independently reviewed the case and similarly assessed the same structures
- Years of faculty MSK US experience: 1–9 yrs
- Fellow and faculty results were compared for concordance
- Surgical correlation when available

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Materials and Methods:

- Ultrasound results were recorded approximately one month into the fellowship, which allowed each fellow to become familiar with our shoulder ultrasound protocol and to identify key anatomic structures during scanning

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Results:

- 647 patients scanned by a fellow and checked by radiology faculty over 4 years
- Average number of shoulder ultrasound exams per fellow / year = 54.4 (range 15 – 117)
- 11% (71/647) of patients had full-thickness tears of supraspinatus diagnosed by faculty
- 12% (76/647) of patients had surgical evaluation of the shoulder

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Results:

- When reviewing how well the group of 15 fellows performed for each sequential ultrasound exam number:

- Exam #1: 83% (5/6 items) correct
- Exam #3: 90% (5.4/6) correct
- Exam #12: 97% (5.6/6) correct
- Exam #14: 98% (5.88/6) correct
- Exam #56: 100% (6/6 items) correct

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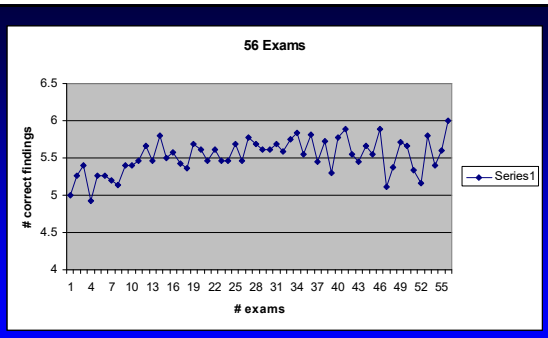

Note upward trend but variability in data points

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Results:

- When reviewing how often assessment of each structure was incorrect throughout the study:

- Supraspinatus: 33%
- Subacromial-subdeltoid bursa: 21%
- Infraspinatus: 15%
- Subscapularis: 11%
- Joint effusion: 11%
- Biceps brachii long head: 9%

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Results:

- When reviewing how many fellows were correct in their assessment of the supraspinatus for each sequential ultrasound exam number:

- Exam #1: 67% (10/15 fellows) correct
- Exam #2: 80% (12/15) correct
- Exam #6: 87% (13/15) correct
- Exam #12: 93% (14/15) correct
- Exam #33: 100% (12/12 fellows) correct

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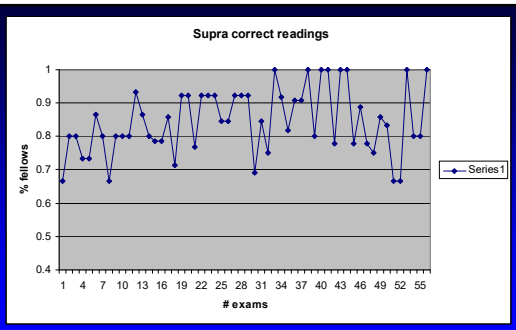

Note upward trend but variability in data points

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Results:

- Looking at the 17 of 71 cases who had surgical follow up evaluated by one faculty:
  - ✓ 82% (14/17) concordance with surgery

# of cases	US fellow	US staff	Surgery
1	Normal	Normal	Normal
2	FTT	PTT/osis	PTT
3	PTT/osis	FTT	FTT
8	FTT	FTT	FTT

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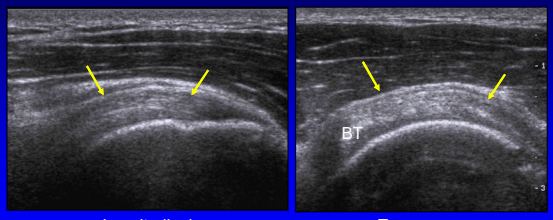
Supraspinatus: normal at surgery
Fellow: normal; Faculty: normal



Longitudinal Transverse

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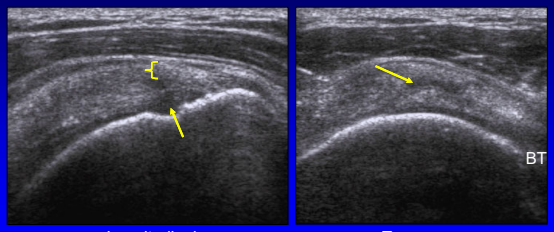
Supraspinatus: PTT at surgery
Fellow: FTT; Faculty: PTT



Longitudinal Transverse

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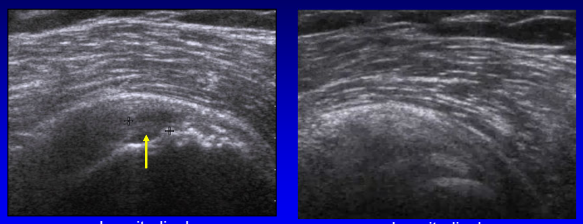
Supraspinatus: FTT at surgery
Fellow: PTT; Faculty: FTT



Longitudinal Longitudinal

Focal full-thickness tear: distal

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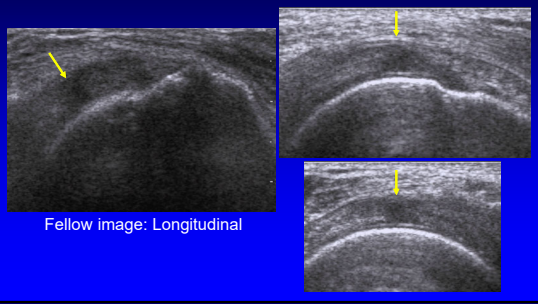
Supraspinatus: FTT at surgery
Fellow: PTT; Faculty: FTT



Fellow image: Longitudinal

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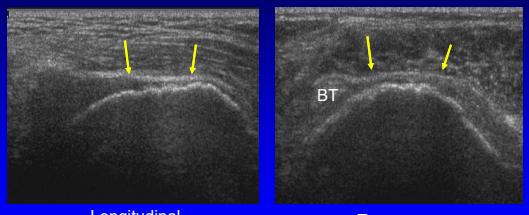
Supraspinatus: FTT at surgery
Fellow: PTT; Faculty: FTT



Longitudinal Transverse

Large full-thickness tear: chronic

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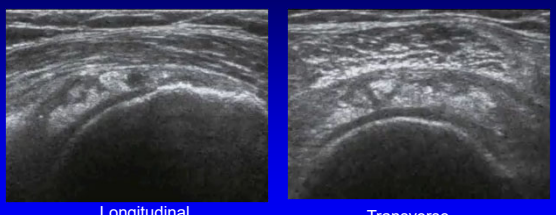
Supraspinatus: FTT at surgery
Fellow: FTT; Faculty: FTT



Longitudinal Transverse

Large full-thickness tear: acute

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Results:

- Looking at 17 cases from one faculty:
  - ✓18% (3/17) discordant with surgery

# of cases	US fellow	US staff	Surgery	Time interval
1	Normal	Normal	Massive	149 weeks
1	Normal	Normal	Mild fraying	19 weeks
1	Normal	Tendinosis	Normal	1 week

✓No false-positive tear by ultrasound

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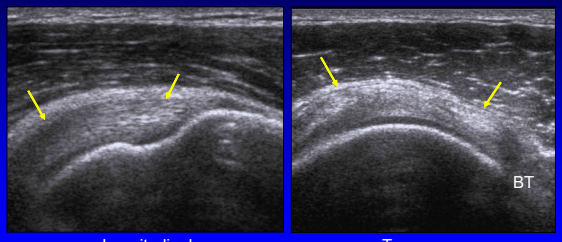
Supraspinatus: mild fraying at surgery

Fellow: normal; Faculty: normal



Longitudinal Transverse

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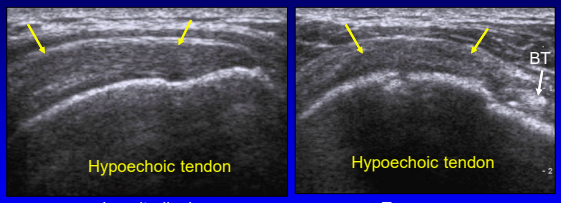
Supraspinatus: normal at surgery

Fellow: normal; Faculty: tendinosis



Longitudinal Transverse

False-negative surgery for tendinosis? Fellow beginners luck?

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Discussion:

- Musculoskeletal radiology fellows:
  - Initially reached 100% correct assessment of supraspinatus at patient #33
  - Initially reached 100% correct assessment of the entire shoulder at patient #56

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Discussion:

- Musculoskeletal radiology fellows:
  - Steepest part of learning curve:
    - Patients 1 through 12-15
  - In general, reaching 90% by patient #20
  - Variability in results continued throughout

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Discussion:

- With regard to anatomic structures evaluated:
  - Supraspinatus: 33% incorrect
  - Highest rate of the 6 structures
  - Related to complex anatomy, technical and interpretation errors
    - For example: deep partial versus full-thickness tear

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Discussion:

- With regard to anatomic structures evaluated:
  - Biceps brachii long head: 9% incorrect
  - Lowest rate of the 6 structures
  - Related to simpler anatomy
    - Tubular structure
    - Relatively superficial

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Limitations:

- Variable gold standard:
  - 12 faculty: all fellowship trained with MSK US
  - Limited surgical follow up
  - Faculty #1: concordance 88%*
- Fellows scanned different patients
- Combined partial-thickness tear and tendinosis

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Conclusion:

- Steepest part of learning curve: patients 1 – 12
- Reached 90% correct by patient #20
- Reached 100% correct in assessment of:
  - Supraspinatus at patient #33
  - Entire shoulder at patient #56
- Increased variability in results toward end of study suggests additional training may be needed to achieve consistent and accurate results

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Conclusion:

- As a group, musculoskeletal radiology fellows in training initially reached 100% correct in assessment of:
  - Supraspinatus at patient #33
  - Entire shoulder at patient #56 (97% at #12)
- Increased variability in results toward end of study suggests additional training may be needed to achieve consistent and accurate results

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Take Home Points

- Remote peer-review of MSK US can be effective method of training
- Initial "boots on the ground" still needed:
  - To establish initial ultrasound scanning protocol
  - To ensure sonographer is a "good fit"
  - To understand the patient access issues
  - To understand barriers to treatments

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Potential Algorithm

- Home shoulder exercises at initial contact: local
- Shoulder ultrasound if failed physical therapy: regional
- If non-surgical: ultrasound-guided steroid injection
- If surgical:
  - Can treatment occur locally
  - Assess need for advanced treatment

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Thank you!

Syllabus on line and other educational material:
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