When to Refer to Ortho

January 17, 2017
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Objectives

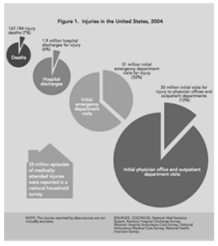
- Recognize the impact of musculoskeletal referrals
- Recognize indications for orthopedic referrals
- Recognize evaluations, testing and nonoperative treatments to consider
- Recognize when a rheumatologist may become appropriate
- Recognize indications for ultrasound imaging

- In 2002, the Centers for Disease Control reported that musculoskeletal problems are second only to upper respiratory illness as reasons why people seek medical attention in the emergency department.
  - McCaig LF, Burt CW. National Hospital Ambulatory Medical Care Survey: 2001 emergency department summary. *Adv Data. 2003;335: 1-29.*

- Musculoskeletal symptoms are also the most common reason for visits to outpatient departments
  - Ly N, McCaig LF. National Hospital Ambulatory Medical Care Survey: 2000 outpatient department summary. *Adv Data. 2002;327: 1-27*

Economic burden of injury

- In 2000 are estimated to cost the U.S. health care system
  - $1.1 billion for fatal injuries
  - $33.7 billion for injury hospitalizations
  - $31.8 billion for injury emergency department visits
  - $13.6 billion for other outpatient visits
  - costs reflect treatment for physical injuries only



https://www.cdc.gov/nchs/data/misc/injury2007.pdf

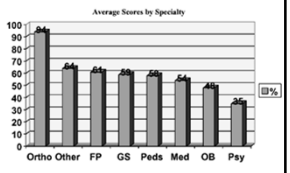
Testing

- Xray
- CT
- MRI
- US
- EMG/NCS
- Vascular studies
- Lab
  - Serum
  - Synovial fluid analysis

Nonoperative Treatments

- Physical therapy
  - Eccentric exercise
  - Stretching
  - AROM/PROM
  - ASTYM
  - Modalities
- Medications
  - NSAIDs
    - Oral
    - Topical
  - Opioids
  - Tylenol
- Injections
  - Cortisone
  - PRP
  - Stem Cells
  - Hyaluranate
- Immobilization
  - Bracing/Splints
  - Sling
  - Casting
  - Boots

- Education in musculoskeletal medicine has been shown to be inadequate in some medical school curricula
- Seventy-nine percent of the participants failed the basic musculoskeletal cognitive examination.



Freedman KB, Bernstein J. The adequacy of medical school education in musculoskeletal medicine. J Bone Joint Surg Am. 1998;80(10):1421-

- One of the most frequent referrals from primary care to specialist care is for a patient with a musculoskeletal complaint
- Professional society practice guidelines exist for many musculoskeletal diseases

Referring Wisely: Orthopedic Referral Guidelines at an Academic Institution Am J Manag Care. 2016;22(5):e185-e191

American Academy of Orthopedic Surgeons

PUBLISHED AAOS CLINICAL PRACTICE GUIDELINES

- Achilles Tendon Rupture
- Anterior Cruciate Ligament Injuries
- Carpal Tunnel Syndrome
- Distal Radius Fractures
- Glenohumeral Joint Arthritis
- Hip Fractures in the Elderly
- Orthopaedic Implant Infection in Patients Undergoing Dental Procedures: Prevention
- Osteoarthritis of the Knee(Non-Arthroplasty)
- Osteoarthritis of the Knee (Arthroplasty/Surgical Management)
- Osteochondritis Dissecans
- Pediatric Developmental Dysplasia of the Hip in Infants up to Six Months of Age: Detection and Management
- Pediatric Diaphyseal Femur Fractures
- Pediatric Supracondylar Humerus Fractures
- Periprosthetic Joint Infections
- Rotator Cuff Problems
- Symptomatic Osteoporotic Spinal Compression Fractures
- Venous Thromboembolic Disease: Prevention

Full Thickness Tears and Asymptomatic Patients

1. In the absence of reliable evidence, it is the opinion of the work group that surgery not be performed for asymptomatic, full thickness rotator cuff tears.

Strength of Recommendation: Consensus

Full Thickness Tears and Symptomatic Patients

2. Rotator cuff repair is an option for patients with chronic, symptomatic full thickness tears.

Strength of Recommendation: Weak

Rotator Cuff Tears and Exercise

3. a. We cannot recommend for or against exercise programs (supervised or unsupervised) for patients with rotator cuff tears.

Strength of Recommendation: Inconclusive

Rotator Cuff Tears and Corticosteroid Injections

3. b. We cannot recommend for or against subacromial injections for patients with rotator cuff tears.

Strength of Recommendation: Inconclusive

Rotator Cuff Tears and NSAIDS, Activity Modification, Ice, Heat, Iontophoresis, Massage, T.E.N.S., PEMF, and Phonophoresis

3. c. We cannot recommend for or against the use of NSAIDS, activity modification, ice, heat, iontophoresis, massage, Transcutaneous Electrical Nerve Stimulation (TENS), Pulsed Electromagnetic Field (PEMF), or phonophoresis (ultrasound) for nonoperative management of rotator cuff tears.

Strength of Recommendation: Inconclusive

Rotator Cuff Related Symptoms and Exercise or Nonsteroidal Anti-Inflammatory Medication

4. a. We suggest that patients who have rotator cuff-related symptoms in the absence of a full thickness tear be initially treated non-operatively using exercise and/or non-steroidal anti-inflammatory drugs.

Strength of Recommendation: Moderate

Rotator Cuff Related Symptoms and Corticosteroid Injections or PEMF

4. b. We cannot recommend for or against subacromial corticosteroid injection or Pulsed Electromagnetic Field (PEMF) in the treatment of rotator cuff-related symptoms in the absence of a full thickness tear.

Strength of Recommendation: Inconclusive

ACOEM guidelines

- American College of Occupational and Environmental Medicine
- http://www.mdguidelines.com

Sideline Guidelines

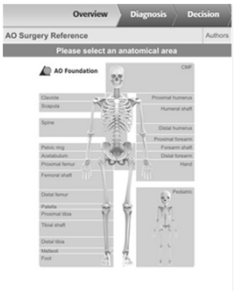
- Searchable database on over 250 conditions
- Annotated x-ray, MRI, CT, and photographic examples
- References to related scientific literature
- Access to emergency guidelines

Cleveland Clinic

Sideline Guidelines
Management of Athletic Injuries

AO Surgery Reference

- AO Foundation
- Arbeitsgemeinschaft fur Osteosynthesefragen/Association for the study of Internal Fixation



Consensus for Referral

- University of California, San Francisco (UCSF) Health
- 36 clinical scenarios
- 214 questions
- 178 PCPs
- 24 orthopedists
- ~65,000 primary care patients
- 5000 referrals to orthopedics per year

Referring Wisely: Orthopedic Referral Guidelines at an Academic Institution, The American Journal of Managed Care, VOL. 22, NO. 5, **e185-e191**

Consensus for Referral

- What tests and treatments should be performed in primary care prior to orthopedic consultation for specific common musculoskeletal problems?
- Which common musculoskeletal problems could be managed by the PCP with an eConsult by an orthopedist, in place of a face-to-face patient visit?

Referring Wisely: Orthopedic Referral Guidelines at an Academic Institution, The American Journal of Managed Care, VOL. 22, NO. 5, **e185-e191**

Consensus for Referral

■ **Figure 2** Sample Survey Questions

A **<65 year old** patient with **acute** knee pain **after a fall** concerning for **ligamentous injury** and/or **meniscal tear** (knee effusion, joint line tenderness, decreased flexion and extension of the knee).

The following should occur **prior to referral** to the orthopaedic clinic:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. Plain films	○	○	○	○	○
2. MRI	○	○	○	○	○
3. Conservative management by the PCP, with written guidance embedded in the referral interface (including activity modification, ice, elevation, NSAIDs)	○	○	○	○	○
4. Physical therapy for 6 weeks	○	○	○	○	○
5. Confirmation that the patient is amenable to orthopaedic intervention (e.g. injection, bracing, surgery)	○	○	○	○	○
6. Management by PCP with electronic consultation by an orthopaedist, in place of a patient visit, could be appropriate for this patient.	○	○	○	○	○

Referring Wisely: Orthopedic Referral Guidelines at an Academic Institution, The American Journal of Managed Care, VOL. 22, NO. 5, **e185-e191**

Consensus for Referral

■ **Table 2.** Number of Questions That Reached Consensus

	Number of Questions, n	Consensus Round 1, n	Consensus Round 2, n	Total Consensus n (%)
Total	214	110	35	145 (68%)
Foot and ankle	38	24	5	29 (76%)
Hand and upper extremity	57	36	6	42 (74%)
Hip	18	11	2	13 (68%)
Knee	23	13	3	16 (70%)
Shoulder	36	7	11	18 (50%)
Spine	42	19	8	27 (64%)

Referring Wisely: Orthopedic Referral Guidelines at an Academic Institution, The American Journal of Managed Care, VOL. 22, NO. 5, **e185-e191**

Consensus for Referral

- Acute
- Chronic
  - > 3 months
- Acute exacerbation of a chronic condition

TABLE 68.3 Guidelines for Referral of Patients with Musculoskeletal Problems to a Specialist

Fractures
Acute dislocations
Grade III or severe grade II sprains
Suspected joint infections
Suspected compartment syndromes
Suspected cauda equina syndrome or acute myelopathy
Severe or progressive loss of function or work productivity
Problems that do not respond to a reasonable trial of nonoperative treatment

Principles of Ambulatory Medicine

Consensus for Referral

- Little agreement exists regarding which orthopedic problems a primary care pediatrician should understand to care effectively for children.
  - no set of referral guidelines has been established
  - judgment has been primarily subjective
- Previous attempts to create orthopedic referral guidelines have not been successful, even with primary care support.
- It therefore is difficult to establish criteria for appropriate referral to a pediatric orthopedic surgeon.

Referral Patterns to a Pediatric Orthopedic Clinic: Implications for Education and Practice. PEDIATRICS Vol. 113 No. 3 March 2004 **e163**

TABLE 1. Orthopedic Diagnoses: Number and Age Distribution Based on Final Orthopedic Diagnoses

	No. of Cases	Diagnosis Percentage of Total	Age Mean (SD, Median)
Torsional variation	50	16.2	2.80 (2.61, 1.76)
Normal	42	13.6	5.98 (6.29, 2.49)
Musculoskeletal pain	24	7.8	9.72 (4.77, 8.64)
Angular variation	20	6.5	1.96 (3.62, 1.32)
Scoliosis	19	6.2	11.52 (3.88, 12.99)
Trauma/fracture	19	6.2	9.75 (5.84, 10.84)
Neurodevelopmental deficit	12	3.9	1.7 (5.99, 10.63)
Developmental dysplasia of the hip	11	3.6	0.12 (0.176, 0.02)
Equinovarus deformity	10	3.2	0.063 (1.7, 0.03)
Legg-Calve-Perthes	8	2.6	6.80 (4.13, 5.32)
Leg length discrepancy	8	2.6	10.55 (4.39, 12.2)
Other*	85	27.6	
Total	308	100	

SD indicates standard deviation.
* Other constitutes all diagnoses with <8 cases.

Referral Patterns to a Pediatric Orthopedic Clinic: Implications for Education and Practice. PEDIATRICS Vol. 113 No. 3 March 2004 **e163**

Consensus for Referral

- **A large proportion of referrals indicated either a lack of basic textbook knowledge or lack of examination skills and appropriate diagnostic tools as demonstrated by a high number of definitive diagnosis indicating normal variants.**

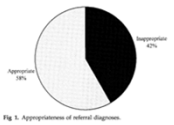


Fig 1. Appropriateness of referral diagnoses.

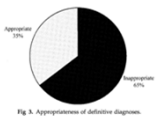


Fig 3. Appropriateness of definitive diagnoses.

Referral Patterns to a Pediatric Orthopedic Clinic: Implications for Education and Practice. PEDIATRICS Vol. 113 No. 3 March 2004 **e163**

Consensus for Referral

TABLE 3. Inappropriate Rate for Most Frequent Orthopedic Diagnoses (>8 Cases)

Definitive Pediatric Orthopedic Diagnosis	Percentage Inappropriate With AAP Guidelines (Inappropriate/Total of Diagnosis)
Torsional variation	94% (47/50)
Normal	97.6% (41/42)
Musculoskeletal pain	87.5% (21/24)
Angular variations	85% (17/20)
Trauma/fracture	57.9% (11/19)
Scoliosis	52.6% (10/19)
Neurodevelopmental deficit	16.7% (2/12)
Developmental dysplasia of the hip	9.1% (1/11)
Equinovarus deformity	0% (0/10)
Leg length discrepancy	62.5% (5/8)
Legg-Calve-Perthes	0% (0/8)

$P < .0001$ for relationship between percentage of inappropriate referrals and diagnosis.

Referral Patterns to a Pediatric Orthopedic Clinic: Implications for Education and Practice. PEDIATRICS Vol. 113 No. 3 March 2004 **e163**

Consensus for Referral

TABLE 3 *Age distribution of patients referred, by type of specialist*

Specialist	≤ 44 n	(%)	45–64 n	(%)	≥ 65 n	(%)	*Total n	(%)
Orthopaedic surgeon	86	(16.9)	45	(15.0)	46	(16.5)	183	(16.3)
Ophthalmologist	61	(12.0)	39	(13.0)	42	(15.4)	146	(13.0)
Dermatologist	67	(13.2)	33	(11.0)	32	(11.5)	139	(12.4)
Ear, nose and throat	65	(12.8)[b]	38	(12.6)	21	(7.5)	127	(11.3)
General surgeon	40	(7.9)	31	(10.3)	24	(8.6)	98	(8.7)
Plastic surgeon	30	(5.9)	17	(5.6)	11	(3.9)	62	(5.5)
Cardiologist	14	(2.8)[b]	13	(4.3)	18	(6.5)	48	(4.3)
Gynaecologist	31	(6.1)	11	(3.7)	3	(1.1)	46	(4.1)
Urologist	6	(1.2)	12	(4.0)	27	(9.7)[b]	45	(4.0)
Neurologist	16	(3.1)	9	(3.0)	11	(3.9)	36	(3.2)
Others	92	(18.1)	53	(17.6)	44	(15.8)	195	(17.3)
Not referred	508	(46.7)	301	(27.7)	279	(25.6)	1125	(100)

[a] Includes patients of unknown age.
[b] $P < 0.01$.

Referrals of patients by family physicians to consultants: a survery of the Israeli Family Practice Research Network. Family Practice. 1998. Vol 15, N2. 158-164.

Consensus for Referral

TABLE 5 *Distribution of patients by initiator of referral and type of specialist*

Specialist	All referrals (*n*)	Physician-initiated *n*	(%)	Jointly initiated *n*	(%)
Orthopaedic surgeon	183	111	(61.0)	46	(25.1)
Ear, nose and throat	127	67	(52.8)	29	(22.8)
Ophthalmologist	146	63	(43.4)	50	(34.5)
Dermatologist	139	71	(51.1)	55	(39.6)
General surgeon	98	73	(74.5)	10	(10.2)
Plastic surgeon	62	28	(45.2)	30	(48.4)
Cardiologist	48	25	(53.2)	7	(14.9)
Urologist	45	25	(55.6)	8	(17.8)
Neurologist	36	23	(63.9)	9	(25.0)

Referrals of patients by family physicians to consultants: a survery of the Israeli Family Practice Research Network. Family Practice. 1998. Vol 15, N2. 158-164.

Consensus for Referral

TABLE 6 *Indications for referrals that were physician-initiated (more than one indication was listed for some referrals)*

Indication	Referrals *n*	(%)
Diagnosis		
Unknown	226	(32.0)
Confirmation	178	(25.2)
Diagnostic tool unavailable to primary physician	74	(10.5)
Diagnosis (total)	478	(67.7)
Therapy		
Lack of experience in therapeutic procedure	152	(21.4)
Referral for surgical procedure	119	(16.7)
Therapeutic tools unavailable to primary physician	84	(12.0)
Therapy (total)	355	(50.0)
Other		
Physician reassurance	46	(6.5)
Patient reassurance	90	(12.7)
Physician and patient reassurance	37	(5.2)
For prescriptions or formal documentation	19	(2.7)
Other (total)	192	(27.0)

Referrals of patients by family physicians to consultants: a survery of the Israeli Family Practice Research Network. Family Practice. 1998. Vol 15, N2. 158-164.

Orthopedic Referral

- Expectations/Goals
  - Not met
  - Not set
- Does the patient want to be referred?
- Is the patient agreeable to surgery if recommended?

Orthopedic Referrals

- Emergent
- Non emergent
  - Urgent
  - Elective

Emergent Referrals

- Amputations
- Open Fractures
- Closed Fractures with Gross Deformity
- Dislocations
- Acute Compartment Syndrome
- Neurovascular Compromise

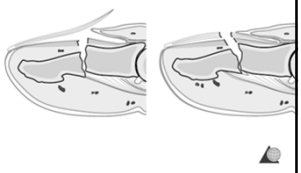
Open Fractures

- Wound cultures
  - Not recommended
    - 29% of positive pre-debridement
    - 60% of post-debridement cultures
- Tetanus prophylaxis
  - Booster
    - 10 years or more if vaccination history
    - contaminated wounds if more than 5 since the last tetanus vaccination history
  - IG 3000 – 5000 units IM
    - Highly contaminated wound
- Antibiotic prophylaxis
  - Recommended within 3 hrs
    - except open finger fx
  - First-generation cephalosporin and an aminoglycoside
  - Duration debated > 24 hours
- Surgical debridement
  - Critical step
  - Within 6 hours
- Irrigation solution
  - Type and volume debated
- Suspicion for compartment syndrome

Acute Management of Open Fractures: An Evidence-Based Review. Orthopedics. 2015 Nov;38(11):e1025-33.

Distal Phalynx Fractures

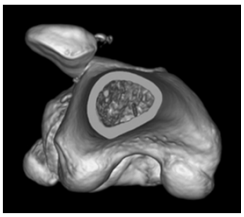
- Commonly missed open fracture



AO Foundation

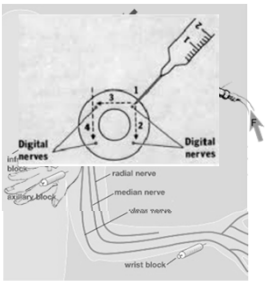
Closed Reductions

- Fractures/Dislocations
  - Multiple techniques depending on site
- If it won't reduce
  - Fracture (complicated)
  - Tissue impeding
  - Muscle spasm
- Maintaining reduction
  - Immobilization
  - Swelling
- Adequate anesthesia



Anesthesia

- Local Anesthetic
  - Hematoma block/Digital block/Intraarticular injection
  - No monitoring
  - Shorter time to discharge
- Regional
  - Nerve block/Bier block
  - Pain relief
  - Neurovascular injury, time, equipment
- General
  - Muscular relaxation
  - Pain relief
  - Expense, time, monitoring, adverse effects to meds



Dislocations

External rotation

Milch technique

Dislocations

Stimson technique

Cunningham technique

Dislocations

Traction/Counter Traction

Dislocations

- Sometimes overlooked
  - Perilunate
- High suspicion
  - Nurse maid's elbow

- Crush injuries
  - leg
  - forearm
- Compartment syndrome
  - Rapid Set-up
    - simple, sterile, disposable
  - Accurate
    - built-in microchip technology
  - Convenient
    - pre-filled syringe, hand held and easy to transport
  - Versatile
    - quick and continuous pressure monitoring

- Neurovascular compromise
  - Warmth of extremity
  - Color of extremity
  - Pulses
  - Pain
  - Capillary refill
  - Sensation
  - Active movement

Nonemergent Referrals Urgent/Elective

- Structural
  - Congenital
  - Physeal/Apophyseal
  - Bone
    - Fracture
    - Tumor/Metastasis
    - Avascular necrosis
  - Joint
    - Cartilage
    - Ligament
    - Capsule
  - Soft Tissue
    - Muscle
    - Tendon
    - Bursa
  - Hardware
    - Retained ORIF
    - TJA
    - Foreign body/penetrating trauma
- Synovitis/Tenosynovitis
  - Rheumatologic
  - Crystal induced
  - Infectious
  - Reactive
- Neuromuscular
  - Entrapments
  - Dystrophies
- Arthralgias/Myalgias
  - Hemochromotosis
  - Vitamin D deficiency
  - Thyroid disorders
  - Medication induced
    - Statins
    - Accutane

Congenital

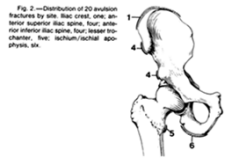
- Developmental dysplasia of the hip
- Femoral acetabular impingement
- Femoral torsion
- Genu varum and genu valgum
- Tibial torsion
- Metatarsus adductus
- Club foot
- Tarsal coalition
- Congenital trigger thumb
- Syndactyly
  - Webbed digits
- Polydactylyl
- Osteogenesis imperfecta
- Ehlers Danlos
- Marfans
- Trisomy 21

Apophyseal Injuries

- Apophysitis
  - Iliac Crest
  - ASIS
  - Ischial Tuberosity
  - Greater Trochanter
  - Inferior patellar pole
    - Sindig-Larsen-Johansson
  - Proximal tibial tubercle
    - Osgood-Schlatter
  - Calcaneal
    - Severs

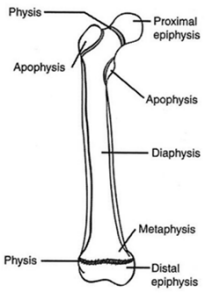
Imaging Findings of Lower Limb Apophysitis. AJR:196, March 2011

Avulsion of Apophysis



Fracture

- Location, location, location



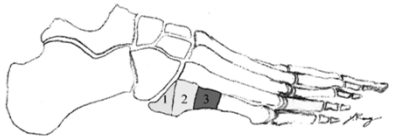


Figure 3. Proximal fifth metatarsal zones of injury. Zone 1 (green): avulsion fracture. Zone 2 (blue): Jones fracture. Zone 3 (purple): stress fracture.

High-Risk Stress Fractures: Diagnosis and Management. PM R. 2016 Mar;8(3 Suppl):S113-24.

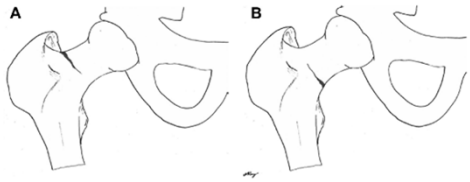
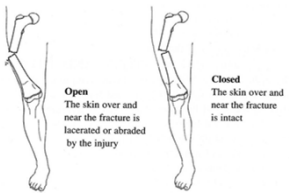


Figure 1. Femoral neck stress fractures (FNSFs). (A) High-risk tension-sided FNSF. (B) Low-risk compression-sided FNSF.

High-Risk Stress Fractures: Diagnosis and Management. PM R. 2016 Mar;8(3 Suppl):S113-24.

Fracture Classification

- Integrity of Skin
  - Open (compound)
  - Closed



Fracture Blisters

- Delayed treatment
- Leave intact
- Alter treatment
  - difficult to splint or cast
  - surgical incision sites

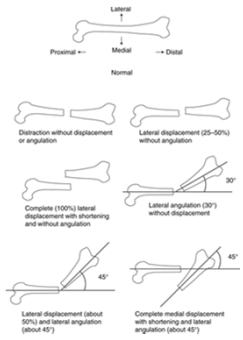
Table 1. Fracture location and blister frequency [1,5]

Location	Number of fractures	Number of blisters	Percentage of blisters at each fracture site
Pilon	54	9	16.7%
Distal humerus	10	2	20%
Elbow dislocation	18	3	16.7%
Calcaneus	102	15	14.7%
Tibial plateau	195	17	8.7%
Ankle	412	27	6.6%
Tibial shaft	416	14	3.4%
Humeral shaft	34	1	2.9%
Radius (shaft and distal)	115	2	1.7%
Total	1356	90	6.6%

Fracture blisters. West J Emerg Med. 2011 Feb;12(1):131-3.

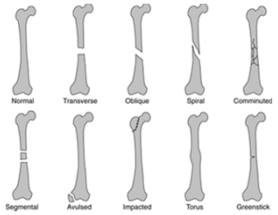
Fracture Classification

- Stable vs unstable
- Displacement & Angulation
  - deforming forces



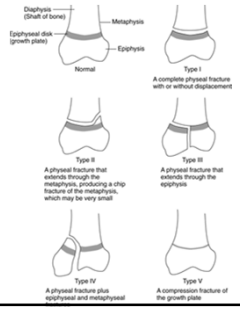
Fracture Classification

- Orientation of Fracture



Fracture Classification

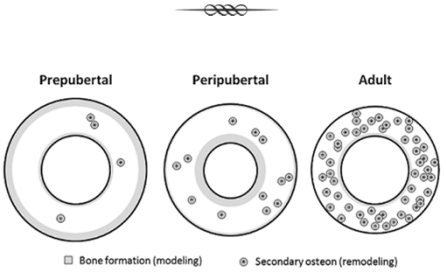
- Physis
  - contributes to length
- Apophysis
  - is a secondary center of ossification
  - contributes to contour
- Weakest parts of a developing skeleton
- Vulnerable to injury



SCFE

- More likely or common
  - during a growth spurt
  - boys than girls
    - 10-16 years of age
- Risk factors
  - excessive weight or obesity
    - 95th percentile
  - family history of SCFE
  - hyperthyroidism

AAOS



http://www.orthopaedicsone.com/display/Main/Osteogenesis+and+exercise

High Risk Stress Fractures

High-Risk Stress Fractures: Diagnosis and Management. PM R. 2016 Mar;8(3 Suppl):S113-24.

Table 2
High-risk stress fractures: characteristics and initial treatment

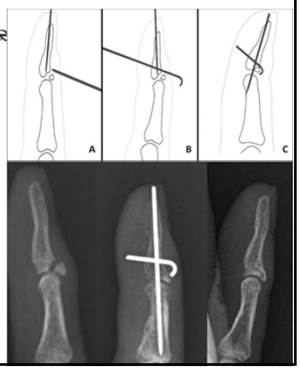
Site	Stress Fractures (%)	Common Sports	Initial Treatment
Femoral neck	<5%	Running, endurance athletes	Compression-side: NWB × 4-6 wk Tension-side: surgical referral Displaced: urgent surgical referral
Patella	<1%	Running, basketball, gymnastics	Low grade*: Activity restriction, WB as tolerated High grade*: NWB, knee extension brace immobilization × 4-6 wk Displaced: Surgical referral
Anterior tibia	0.8%-7%	Basketball, gymnastics	NWB × 6-8 wk†
Medial malleolus	0.6%-4.1%	Running, track and field, basketball, gymnastics	Surgical referral if poor healing at 3-6 mo NWB and cast immobilization × 4-8 wk† Displaced: Surgical referral
Talus	–	Running, pole vaulting, basketball, gymnastics	NWB × 6 wk ± cast immobilization
Navicular	14%-25%	Track and field, football, basketball	Type 1: NWB and cast immobilization ≥6 wk† Type 2 or 3: Surgical referral
Proximal Fifth metatarsal	<1%	Soccer, basketball, football	Low grade*: NWB and immobilization × 6 wk High grade (Type 1-3)*: Surgical referral
Sesamoid	–	Dance, gymnastics, racquet sports, basketball, soccer, volleyball, running, sprinting	NWB and immobilization × 6 wk; orthotics Surgical referral if poor healing at 3-6 mo

NWB = nonweight-bearing.
* Low grade: stress reaction; high Grade: fracture line.
† Early surgical intervention considered; may allow quicker return to play but further research is needed.

High-Risk Stress Fractures: Diagnosis and Management. PM R. 2016 Mar;8(3 Suppl):S113-24.

Bony mallet fracture

- > 50% articular surface
- Subluxation of joint
- K wire fixation



The "Fish Hook" Technique for Bony Mallet Finger. Orthopedics. 2016 Sep 1;39(5):295-8.

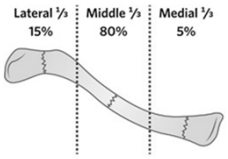
Clavicle Fractures

- Compromise skin integrity
  - extremely rare of the skin to be perforated from within

Is Skin Tenting Secondary to Displaced Clavicle Fracture More Than a Theoreti Risk? A Report of 2 Adolescent Cases. Am J Orthop (Belle Mead NJ). 2015 Oct;44(10):E414-6

Clavicle Fractures

- Midshaft
- Distal
  - Unstable - ligamentous
  - Controversial
- Proximal
  - Uncommon
  - Ligamentous support – rarely displace



Fracture of distal end clavicle: A review. J Clin Orthop Trauma. 2014 Jun;5(2):65-

Clavicle Fractures

- Displacement
  - Nonunion of displaced midshaft clavicular fractures was 15.1% after nonoperative care compared with 2.2% after plate fixation

Nonoperative treatment compared with plate fixation of displaced midshaft clavi fractures. Surgical technique. J Bone Joint Surg Am. 2008 Mar;90 Suppl 2 Pt 1:1-8

Clavicle Fractures

- Shortening
  - > 2 cm
  - predispose to nonunion and weakness
    - *Wick, Orthop Trauma Surg. 2001*

A comparative study of non-operative and operative management in fracture cla J Indian Med Assoc. 2013 Dec;111(12):806, 808-9.

Fracture Nonunion

- According to American Food and Drug Administration
  - A non-union is established when a minimum of 9 months has elapsed since injury and the fracture shows no visible progressive signs of healing for three months.

Fracture non-union epidemiology and treatment. Trauma 2016, Vol. 18(1) 3–11

Fracture Nonunion

- Incidence and prevalence
  - vary significantly based on anatomic region and the criteria used to define non-union
- It has been estimated that 100,000 fractures go on to non-union each year in the USA

Table 2. The risk factors for fracture non-union.[8,15,20]

Patient factors	Fracture-specific factors
Increasing age	High-energy trauma or injury severity score
Smoking	Soft tissue injury. Larger zone of injury and high Gustilo-Anderson Grade
Poorly diabetic control	Large inter-fragmentary gaps
Osteoporosis	Biomechanical instability
Vitamin D, calcium or protein deficiency	Infection
Increased alcohol consumption	Prolonged immobilisation
Reduced muscle mass and mechanical stimuli	Perioperative or prolonged non-steroidal anti-inflammatory drugs (NSAID) use
Post-menopausal females	Complex of comminuted fractures
	Diaphyseal fractures
	Large fracture haematoma

Fracture non-union epidemiology and treatment. Trauma 2016, Vol. 18(1) 3–11

Fracture Nonunion

- Risk factors
  - location of the fracture site
  - surgical treatment
  - bone displacement
  - type of fixation
  - treatment delay
  - comminution
  - inadequate treatment
  - wound infection
- Biological causes
  - patient age
  - smoking
  - diabetes
  - obesity
  - NSAID use

Biological Risk Factors for Nonunion of Bone Fracture.Zura R, Mehta S, Della Rocca GJ, Steen RG.JBJS Rev. 2016 Jan 5;4(1).

Fracture Nonunion

- Locations prone to nonunion
  - Scaphoid
  - Femur
  - Tibia
  - Humerus
  - Clavicle
  - 5th MT

Bone Stimulators

- Bone stimulators
  - Exogen
- 86% healed in an average treatment time of 22 weeks

Low-intensity pulsed ultrasound in the treatment of nonunions. J Trauma. 2001 Oct;51(4):693-702

Bone Tumors

- Detected
  - Painful
  - Associated with a palpable mass
  - Associated with a pathologic fracture
  - Discovered incidentally on an imaging study
- Lytic bone lesions
  - often not detectable on standard radiographs until the tumor has resulted in 30–50% loss of mineralization

Staging of Bone Tumors: A Review with Illustrative Examples. AJR:186, April 20

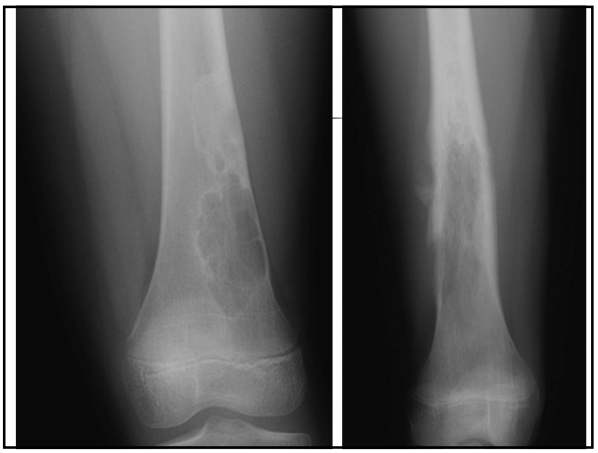
Bone Tumors

TABLE 1: Summary of Appropriate Radiologic Examination Procedures for Evaluation of Bone Tumors

Clinical Condition	Radiologic Examination Procedure and Appropriateness Rating			
	Routine Radiography	MRI	Nuclear Medicine Bone Scanning	CT
Screening, first study	9: Absolute requirement	1	1	1
Persistent symptoms, but radiograph negative		9: Contrast may be useful: depends on expertise and institutional preference	4: Good option if patient cannot have MRI; nonspecific (MRI more specific and sensitive)	3: If MRI not available; useful to evaluate cortex and trabecular pattern
Definitely benign on radiographs[a]		1	1	1
Clinically suspected osteoid osteoma	9: Necessary; follow up with CT if positive	6: CT is more useful but diagnosis can often be made with MRI; contrast may improve nidus identification	6: Very sensitive but nonspecific; good for localization if lesion is occult radiographically	9: Contrast not needed
Suspicious for malignant characteristics on radiographs		9: Contrast can provide more information; useful for vascularity and necrotic areas	3: Probably not indicated except to look for additional lesions	5: May be useful if MRI not available or possible; useful for evaluation of calcification, cortical breakthrough, and pathologic fractures

Note—Modified from the *American College of Radiology Appropriateness Criteria for Bone Tumors* [1]. The appropriateness rating ranges from 1 (least appropriate) to 9 (most appropriate).
[a]Additional studies (MRI or CT) may be needed if surgical intervention is contemplated and further anatomic information is required.

Staging of Bone Tumors: A Review with Illustrative Examples. AJR:186, April 20



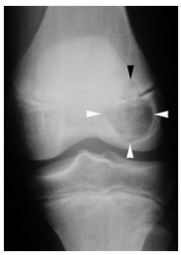
- 6-year old girl with Ewing's sarcoma

- 16-year-old boy with osteosarcoma

- 17-year-old boy with soft tissue mass and osteosarcoma

- 11-year-old girl with osteosarcoma

Giant cell tumor



Chondroblastoma

Benign Bone Tumors

Type	Incidence (% of all benign bone tumours)	Diagnosis	Pathology features	Treatment	Recurrence rates
Osteochondroma	35	Radiograph, CT and MRI are useful, but biopsy is necessary to confirm diagnosis	Lesions occurring in metaphysis and diametaphysis and projects out of the underlying the bone	Surgery necessary if active or aggressive	<2%
Giant cell tumour	20	Radiograph. CT or MR imaging may be useful	Soft, grey or red tumour often with small blood filled cysts	Necessary due to the risk of malignant transformation	20–50%
Osteoblastoma	14	Conventional radiology. MDCT plays a major role in identifying osseous matrix. CT or MRI may be helpful when there is no mineralisation of the cortex	Aneurysmal bone cyst may superimpose and may be associated with osteoblastoma. In long bones, periosteal reaction may be prominent	1st line: medical followed by controversial radio/chemotherapy or surgical removal	9.8%
Osteoma	12.1	Radiograph, CT and MRI are useful, but biopsy is necessary to confirm diagnosis	Tossseous tissue that comprises of condensed bone with a well-defined border, without surface irregularities or satellite lesions	Surgery necessary if active or aggressive	N/A
Osteoid osteoma	10.8–13.5	Radiograph, CT and MRI are useful, but biopsy is necessary to confirm diagnosis	Intracortical osteoid osteoma produces dense sclerosis around the nidus. Subperiostal type produces periosteal reaction while spongiosal type produces very little reactive bone.	Surgery necessary if active or aggressive	4.5%
Aneurysmal bone cyst	9.1	Radiograph, CT and MRI are useful, but biopsy is necessary to confirm diagnosis	Blood filled cavernous spaces with septa	Surgery necessary if active or aggressive	31%
Fibrous dysplasia	5–7	Radiograph. CT or MR imaging may be useful	Dense fibrous tissue with osteoid trabeculae	Surgery necessary if chronic bone pain consists after medical treatment, or if complicated by fractures	18%
Enchondroma	2.6	Radiograph, CT and MRI. Histologic evaluation necessary to exclude chondrosarcoma	Masses of hyaline cartilage in lobular formation	Consider if symptomatic or at risk of fracture	0.04%

Benign tumours of the bone: A review. J Bone Oncol. 2015 Jun; 4(2): 37–41.

Metastatic Bone Disease

- Presentation
  - Pain
  - Pathologic Fracture
  - Impending Fracture
- Treatment
  - Radiation
  - Bisphosphonates
  - Chemo
  - Hormones

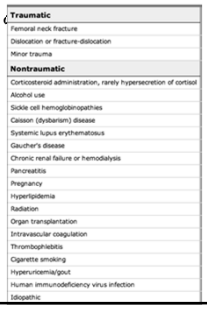
Management of skeletal metastases: An orthopaedic surgeon's guide. Indian J O 2015 Jan-Feb; 49(1): 83–100.

Metastatic Bone Disease

Management of skeletal metastases: An orthopaedic surgeon's guide. Indian J O 2015 Jan-Feb; 49(1): 83–100.

Avascular Necrosis

- Lunate
- Humeral head
- Femoral head
- Knee
- Tarsal Navicular
- 2nd MT head

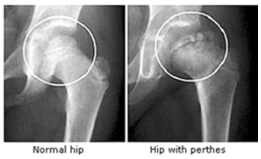


Traumatic
Femoral neck fracture
Dislocation or fracture-dislocation
Minor trauma
Nontraumatic
Corticosteroid administration, rarely hypersecretion of cortisol
Alcohol use
Sickle cell hemoglobinopathies
Caisson (dysbarism) disease
Systemic lupus erythematosus
Gaucher's disease
Chronic renal failure or hemodialysis
Pancreatitis
Pregnancy
Hyperlipidemia
Radiation
Organ transplantation
Intravascular coagulation
Thrombophlebitis
Cigarette smoking
Hyperuricemia/gout
Human immunodeficiency virus infection
Idiopathic

UpToDate

Legg-Calve Perthes

- Male to female ratio 3:1
- Short stature
- Younger age 4-8
- ? Coagulopathies
  - higher incidence of factor V Leiden mutation, protein S deficiency, elevated factor VIII, and prothrombin G20210A mutation in LCP patients, especially males
    - Vosmaer JBJS 2010
-



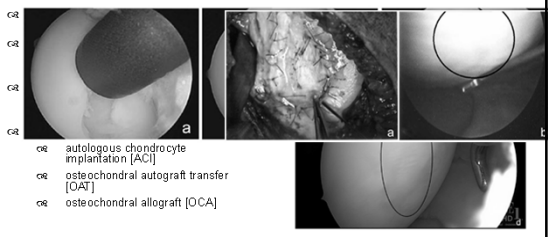
Normal hip Hip with perthes

Legg-Calvé-Perthes Disease An Overview with Recent Literature. Bulletin of the Hospital for Joint Diseases 2014;72(1):18-27

Labral tears

- Shoulder
- Hip

Osteochondral Lesions



- autologous chondrocyte implantation [ACI]
- osteochondral autograft transfer [OAT]
- osteochondral allograft [OCA]

Knee **Articular Cartilage Repair and Restoration Techniques: A Review of the Literature.Richter DL, Schenck RC Jr, Wascher DC, Treme G.Sports Health. 2016 Mar-Apr;8(2):153-60.**

Arthritis

- Primary
  - Degenerative
- Secondary
  - Disease driven
- Post Traumatic
  - Injury driven
- Erosive
  - Auto immune
  - Infectious
  - Neuropathic
- Injections
  - Cortisone
  - Hyaluronte
  - PRP
  - Stem Cells
  - Palpation vs guided
- Bracing
- Surgical
  - Fusion
  - TJA

Ligament Injuries

- Scapholunate ligament
- Thumb UCL
  - Stener lesion
- Elbow UCL
- HAGL lesion
- SC Separation
  - posterior
- AC Separation
  - Grade 3-6
- Lisfranc injury
- Syndesmotic injury
- Persistent instability after Grade 3 sprain of ankle and knee
- Cruciate ligament injury

Soft Tissue

- Gas

- Injected Material

Muscle

- Strains
- Contusion
- Myositis ossificans

Tendon

- Ruptures
  - Achilles
  - Peroneals
  - PTT
  - Quad
  - Patellar
  - Hamstring
  - RTC
  - Distal biceps
  - Long head biceps
  - FDP
- Calcific tendinitis
- Tenosynovitis
- Tendinopathies
  - Tendinitis
  - Tendinosis
- Trigger fingers
- Tendon subluxation
  - Snapping hip
  - Snapping triceps

Bursitis

- Ankle
  - Medial malleolar
- Knee
  - Pes anserine
- Hip
  - Greater trochanter
  - Iliopsoas bursa
- Elbow
  - Olecranon
  - Distal biceps (cubital)
- Shoulder
  - Subacromial
  - Subcorocoid

Nonemergent Referrals Urgent/Elective

- Structural
  - Congenital
  - Physeal/Apophyseal
  - Bone
    - Fracture
    - Tumor/Metastasis
    - Avascular necrosis
  - Joint
    - Cartilage
    - Ligament
    - Capsule
  - Soft Tissue
    - Muscle
    - Tendon
    - Bursa
  - Hardware
    - Retained ORIF
    - TJA
    - Foreign body/penetrating trauma
- Synovitis/Tenosynovitis
  - Rheumatologic
  - Crystal induced
  - Infectious
  - Reactive
- Neuromuscular
  - Entrapments
  - Dystrophies
- Arthralgias/Myalgias
  - Hemochromotosis
  - Vitamin D deficiency
  - Thyroid disorders
  - Medication induced
    - Statins
    - Accutane

Limping Child

- Initial workup
  - Labs
    - CBC, ESR, and CRP
  - X-ray
    - Pelvis and frog leg lateral of affected side

Non-weight bearing	
Erythrocyte sedimentation rate (ESR)	≥40 mm/h
White blood cell count (WBC)	>12 × 10⁹/L
Temperature	>38.5°C
Probability of Septic Arthritis	
Presence of 0 predictors	<0.2%
Presence of 1 predictor	3.0%
Presence of 2 predictors	40%
Presence of 3 predictors	93.1%
All 4 predictors present	99.6%

Table 1. Differential Diagnosis For The Limping Child

- Septic arthritis
- Osteomyelitis
- Toxic synovitis
- Juvenile rheumatoid arthritis (JRA)
- Rheumatic fever
- Fracture
- Tumor
- Legg calve perthes (LCP)
- Slipped capital femoral epiphysis (SCFE)

Transient synovitis, septic hip, and Legg-Calvé-Perthes disease: an approach t correct diagnosis. Pediatr Clin North Am. 2014 Dec;61(6):1109-18.

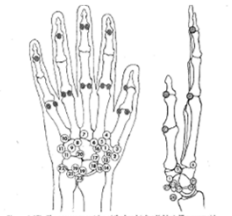
Rheumatologic

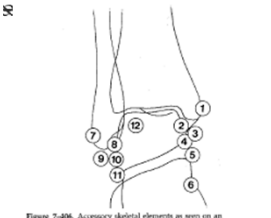
- ESR, CRP
- CBC
- CMP
- RF, anti-CCP
- fANA, anti-DS DNA ab
  - Complement
  - Ro ab
  - ssA, ssB
- HLA B27
- Anti-centromere ab, Anti-smooth muscle ab
- Thyroid ab
- 25 hydroxy vitamin D
- CK
- UA
- Synovial fluid analysis
  - Cell count
  - Crystals
  - Cultures

Hardware

- TJA
  - Loosening
  - Osteolysis
  - Wear
  - Dislocated poly
  - Periprosthetic fracture
- Retained
  - Migrating
  - Failure
- Penetrating foreign body

Accessory Ossicles



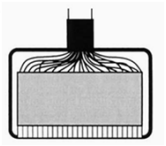


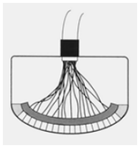
Musculoskeletal Ultrasound

- Advantages
  - Ready accessibility
  - Portability
  - Quick scan time
  - Dynamic
  - Better patient tolerability
    - No Badiation, No Side Effects, No Contraindications
  - Cost
  - Guided procedure(s)
  - Personal interaction with the patient
    - directed examination – extension of physical exam
    - specific for each individual
  - Scanning technique is easily modified, as needed, to optimize the diagnostic effectiveness of the study
    - contralateral comparison
- Disadvantages
  - Training
    - highly operator-dependent
  - Equipment
  - Time

Musculoskeletal Ultrasound Physics

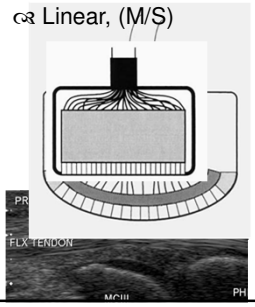
- Transducer
  - Emits sounds waves (1%) and detects returning echoes (99%)
  - Linear array (large footprint & obvious orientation)
  - Superficial > 10 MHz
  - Deep 5-7 MHz

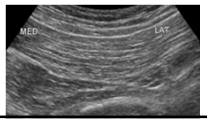




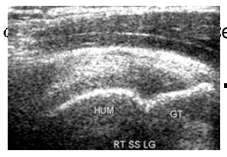
Physics of Sound Waves

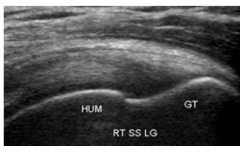
- Transducers
  - Linear, (M/S)
  - Curvilinear (OB/ABD)

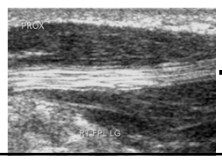


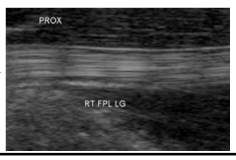


Musculoskeletal Ultrasound









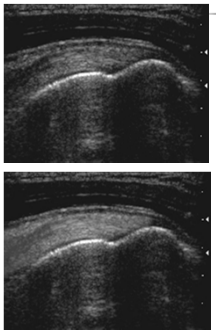
Musculoskeletal Ultrasound

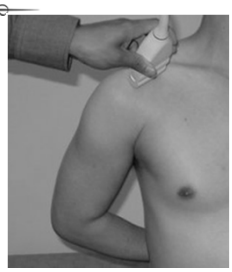
Musculoskeletal Ultrasound

MSK US Applications

- Diagnosis
  - RTC
  - Carpal tunnel
  - Achilles tendon
  - Synovitis
- Guided injections
  - Joint
  - Tendon
  - Cyst
- Percutataneous lavage
  - Calcific tendinitis
- Percutaneous release
  - TF
  - CT

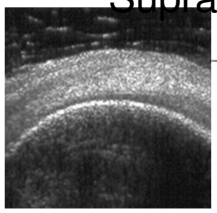
Supraspinatous

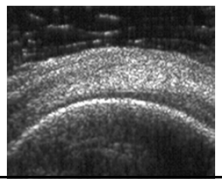




Longitudinal

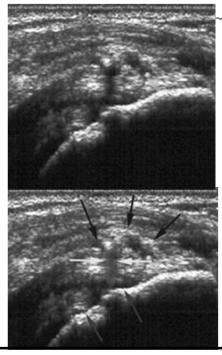
Supraspinatous

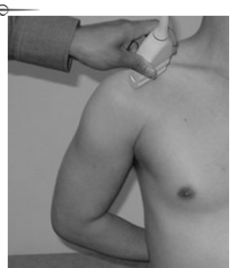




Transverse

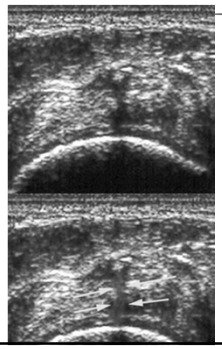
Small Full Thickness Supraspinatous Tear





Longitudinal

Small Full Thickness Supraspinatous Tear

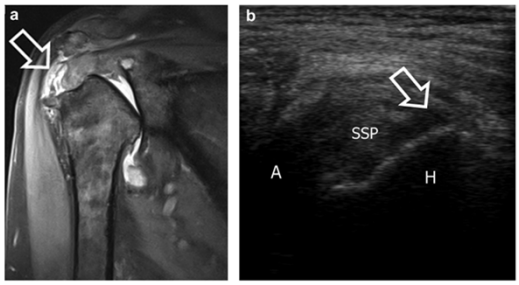


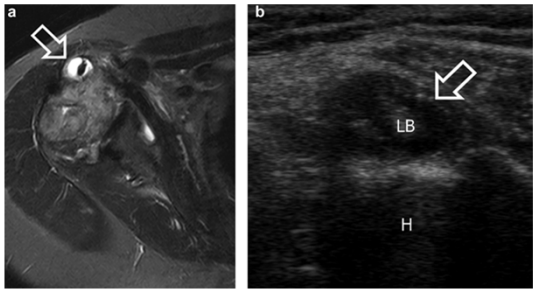
Transverse

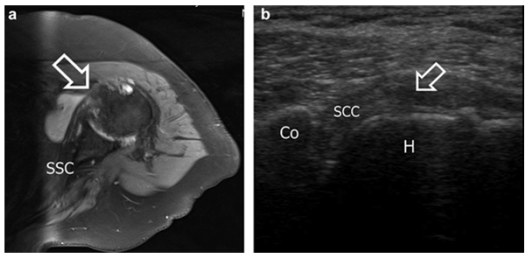
MSK US vs MRI

- Ultrasound detection of rotator cuff and biceps tendon integrity is comparable to MRI and should be preferred in revision cases.

Ultrasound vs. MRI in the assessment of rotator cuff structure prior to shoulder arthroplasty. J Orthop. 2015 Jan 28;12(1):23-30.







MSK US Carpal Tunnel

- Better specificity and equal sensitivity as compared with those of electrodiagnostic testing

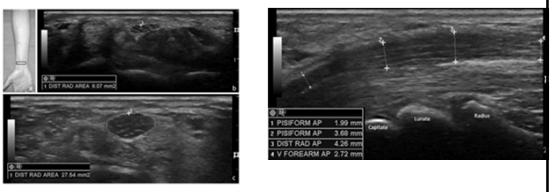
TABLE III Outcomes

	Ultrasound*	Electrodiagnostic Testing*
Sensitivity (%)	89 (77-95)	89 (77-95)
Specificity (%)	90 (72-97)	80 (61-92)
Positive predictive value (%)	94 (83-98)	89 (71-95)
Negative predictive value (%)	82 (64-92)	80 (61-92)

*The 95% confidence interval is given in parentheses.

Comparison of ultrasound and electrodiagnostic testing for diagnosis of carpa tunnel syndrome: study using a validated clinical tool as the reference standar Fowler JR, Munsch M, Tosti R, Hagberg WC, Imbriglia JE.J Bone Joint Surg Am 2014 Sep 3;96(17):e148.

MSK US Carpal Tunnel



Screening for Carpal Tunnel Syndrome Using Sonography. J Ultrasound Med 2011; 30:1657–1667

Ultrasound Guided Injection

- AMSSM 2014 Position Statement
  - Ultrasound guided injections vs Landmark guided injections
  - 717% increase in outpatient diagnostic MSK US from 2000-2009

Ultrasound Guided Injection

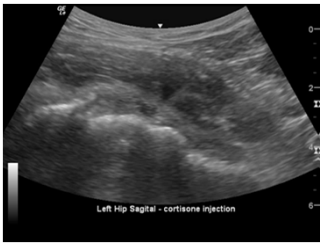
Table 1 Major joint injection accuracy

		Level of evidence				
		Level 1, mean (range) (%)	Level 2, mean (range) (%)	Level 3, mean (range) (%)	Level 4, mean (range) (%)	Level 5, mean (range) (%)
GH joint	USGI	100 (97–100)[8 15 39 42 46 49]	91 (89–93)[3 38]	–	100[16]	–
	LMGI	64 (27–100)[7 10 24 37 43 43 47]	73 (10–100)[5 11 17 25 26 28 38 60 61]	–	–	–
Hip joint	USGI	99 (97–100)[8 27 41 44 45]	–	–	100[10]	100[41]
	LMGI	–	73 (67–78)[12 50]	–	–	–
Knee joint	USGI	95 (75–100)[8 21 23 32 36 37]	98 (96–100)[3 9]	–	100[16]	100[25]
	LMGI	81 (62–100)[19 19 21–23 37 32 36 37 48]	74 (55–100)[3 9 10 13 26]	–	–	–
SI joint	USGI	40[19]	–	100[24]	–	–
	LMGI	–	–	–	–	–

GH, glenohumeral; LMGI, landmark-guided injection; SI, sacroiliac; USGI, ultrasound-guided injection.

Large joint injection

Large joint injection



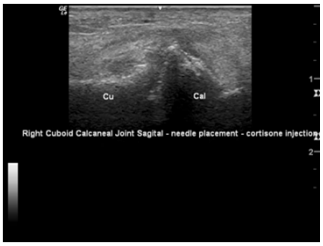
Small Joint Injections

Table 6 Small joint injection accuracy

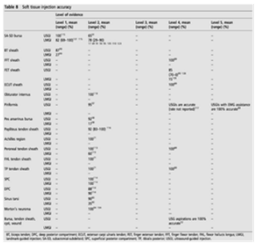
		Level of evidence				
		Level 1, mean (range) (%)	Level 2, mean (range) (%)	Level 3, mean (range) (%)	Level 4, mean (range)	Level 5, mean (range) (%)
CMC joint	USGI	–	94[32]	100[32]	–	–
	LMGI	–	–	0[30 32]		
MCP joint	USGI	–	–	–	–	–
	LMGI	97[31]	–	–	–	0[26]
IP joint	USGI	–	–	100[32]	–	–
	LMGI	–	–	0[32]	–	0[26]
TMT joint	USGI	–	64[48]	–	–	–
	LMGI	–	25[48]	–	–	–
MTP joint	USGI	–	100[77 83]	100[32]	–	–
	LMGI	–	–	0[32]	–	–
MCP and PIP joints	USGI	–	–	96[40]	–	–
	LMGI	–	–	59[40]	–	–

CMC, carpometacarpal; IP, interphalangeal; LMGI, landmark-guided injection; MCP, metacarpophalangeal; MTP, metatarsophalangeal; TMT, tarsometatarsal; USGI, ultrasound-guided injection.

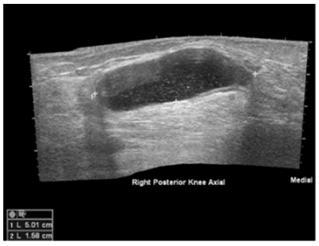
Small Joint Injection



Soft Tissue Injections



Baker's Cyst



Soft Tissue Injection

Soft Tissue Injection

Soft Tissue Injection

Evaluating for disability

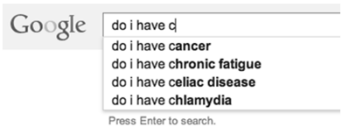
- Disability

- Injury

Before and After

- Teleconsultation
  - Assessment of imaging
  - Smart phone camera/display
  - Triage
  - Initial treatment/reduce waiting times
- HIPPA compliance

Dr. Google



Public Expectations

"These smug pilots have lost touch with regular passengers like us. Who thinks I should fly the plane?"

Clinically Correlate