Common MSK Injections & Joint Aspirations

Thomas V Gocke, MS, ATC, PA-C, DFAAPA
President & Founder
Orthopaedic Educational Services, Inc.
Boone, NC
osteojunky@gmail.com
www.orthoedu.com

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Faculty Disclosures

- ***Orthopaedic Educational Services, Inc.***
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American Academy of Physician Assistants
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PA Course Director, PA's Guide to the MSK Galaxy

Urgent Care Association of America
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Faculty, MSK Workshops

Ferring Pharmaceuticals
Consultant

Learning Goals

- Review the acute inflammatory response
- Describe role anesthetic agents
- Describe role corticosteroids
- Describe proper technique for providing injections to:
  - Shoulder/Sub-acromial space
  - Olecranon Bursa
  - Trochanteric Bursitis
  - Knee Aspiration/Injection
- Proper procedure documentation for injection/aspiration
- Provide discharge instructions for injection/aspiration

Corticosteroids

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Corticosteroids

- Glucocorticoids potent anti-inflammatory capabilities
- Primary anti-inflammatory mechanism
  - inhibits various leukocyte inflammatory events
  - inhibits the two main products of inflammation
    - Prostaglandins
    - Leukotrienes
- Solubility
  - More soluble: less duration: less chance flare
  - Less soluble: longer duration: more chance flare
- Goals
  - Maximize anti-inflammatory effects
  - Minimize adverse effects

Injectable Corticosteroids

Steroid solution	*Potency*	*Half-life*	*Onset/Duration*	*Dose/Volume*
Hydrocortisone (Hydrocortisone)	low	8-12 hrs	Short/Short	50mg/ml
Triamcinolone acet (Kenalog)	Interm	12-36 hr	Intrm/Intrm	4mg/ml
T**riamcinolone** (Aristospan)	Interm	12-36 hr	Intrm/Intrm	40mg/ml
Methylprednisolone (Depo-Medrol)	Interm	12-36 hrs	Intr/long/Intr/long	40 mg/mL
Betamethasone acetate (Celestone)	High	26-54 hr	Longer/Longer	6 mg/mL
Dexamethasone acetate	High	26-54 hr	Longer/Longer	8 mg/mL

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Corticosteroids

- **Risks**
  - Blood sugar elevation
  - Skin pigmentation changes
  - Fat atrophy
  - Infection
  - Articular cartilage loss (AVN)
  - Steroid Flare reaction
  - Tendon rupture
  - Suppress calcium absorption (osteoporosis)
  - Wound healing issues

Corticosteroids

- Seshadri, Coyle & Chu J Arthroscopy & Related Surgery 2009
  - Methylprednisolone & Lidocaine
  - 20-40-80mg/ml & Lidocaine 1%
  - Synergistic effects steroid & Lidocaine
  - Chondrocyte degradation
  - Higher the dose the more the degradation

"*This study clearly shows a dose and time dependent decrease in chondrocyte viability after exposure to methylprednisolone treatment and synergistic decrease in chondrocyte survival*"

- Seshadri, Coyle & Chu: J Arthroscopy & Related Surgery, April 2009, 25(4):337-347

Corticosteroids

Syed, et al; Clinical Orthopaedics October 2011

- Bupivacaine and Triamcinolone
- Single med, combined med (w or w/o buffering)
- Alone or combined Bupivacaine & Triamcinolone showed chondrotoxicity

Syed HM, Green L,Bianski B, Jobe CE, Wongworawat MD: Bupivacaine and Traimcinolone May Be Toxic to Human Chondrocytes: A Pilot study; Clinical Orthopaedics and Related Research, October 2011, 469:10: 2941-2947

Local Anesthetic Agents

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Local Anesthetic Agents

Local anesthesia

- General goal to reduce pain perception
- Can be use for nerve block causing paralysis/paresthesia
- Actions:
  - Local anesthetics are sodium membrane stabilizing drugs
  - **Act mainly inhibiting sodium influx thru sodium ion channels in the nerve cell membrane**
  - **Sodium channel gets blocked and impulse stops**
  - Decrease the rate of depolarization and repolarization of excitable membranes (nociceptors)

Injectable Anesthetic Agents*,**

Anesthetic Agent	*Onset*	*Duration*	*Max Dose*
Lidocaine 1-2% (Xylocaine)	<2min	1-2 hrs	4mg/kg(30ml)*
Mepivacaine 1% (Carbocaine)	3-5 min	1-2hrs	4mg/kg(50ml)**
Prilocaine 1% (Citanest)	<2min	>1 hr	7mg/kg(28ml)**
Bupivacaine 0.25% (Marcaine -0.125%, 0.25%, 0.5%	5min	2-12hrs	2.5mg/kg(50ml)**
Etidocaine 0.5%, 1% (Duranest)	5min	2-3 hrs	4mg/kg

Total milliliter (ML) max dose based on 70kg patient*,**

***http://dailyem.wordpress.com/2012/11/13/quick-er-math-max-dose-lidocaine-for-local-anesthesia/**

**** http://lifeinthefastlane.com/education/procedures/local-anaesthetic/**

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Local Anesthetic Agents

- Dragoo et al: AJSM 2012 Single dose local anesthetic agents
  - Lidocaine & Bupivacaine & Ropivacaine
  - 1%, 0.25 % & 0.5%
  - Bupivacaine 0.25% over 6-12 hrs no significant chondrocyte injury
  - Lidocaine 1% & 2% chondrotoxic
  - **Lidocaine 0.5, Bupivacaine 0.25%, Ropivacaine 0.5% no chondrotoxicity**

Dragoo, Braun, Kim,Phan & Golish: the In Vitro Chondrotoxicity of Single Dose Local Anesthetics, Am J Sports Med; April 2012:40(4): 794-799

Injections & Aspirations:

Therapeutic vs. Diagnostic

Injection considerations:

- 1 injection Q 3-4 months (3-4 times/yr.)
  - One injection vs. multiple injections

- Exceptions to rule
  - Age
  - Arthritic changes
  - Co-morbid conditions
  - Inability to participate other therapies

- Steroid solutions similar to anesthetic agents
  - Onset vs. Duration

- Multi-dose Vial vs. Single dose vial *
  - Storage
  - Security- Room vs. Central storage

*Kirschke, Jones,Stratton,Barnett & Schaffner: Outbreak of Joint and Soft-Tissue Infections Associated with Injections from Multiple-dose medication Vials; Clinical Infectious Disease; Jan 2003, 36(11);1369-1373

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Injection Danger Areas

- **Skin tattoos**
- **Cellulitis**
- **Folliculitis**
- **Psoriasis/Eczema**
- **Abrasions/Lacerations**

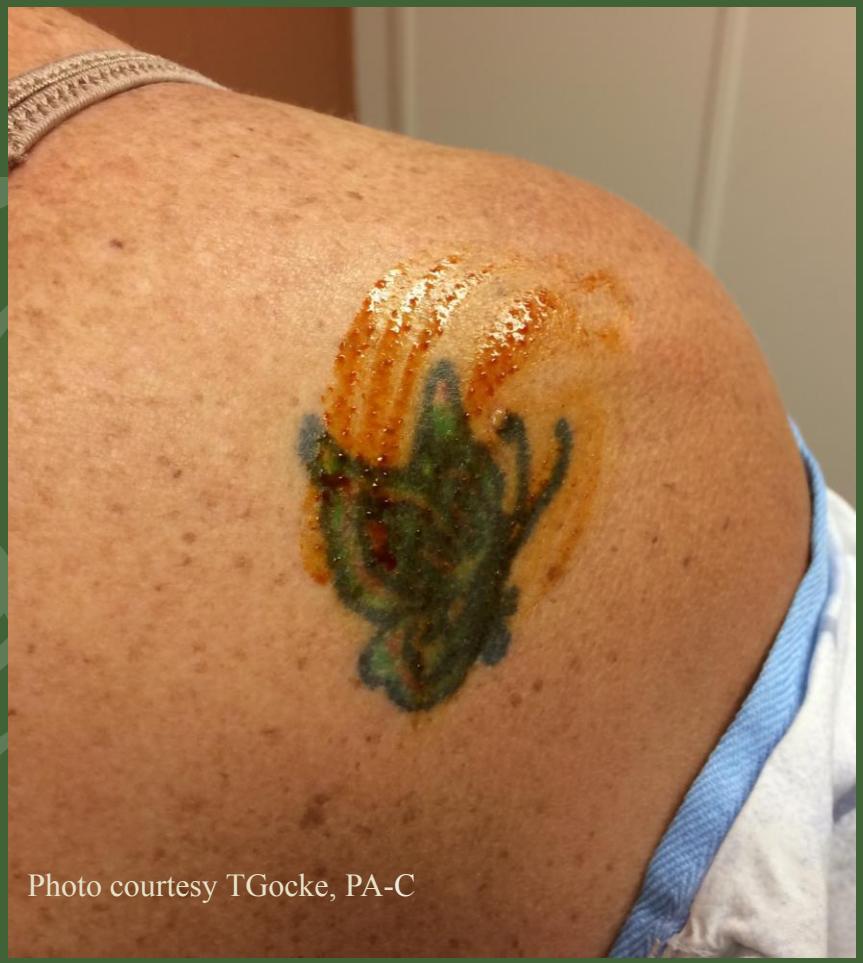

Photo courtesy TGocke, PA-C

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Injection Procedures Checklist

- Patient positioning
- Skin evaluation
- Injection/Aspiration Landmarks
- Assemble Injection solutions/materials
- Sterile Skin Prep
- Procedure
  - Confirm Injection/Aspiration Landmarks
  - Anesthetize skin (Xylocaine vs. Vapocoolant spray
  - Needle position
- Post Injection Instructions

Polishcuk A: Skin Sterility after Application of Ethyl Chloride Spray,JBJS Jan 2012, 94:118

Schleicher WF: Skin Sterility after Application of Vapocoolant Spray, Am Society Derm Surgery, 2014 4;40: 1103-1107

Shoulder

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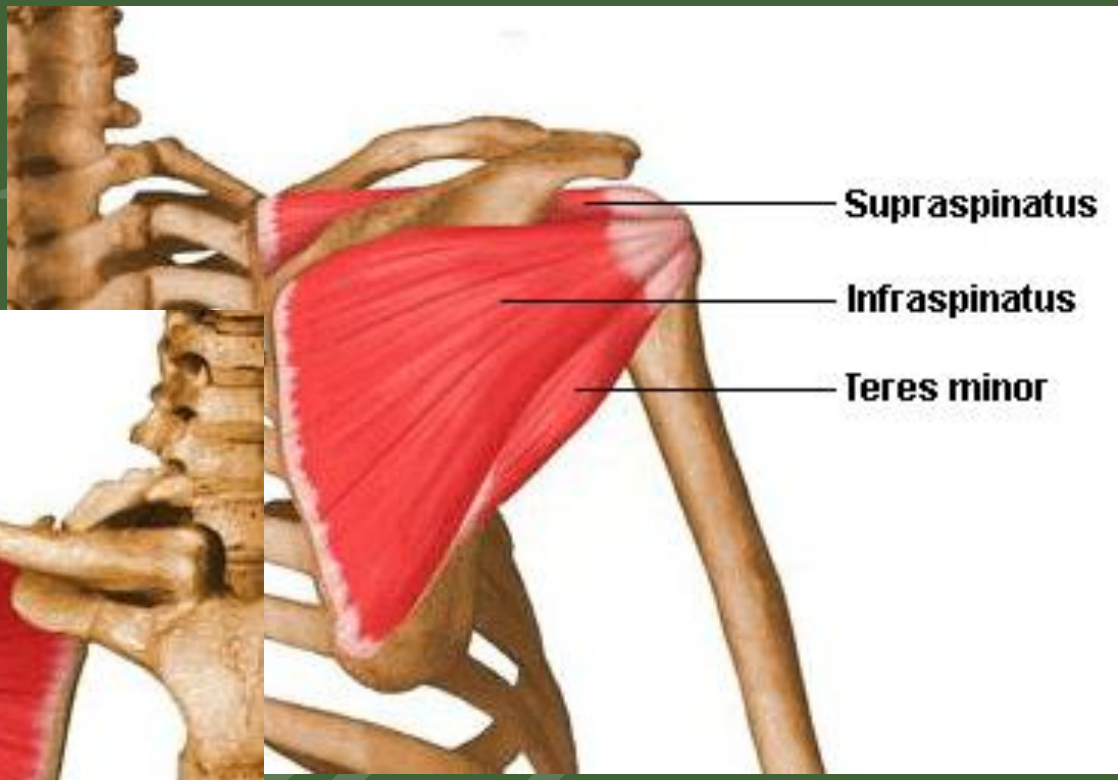
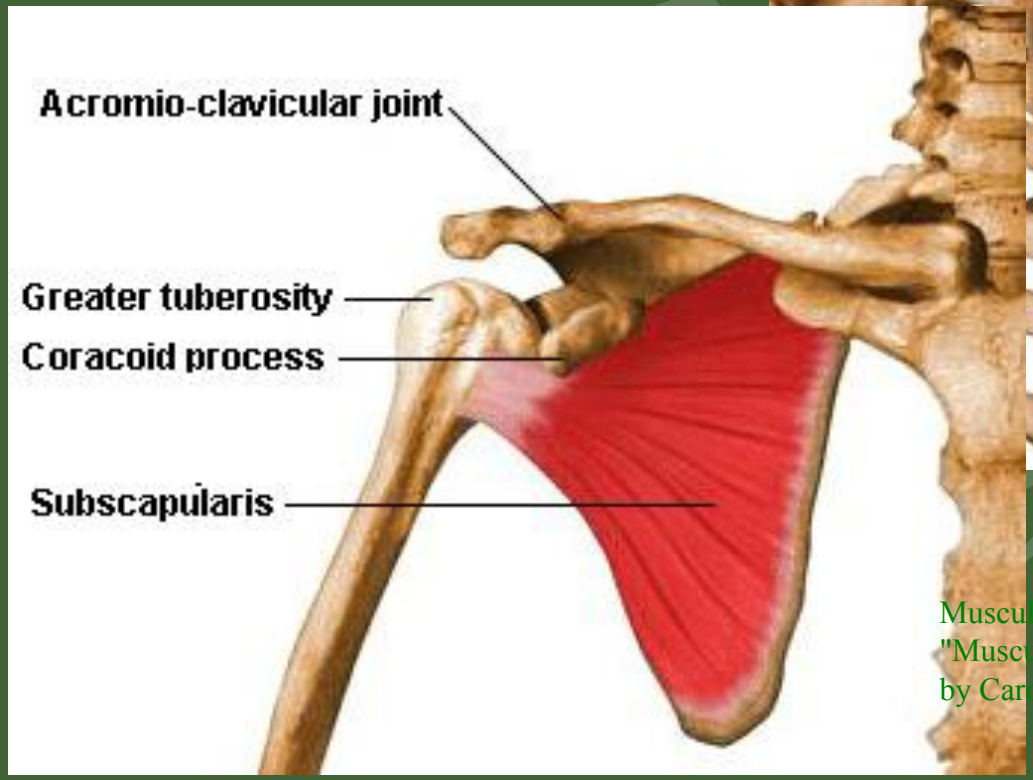
Shoulder Anatomy





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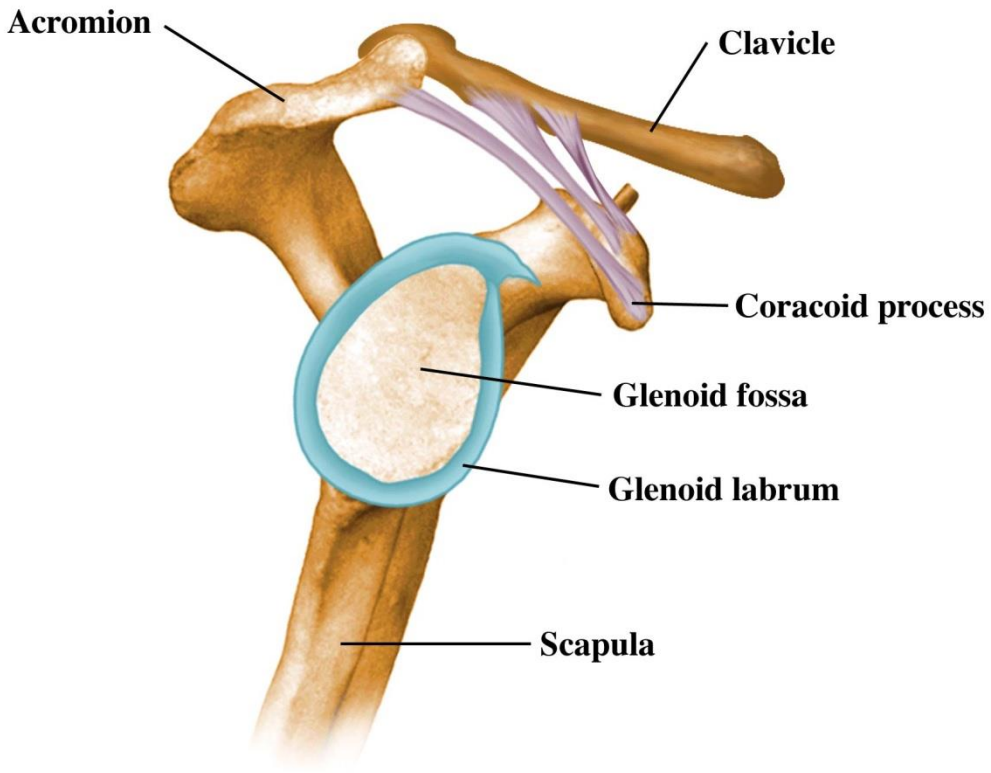
Shoulder Anatomy



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Subacromial Injection

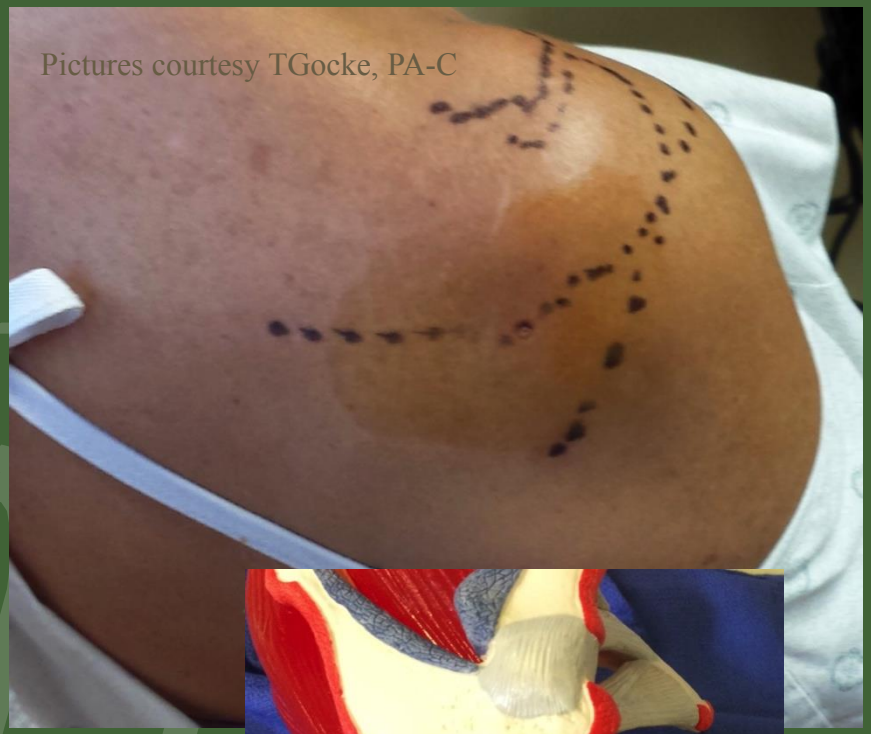
- Determine if appropriate
- Medical problems
  - Diabetes: rescue therapy/monitor blood sugar
  - Document conversation
- Skin check
- Select injection solution
  - Bupivacaine, Lidocaine
  - Corticosteroid
- Identify landmarks
- Sterile Technique
- Post - injection instructions

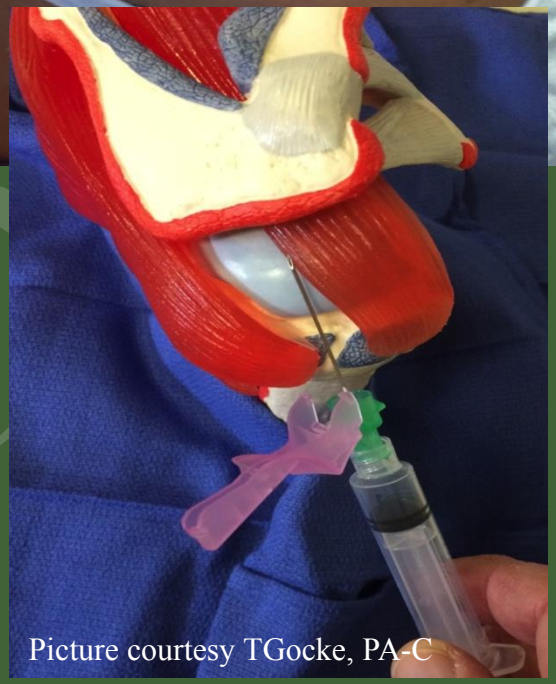
Subacromial Injections

Lateral Approach

- Beginners frequently give intramuscular injection
- More frequent post-injection pain
- Sitting position arm dependent
- Identify lateral edge of acromion
- 1-2cm inferior to lateral edge acromion
- Slight superior angle to hit sub-acromial space

- ***3ML 0.25% Bupivacaine and 2 ml Kenalog 40mg/ml 21/22 gauge needle***





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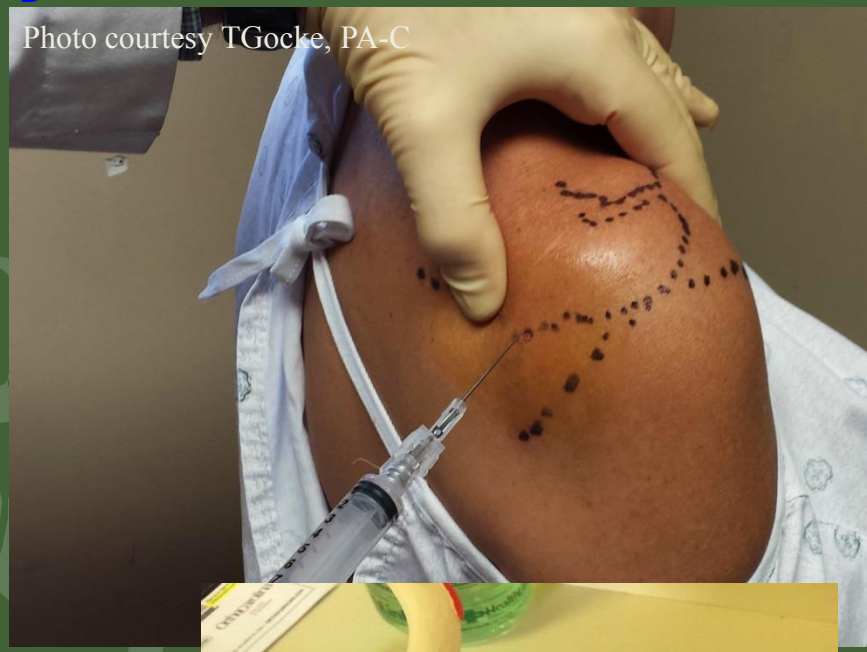
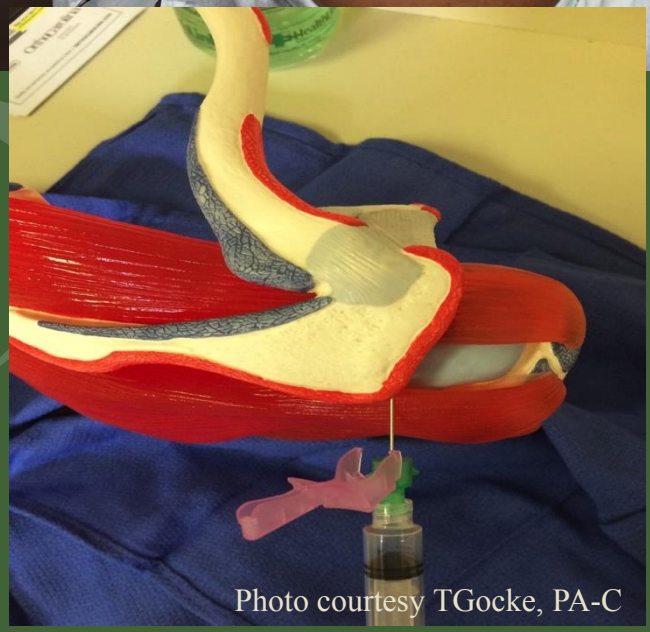
Subacromial Injections

Posterior Approach:

- Posterolateral arthroscopy portal region
- Sitting position with arm dependant
- Identify posterior rim acromion spine
- Slight cephalad angle
- Aim towards coracoid
- Select analgesic & steroid preparation

- ***3ML 0.25% Bupivacaine and 2 ml Kenalog 40mg/ml 21/22 gauge needle***





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Posterior Approach Shoulder Injection

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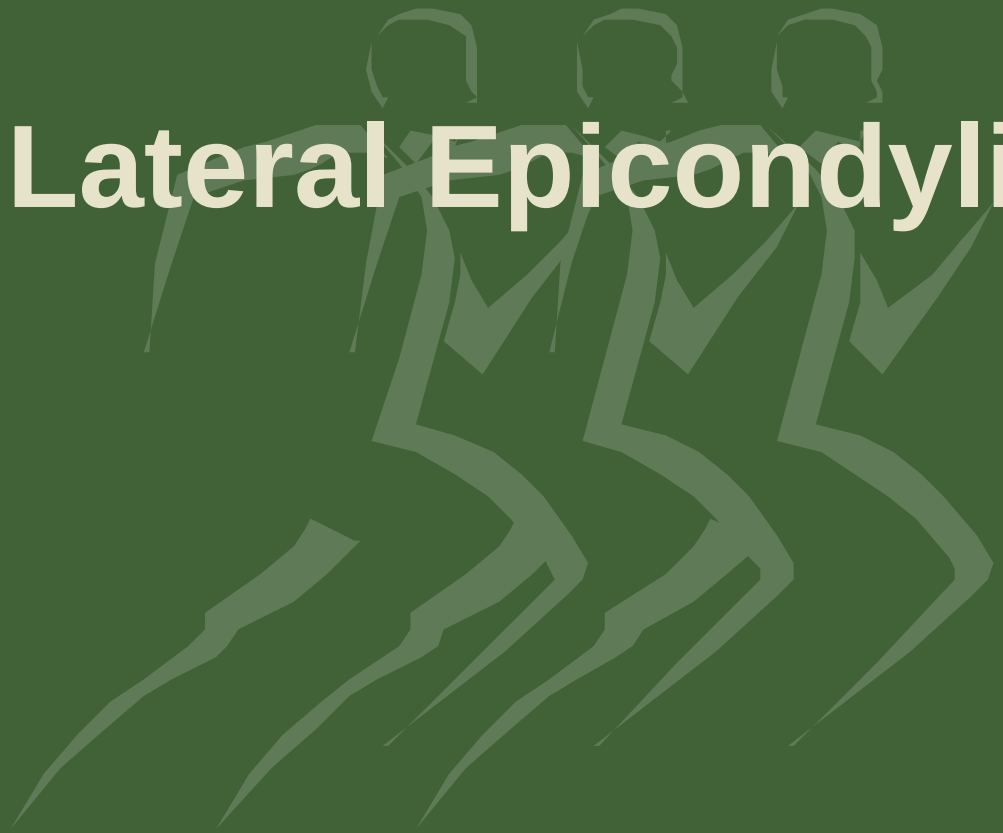
Lateral Epicondylitis



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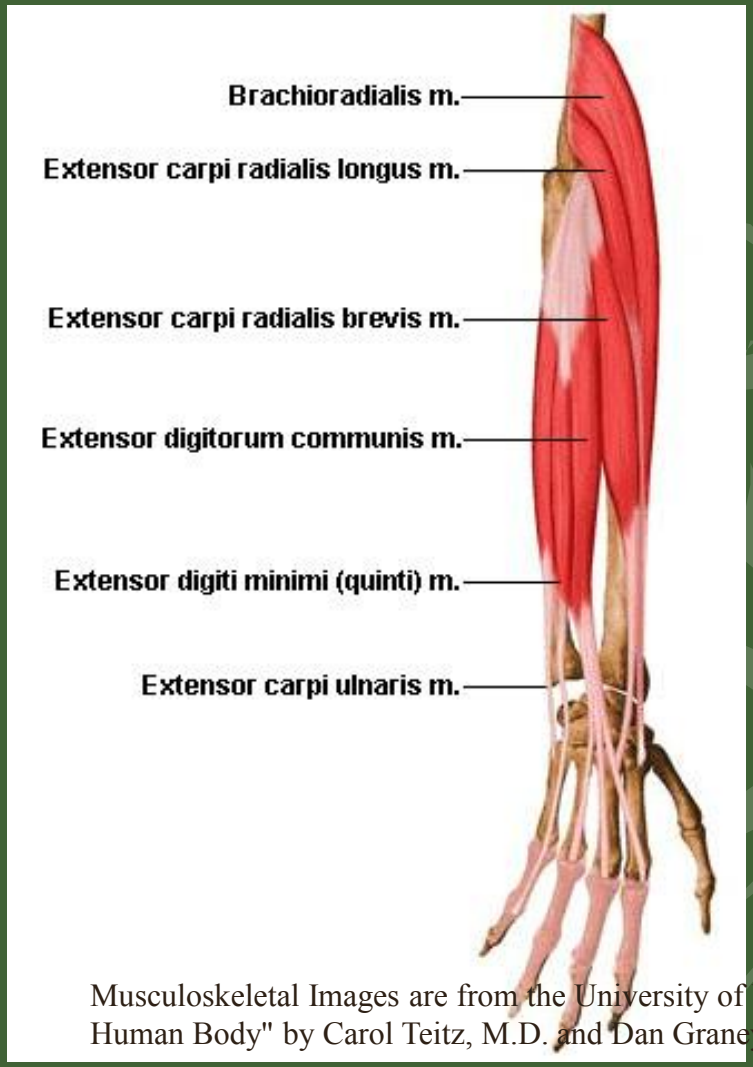
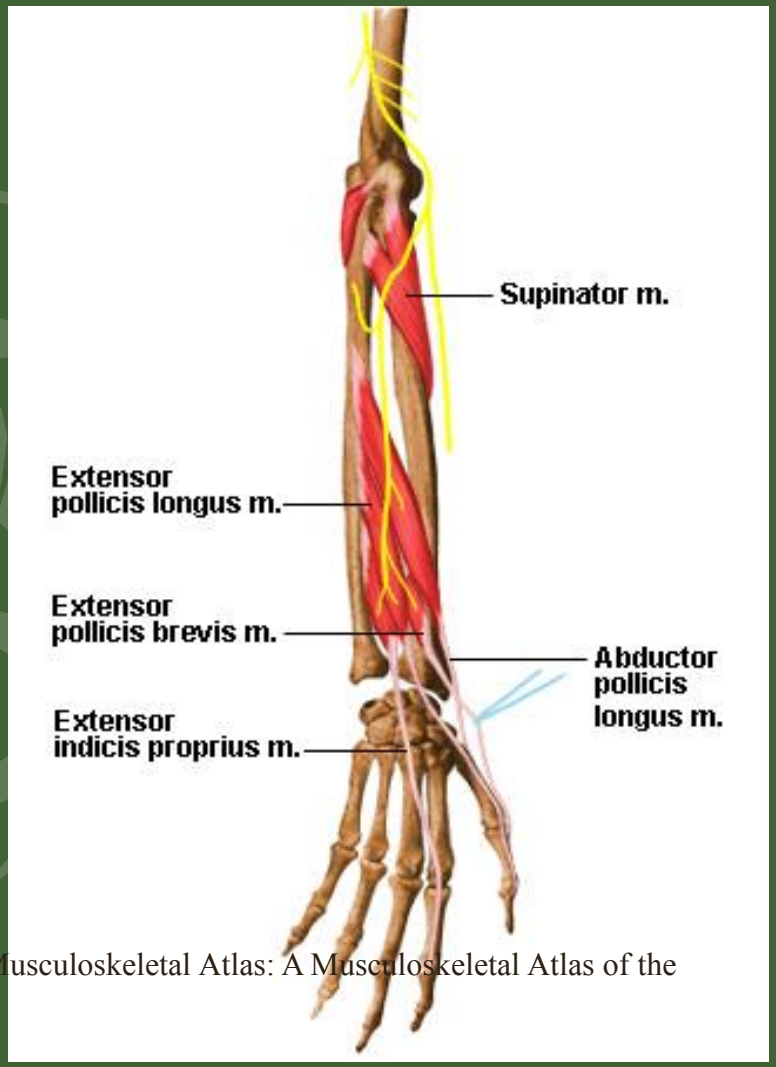
Lateral Epicondylitis





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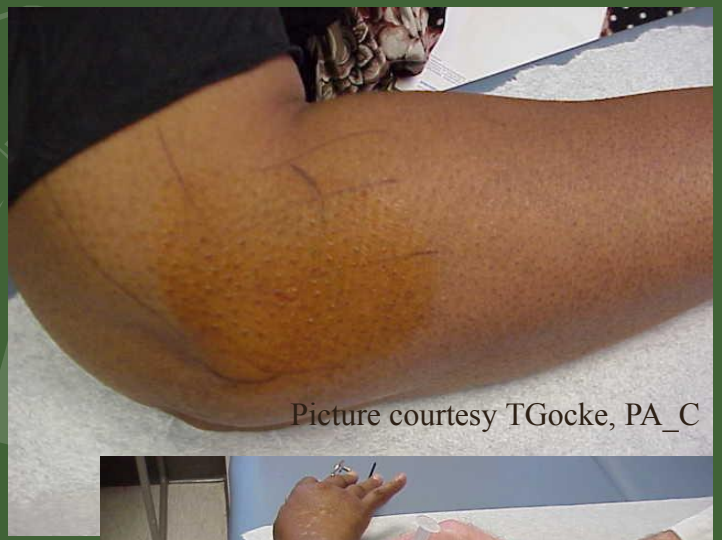
Lateral Epicondylitis

- Steroid injection reminders
  - Localize ECRB & Lat. Epicondyle
  - End flexed elbow crease
  - “Go to the bone”
    - Inject tissue/bone interface
    - ***1ML 0.25% Bupivacaine and 1 ml Kenalog 40mg/ml 26 gauge needle***


Picture courtesy TGocke, PA_C

- ***Post Injection Concerns***
  - Localized numbness sensory radial nerve
  - Ice for pain relief
  - Caution activity
  - Resume therapy
  - Discharge Instructions


Picture courtesy TGocke, PA_C

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Lateral Epicondylitis Injection

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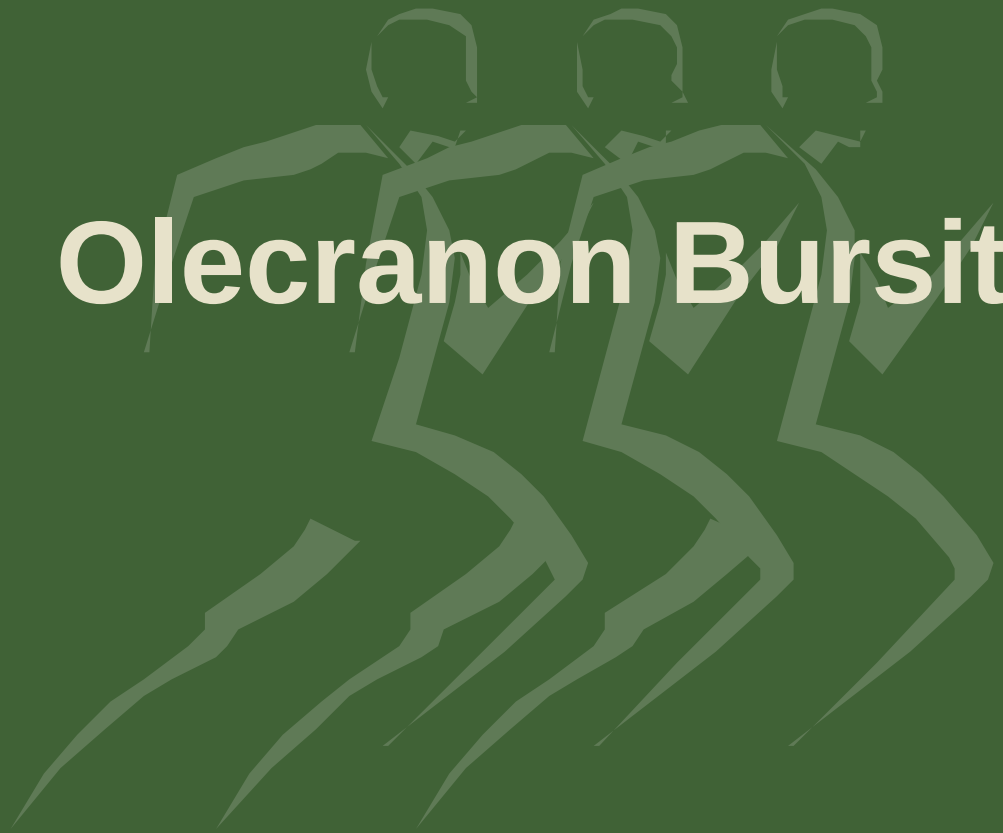

Olecranon Bursitis

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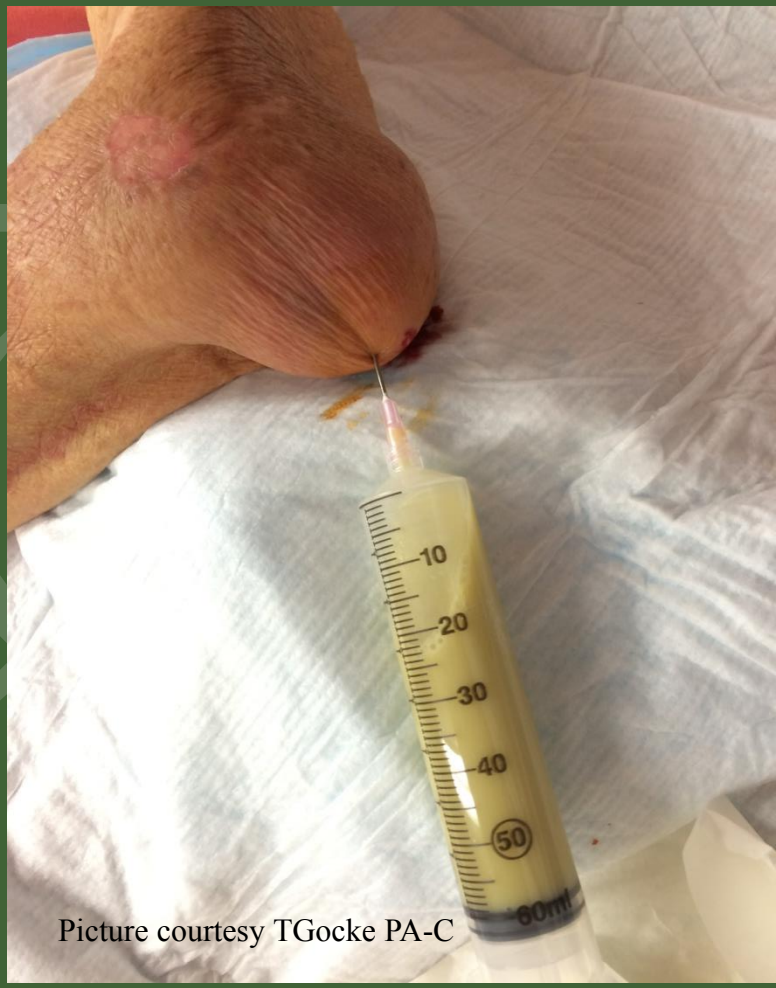
Olecranon Bursitis

- **“Water on the Elbow”**
- Olecranon bursa lies between bony olecranon & skin
- Very superficial bursa and easily traumatized
- Acts to decrease friction between bone and skin
- Inflammation results from overuse, trauma or infection
- Chronic disease states can cause inflammation
  - Gout
  - Pseudogout (CPPD)
  - RA
- Repetitive stress positions can cause inflammation
  - Results for constant contact pressure on bursa
  - Forward leaning position

Aspiration/Injection

- Patient supine position
- Betadine vs Hibiclens skin prep
- Ethyl Chloride
- Lidocaine/skin prep 2nd time
- Sterile gloves
- Pinch skin at injection site
- Aspirate Fluid
  - Synovial (lemonade)
  - Pus (milkshake)
- **INFECTion - STOP**
  - **NO STEROID**
  - **Not infected**: ***3ML 0.25% Bupivacaine and 2 ml Triamcinolone 40mg/ml 21/22 gauge needle***



Picture courtesy TGocke PA-C

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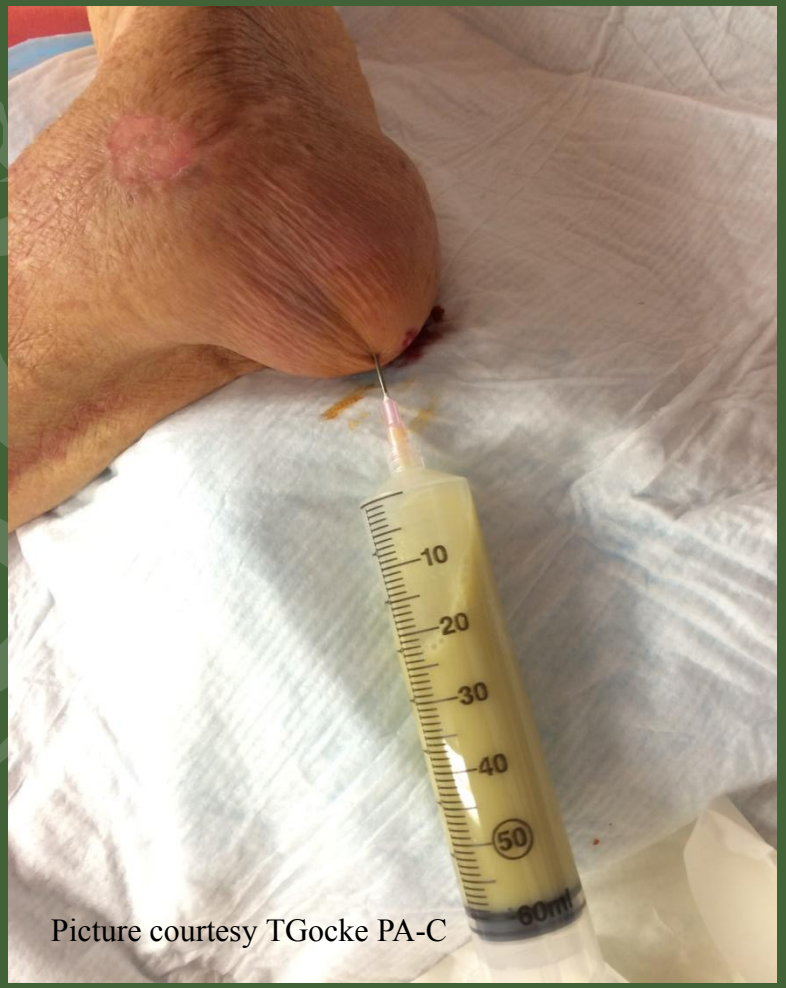
Olecranon Bursitis

Aspiration/Injection

- 30 or 60 ml syringe – aspirate
- 18 gauge needle – aspirate
- Lidocaine vs. Ethyl Chloride
- Prepare for infection labs



Picture courtesy TGocke PA-C

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	Septic Bursitis	Non-Septic Bursitis	Crystals
Fluid Appearance	Purulent	Straw-Serous	Straw-Serous-Bloody
Leukocytes per uL	1.500 – 300,000 Mean # 75,000	50-11,000 Mean 1,100	1-6,000 Mean 2,900
CBC/Differential	>10,000 Polymorphonuclear cells	<1,000 Mononuclear cells	<1,000 Variable
Glucose Ratio	< 50% blood glucose	>50% blood glucose	?
Gram Stain	+ > 70%	Negative	Negative (?)
Crystals	None (?)	None	Monosodium urate crystals- Gout Calcium pyrophosphate or hydroxyapatite crystal- Pseudogout
Culture	Staph Auerus & Epidermiidis (90%) Streptococcal species	None	

McAfee JH, Smith DL: Olecranon and Pre-patellar Bursitis: Diagnosis & Treatment, Western Journal Medicine Nov 1988, 149:5;607-610

Ganglion Cysts

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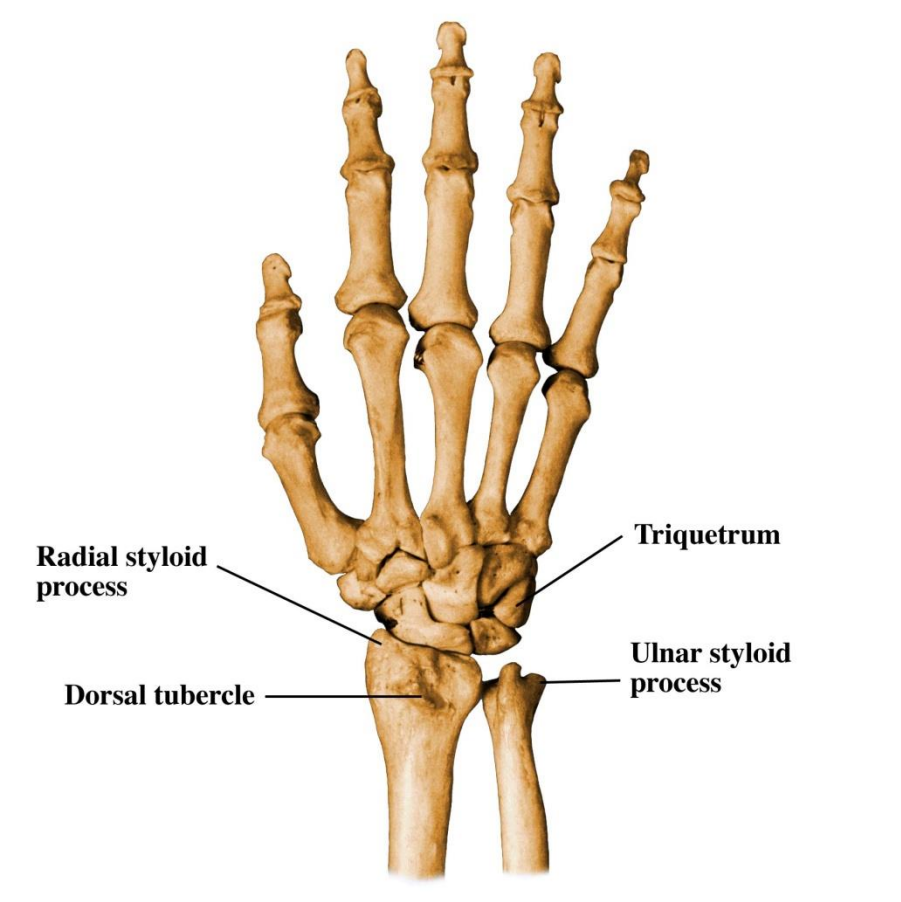
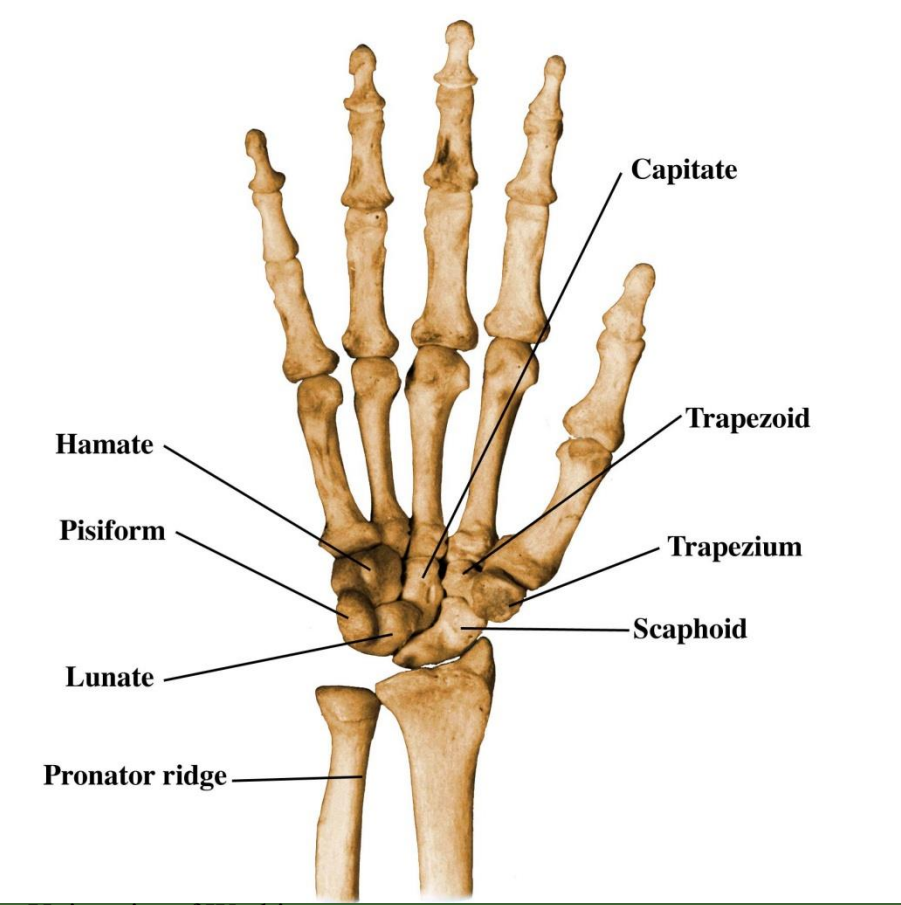
Wrist Anatomy





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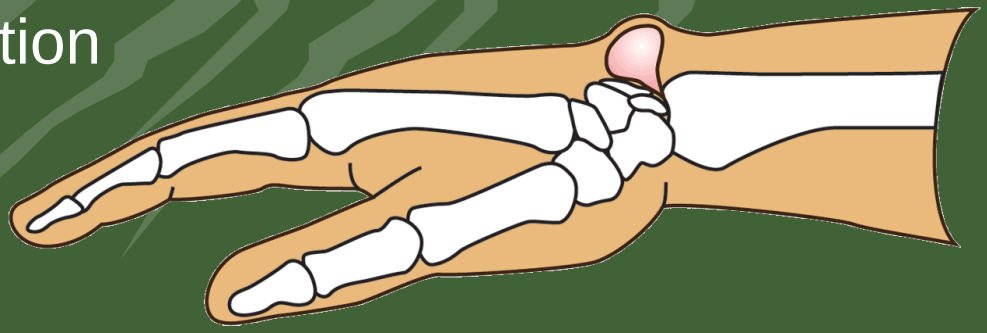
Ganglion Cysts

- Most common soft-tissue tumors of the hand
- Modified synovial cells
- Connected to joints or tendon sheaths
- **Occurs as a result of a tear in the joint capsule and allows synovial tissue to herniate out of the joint**
- Commonly occur dorsal wrist, volar wrist (radial), fingers (dorsal finger DIP – Mucous cyst)
- Transilluminate
- Transient presentation
- Size Fluctuates



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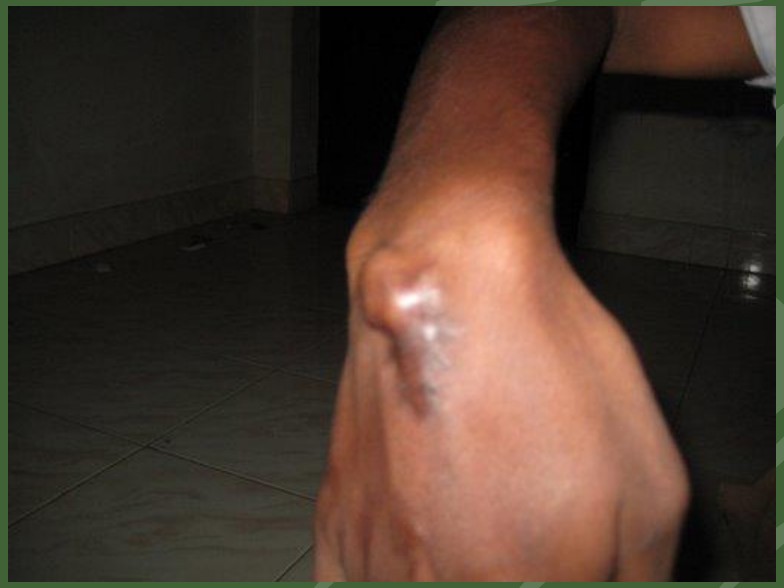
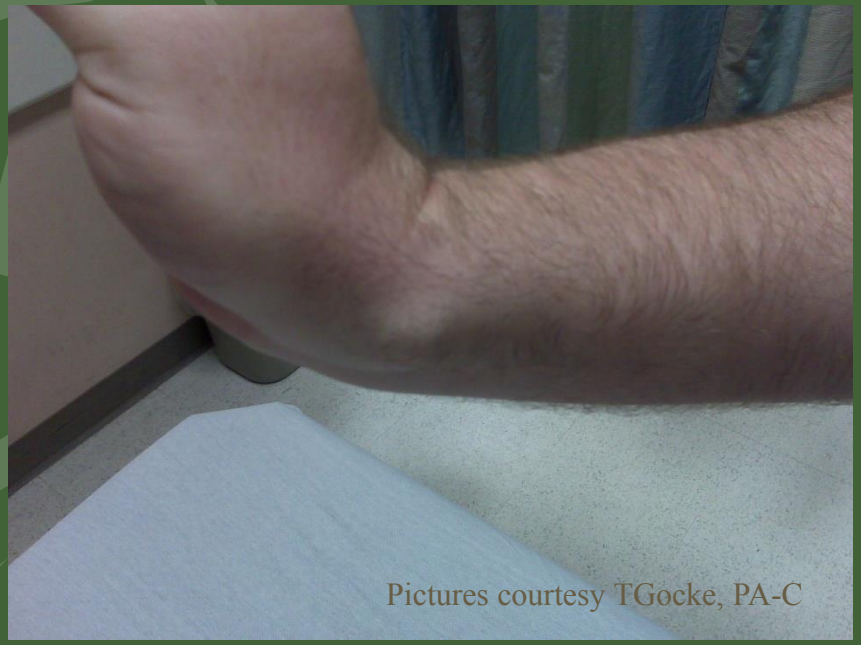
Ganglion Cysts

Dorsal Wrist



Volar Wrist (radial)



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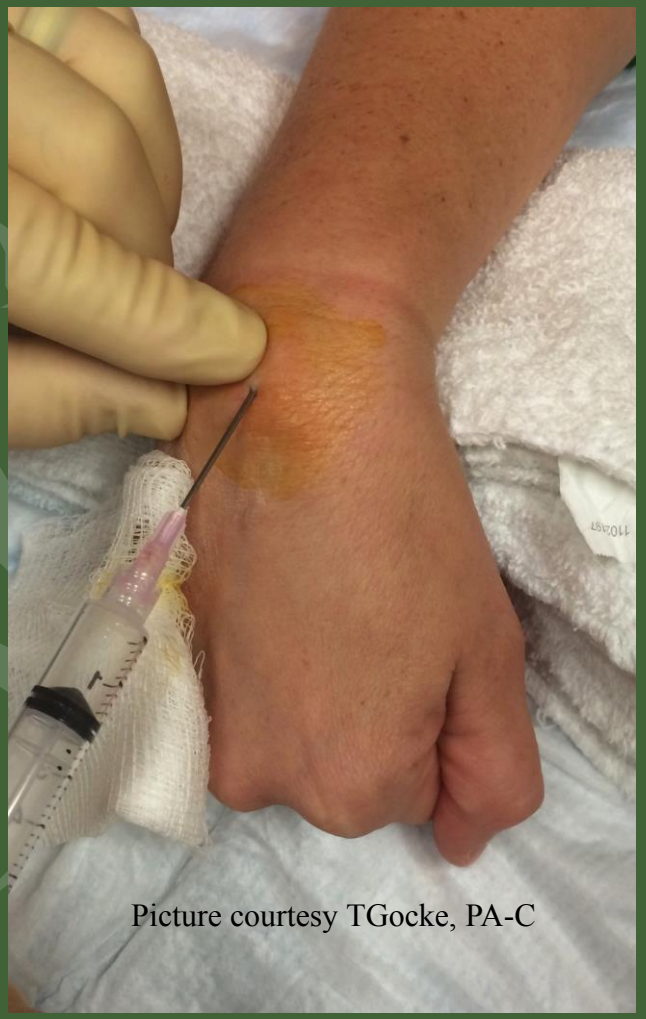
Ganglion Cysts

Treatment

- Isolate Dorsal wrist Ganglion
- Prep skin
- Anesthetize skin with “freeze spray” 2 ml Lidocaine
- Use 18 or 20 gauge needle to aspirate
- Do not remove aspiration needle
- Change syringe for injection
  - ***1ml Bupivacaine 0.25% & 1 ml Triamcinolone 40mg/ml***



Picture courtesy TGocke, PA-C

Inform Pt ganglion will probably come back

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HIP & PELVIS

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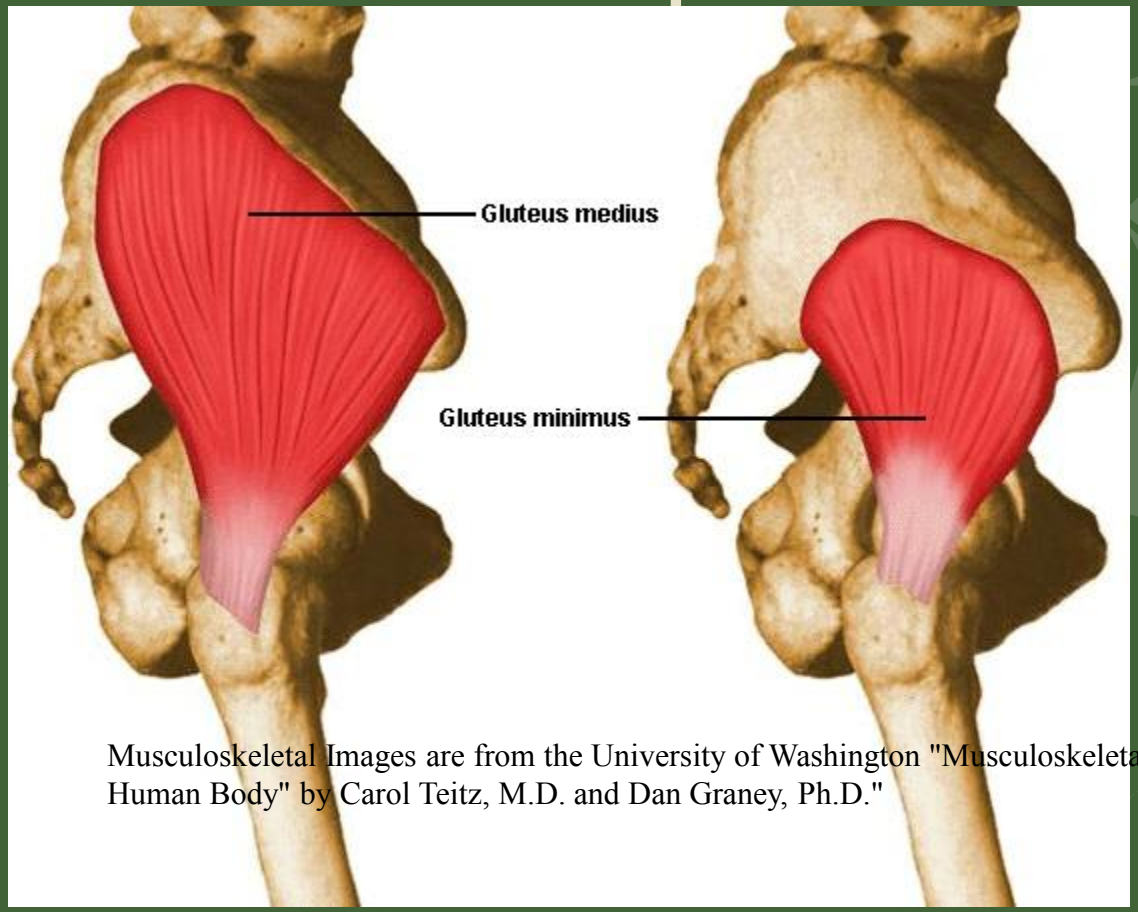
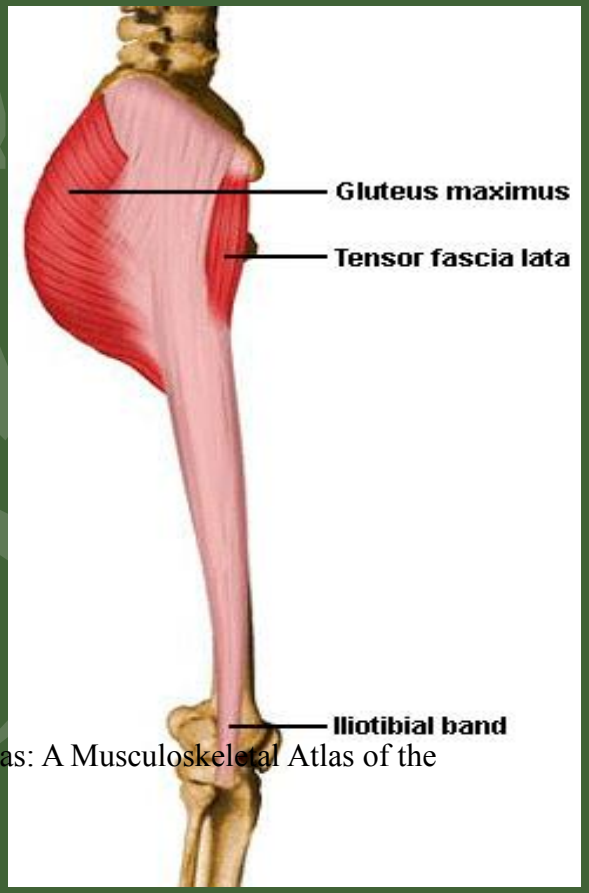
Hip Anatomy





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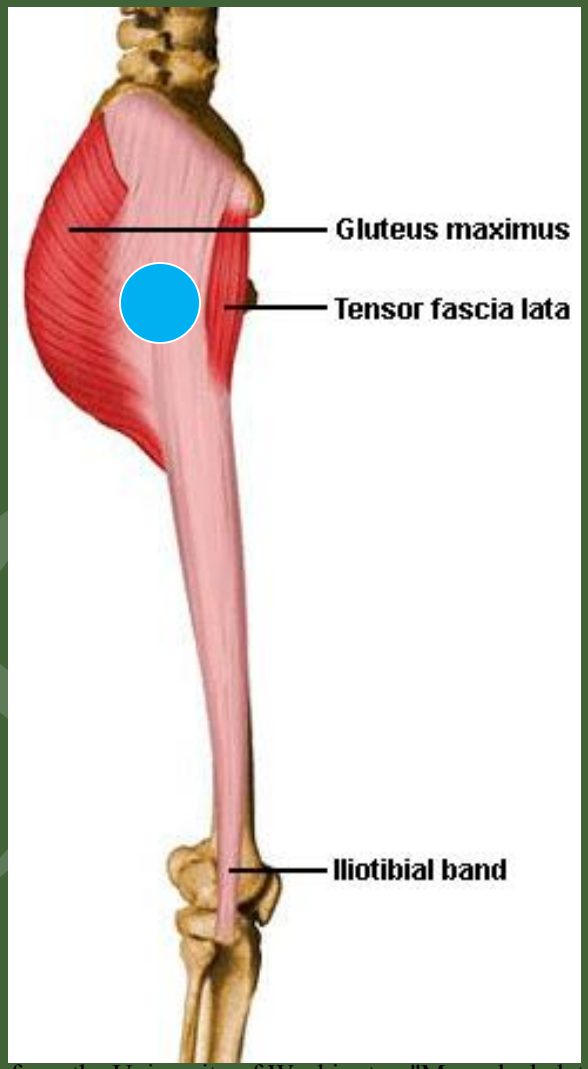
Trochanteric Bursitis

- **Clinical Presentation:**
  - Mechanism of injury
    - Variable trauma
    - Sedentary
    - Change activity
  - Symptoms
    - Start-up pain
    - Sitting
    - **Side sleeping position**
    - **Isolated lateral hip pain**

Groin or Butt pain think something else



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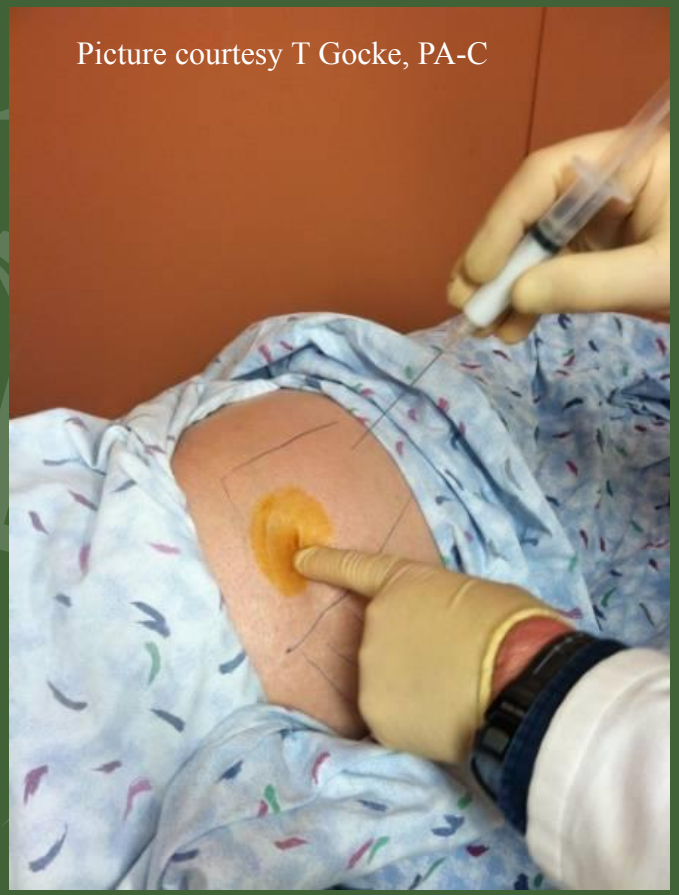
Trochanteric Bursitis Injection

- Consider other problems vs. Trochanteric bursitis:
  - Lumbar radiculopathy
  - Sacroiliac (SI) joint dysfunction
  - Gluteal Muscle/tendon – Quadratus laborium
  - Dysplastic hip disease
  - Femoroacetabular Impingement (FAI)
  - Hip Osteoarthritis
- Medical problems
  - Diabetes: rescue therapy/monitor blood sugar
  - Document conversation

Trochanteric Bursitis

- **Procedure:**
  - Confirm Trochanteric bursitis
  - Lateral decubitus position
  - Identify point of maximal tenderness
  - Skin prep (Betadine vs. Hibiclens)
  - Ethyl Chloride
  - Injection solution
- ***3ml Bupivacaine/ 2 ml Lidocaine &***

  1-2 ml Triamcinolone 40mg/ml
  - ***Spinal needle 22 gauge vs. 1 ½ inch needle***



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Trochanteric Bursitis Injection

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KNEE

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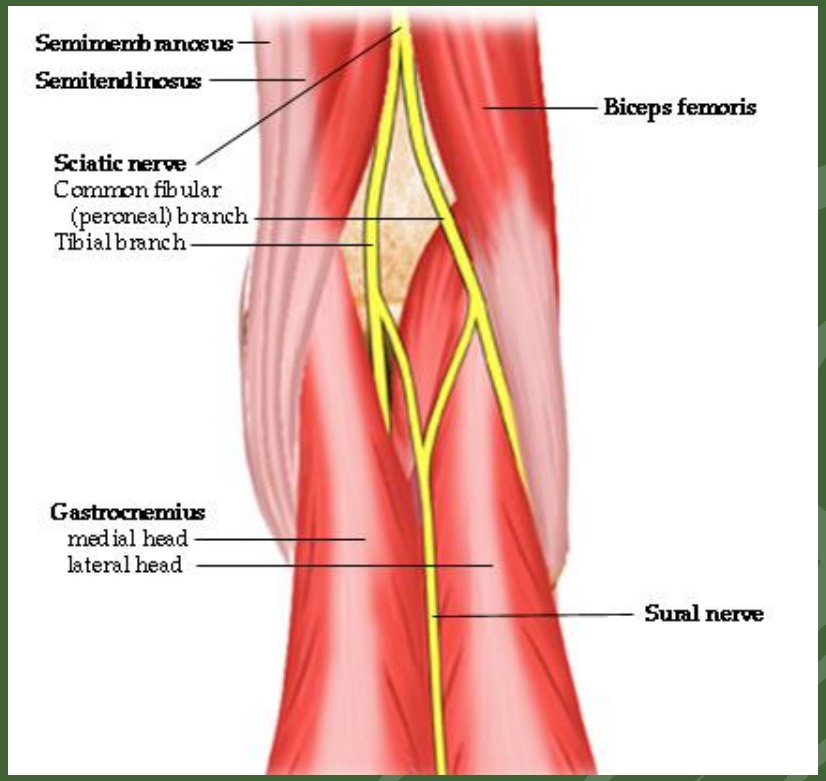
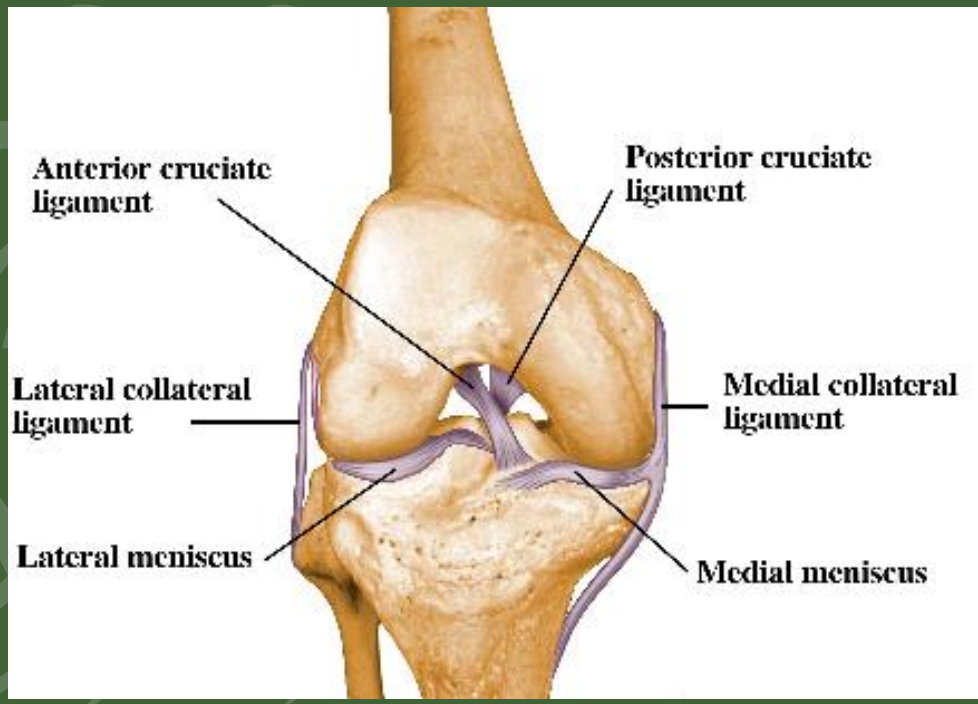
Knee Anatomy





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Knee Injection

- Injection has its purpose
  - Know your patient
    - Most want “rescue” therapy for pain
    - Hx OA or knee problems
    - **TKA- Danger close with aspiration/injection**
    - Any uncertainty abort injection
  - **Effusion: best if aspirated before injection**

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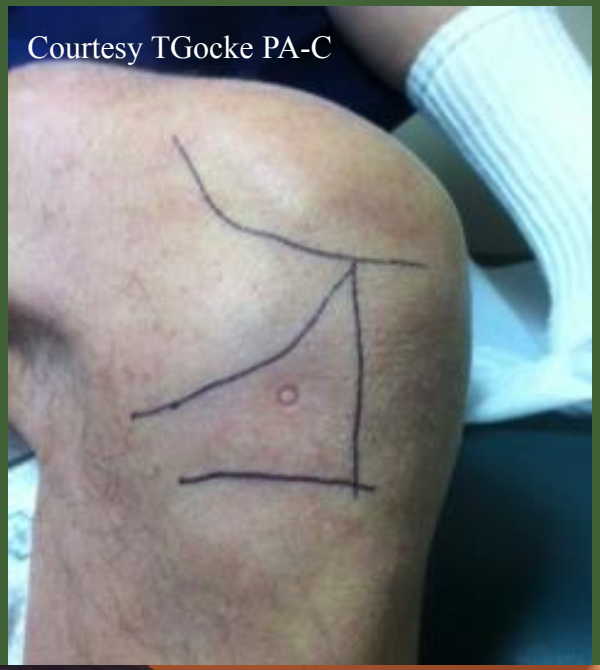
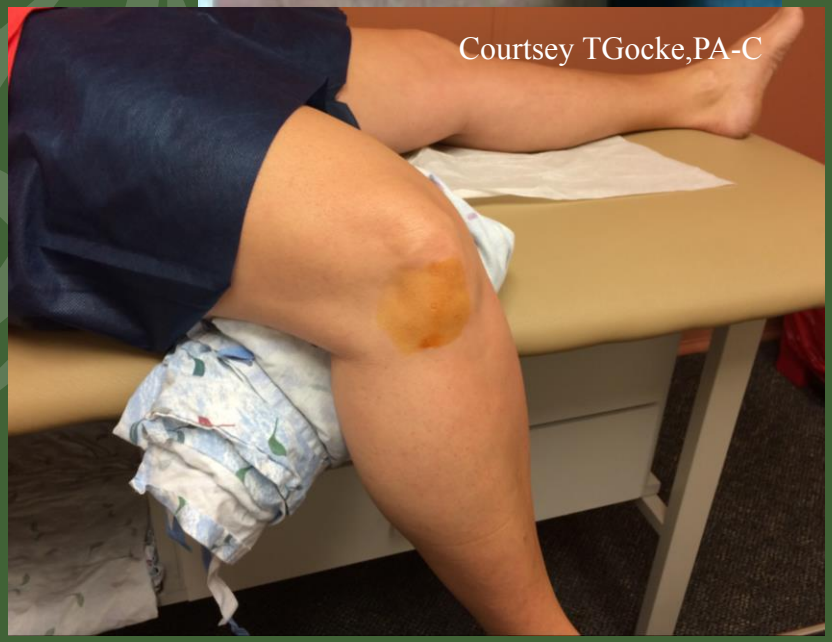
Corticosteroid Injection

Technique

- Sitting position or supine leg off table
- Knee flexed 90 degrees.
- Palpate the lateral joint line & inferior-lateral aspect of the patella.
- Dimple or window in lateral joint space (same medial)

- Skin Prep: Betadine vs Hibiclens
- Ethyl Chloride





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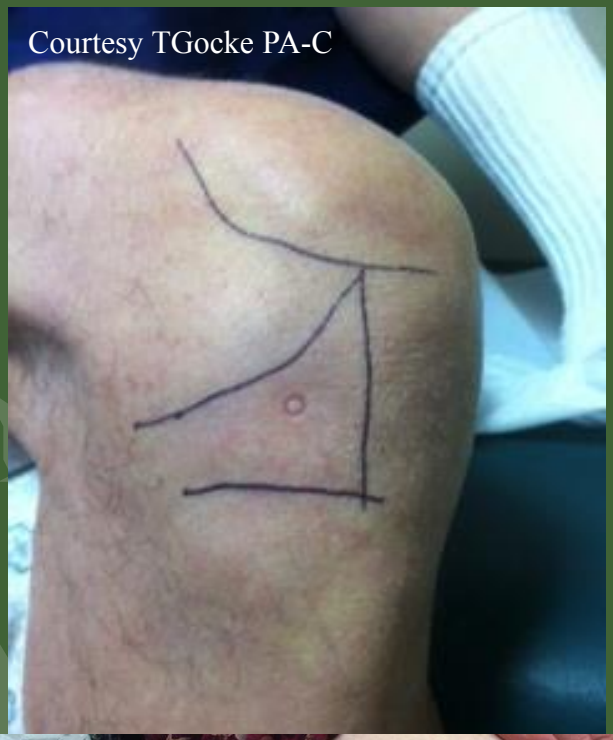
Corticosteroid Injection

Technique

- Sterile glove(s)
- Using a 21/22 gauge, 1.5 inch needle
- Aim for Femoral notch
  - 45 degrees medially, level of the joint line.
- Resistance or you feel bone:
  - Redirect needle
- Injection Meds:

3ml Bupivacaine 0.25% & 2mlTriamcinolone 40mg/ml, 21/22 gauge needle



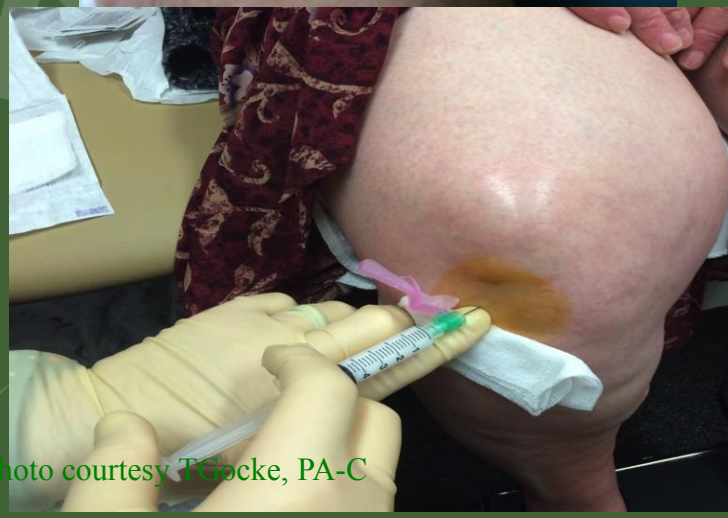


Photo courtesy TGocke, PA-C

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Knee Joint Injection

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Knee Aspiration

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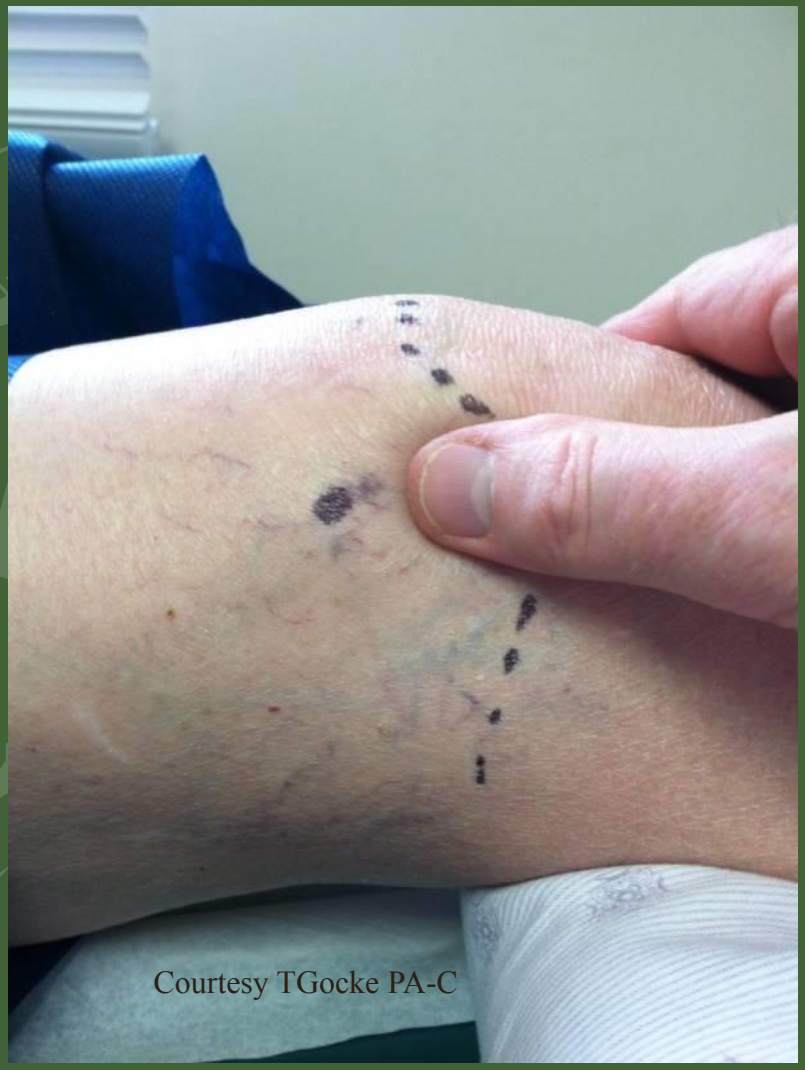
Knee Aspiration

Positioning Pointers

- Supine position
- Bump under knee
- Patella border
- Lateral joint line
- Measure 1cm north patella then down 1cm
  - Thumb nail
- Under lateral portion Quad tendon & above ITB



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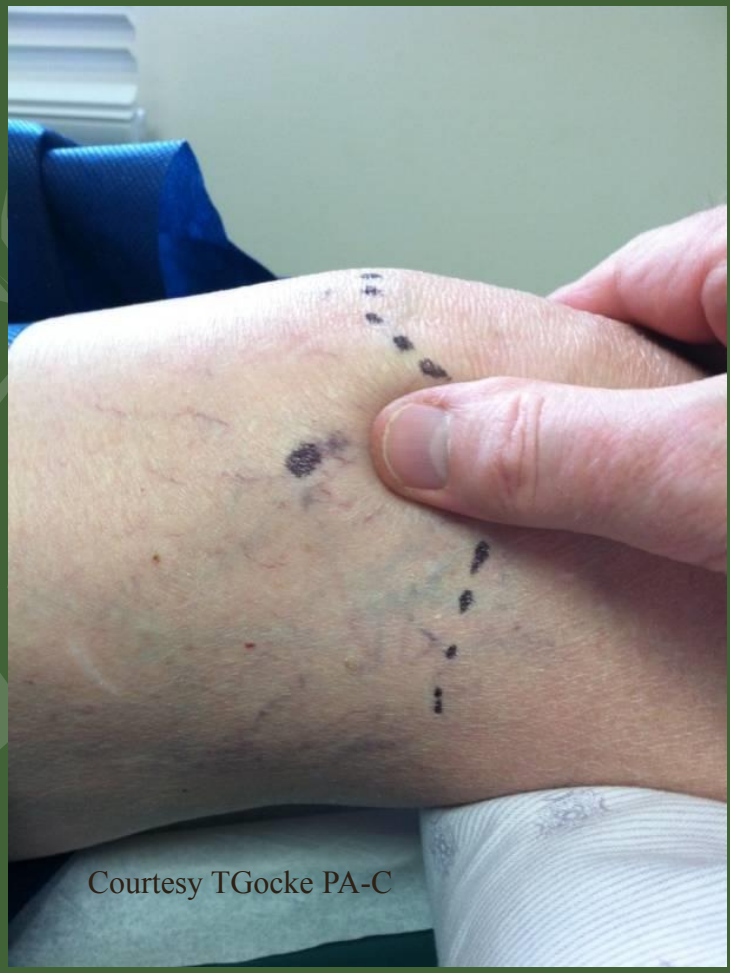
Knee Aspiration

Supine position

- Skin prep: Betadine vs. Hibiclens
- Anesthetic: Ethyl Chloride & 10ml 1% Lidocaine
- 2nd sterile prep
- Sterile glove(s)
- Use 18 gauge needle and 60cc syringe for aspiration

- Check fluid:
  - **INFECTED STOP NO STEROID**
  - **SEND FLUID TO LAB FOR ANALYSIS**



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Knee Aspiration & Injection

- Change syringe at hub – sterile
- Inject Cortisone solution
  - ***3ml Bupivacaine 0.25%***
  - ***1-2 ml Triamcinolone 40mg/ml***
- Sterile bandage
- Compression wrap x 24 hours
- Ice 2-3 time/day- 30 min/
- Discharge Instructions


Courtesy TGocke PA-C

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	Septic knee	Non-Septic knee	Acute Gouty Flare
Fluid Appearance	Purulent	Straw-Serous	Straw-Serous-Bloody
WBC count (mm3)	>50,000 suspicious > 100,000 infection	2,000-<50,000	2,000 - <50,000
Polymorphonuclear	>75%	<50%	<50%
ESR/CRP	Elevated/elevated	Elevated/variable	Elevated/variable
Gram Stain	+ > 70%	Negative	Negative (?)
Crystals	None (?)	None	Monosodium urate crystals- Gout Calcium pyrophosphate or hydroxyapatite crystal- Pseudogout
Culture	Staph Auerus & Epidermiidis (90%) Streptococcal species	None	

McAfee JH, Smith DL: Olecranon and Pre-patellar Bursitis: Diagnosis & Treatment, Western Journal Medicine Nov 1988, 149:5;607-610

Knee Aspiration

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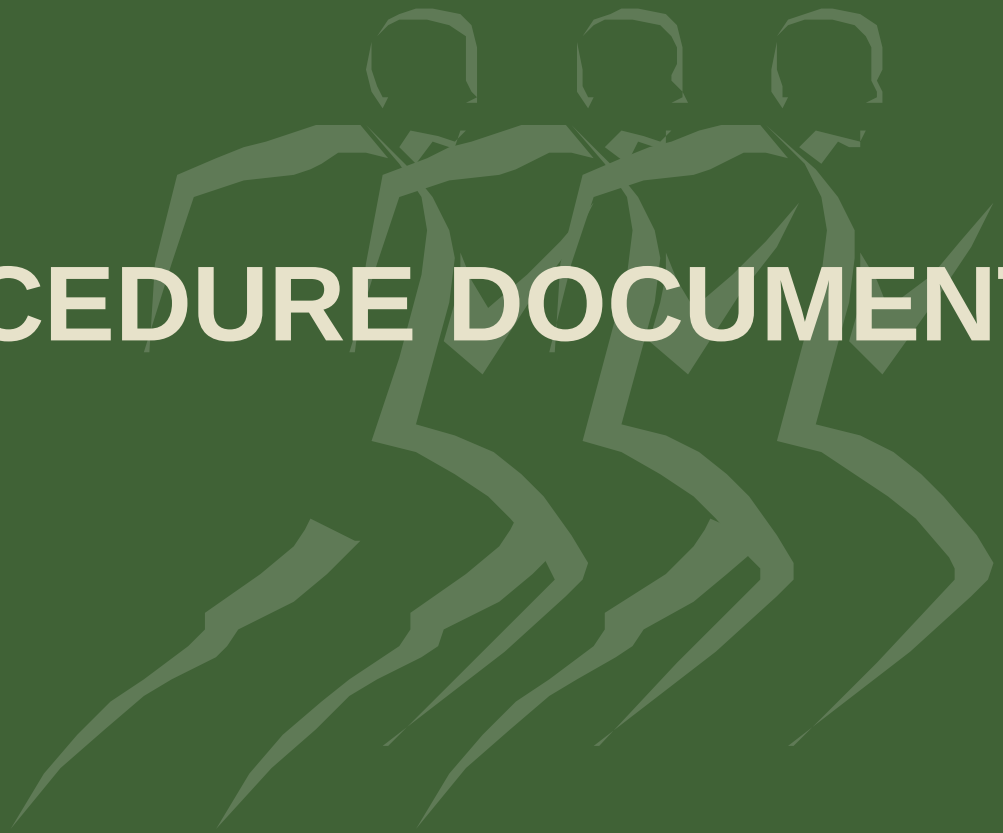

PROCEDURE DOCUMENTATION

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Procedure Documentation

Risks & Benefits:

"I discussed with the patient today the risks and benefits regarding knee joint aspiration and injection to include but limited to: improvement of pain, worsening of pain, failure of the injection/aspiration to to relieve their pain, reacculumation of fluid, flare reaction, facial flushing, injection site soreness, skin pigment changes, fat atrophy, tendon rupture, joint surface injury and infection. I also discussed with the patient concerns regarding elevation of blood sugar. They are advised to follow the rescue guidelines provided by their Primary Care Provider for elevations of blood sugar beyond their safety threshold. If this does not resolve their elevated blood sugar, they are advised to contact their Primary Care Provider immediately or go to the closest Emergency Department for further treatment. The patient is aware of these possible reactions/adverse effects and choses to proceed with the procedure."

Tom Gocke, MS, ATC, PA-C, DFAAPA

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Procedure Documentation

*"The **XXXXXXis identified and examined with findings as describe in the physical examination. The XXXXXXXX injection site portal was identified and prepped with Betadine/Hibiclens/Alcohol in the usual sterile fashion. Under sterile technique (XXXXXX), X ml of 0.25% Bupivacaine and X ml of Kenalog 40mg/ml was injected into the XXXXXXXXXXX. The patient tolerated the procedure well and was able to move the affected shoulder without pain or difficulty. "*

"Discharge instructions were reviewed and provided to the patient prior to discharge. The patient was instructed to apply an ice pack to he affected area 2 times today for 20mins each session. Their questions were answered prior to discharge. They will have XXX restrictions for the next XXX days then resume XXX activity level. They will follow up with me in XXXX days."

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Discharge Instructions

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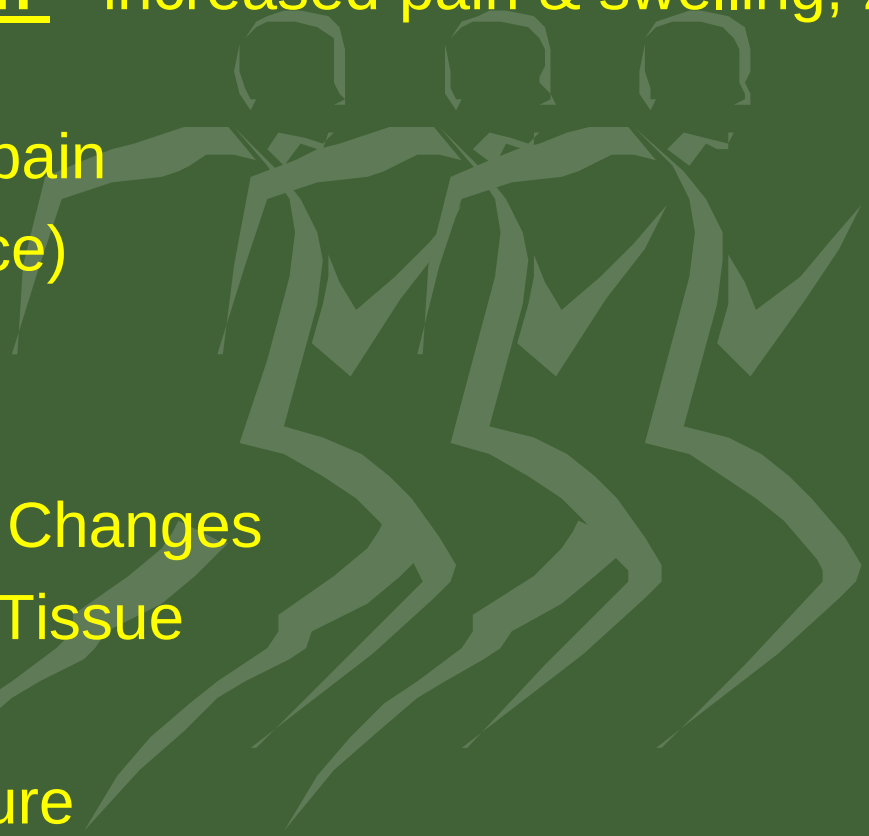
Discharge Instructions:

- **Elevated Blood Sugar** – follow rescue instructions PCP
- **Flare reaction** – increased pain & swelling, 24-36 hrs response
- Injection site pain
- Redness- (face)
- Headache
- Jittery
- Skin Pigment Changes
- Loss of Fatty Tissue
- Infection
- Tendon Rupture



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Discharge Instructions:

- **Apply ice pack** to injection site three (3)x daily for 20-30 min for next 3 days to reduce pain & swelling
- **Anti-inflammatory medication or pain medications** if you need something for injection site soreness.
- **Allergic Reaction symptoms:** Hives, rashes, difficulty breathing, facial swelling or anaphylactic symptoms go to the closest Emergency room or call 911 IMMEDIATELY.
- **Infection:** If you get a red swollen knee, run a fever >101.5 for 24 hours after the injection call our office 000-000-0000
- **Limit activity** for the next 3 days following injection/aspiration to help reduce pain & help reduce inflammation.
- **Follow up appt:**
- **Call office 000-000-0000 if you have questions**

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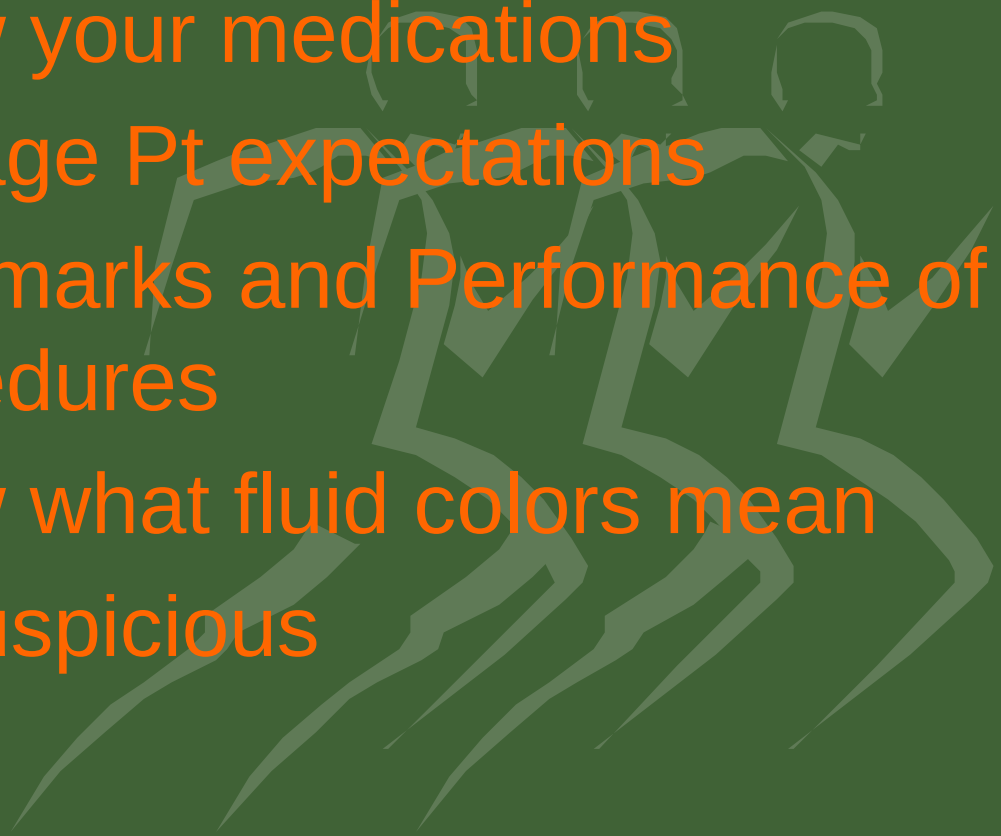
Key Take Home Points



- Know your medications
- Manage Pt expectations
- Landmarks and Performance of procedures
- Know what fluid colors mean
- Be suspicious

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THUNDER HILL OVERLOOK, BLUE RIDGE PARKWAY
BLOWING ROCK, NC courtesy TGocke, PA-C

REFERENCES

- McAfee JH, Smith DL: Olecranon and Pre-patellar Bursits: Diagnosis & Treatment, Western Journal Medicine, Nov 1988, 149:5;607-610
- McNabb JW: Joint & Soft Tissue Injections, 3° edition, Wolters Kluwer 2015
- Musculoskeletal Images are from the University of Washington "Musculoskeletal Atlas: A Musculoskeletal Atlas of the Human Body" by Carol Teitz, M.D. and Dan Graney, Ph.D."
- Seshaadri, Coyle & Chu: J Arthroscopy& Related Surgery, April 2009, 25(4):337-347
- Knight KL, Pain and Pain relief during Cryotherapy: Cryotherapy: Theory, Technique and Physiology, 1st edition, Chatanooga Corporation, Chatanoga, TN 1985, p 127-137
- http ://dailyem.wordpress.com/2012/11/13/quick-er-math-max-dose-lidocaine-for-localanesthesia/
- http://lifeinthefastlane.com/educaDon/procedures/local-anaestheDc/
- Schleicher WF: Skin Sterility after Application of Vapocoolant Spray, Am Society Derm Surgery, 2014 4;40: 1103-1107

REFERENCES

- Chu CR, Coyle CH, Chu CT, et al: In Vivo effects of Single Intra-articular Injection of 0.5% Bupivacaine on articular Cartilage; JBJS 2010,Mar;92(3):599-608
- Farkas B,Kvell K,Czomply T, et al: Increased Chondrocyte Death after Steroid and Local Anesthetic Combination; Clinical Orthopaedics and Related Research, November 2010 468:11: 3112-3120
- Syed HM, Green L,Bianski B, Jobe CE, Wongworawat MD: Bupivacaine and Traimcinolone May Be Toxic to Human Chondrocytes: A Pilot study; Clinical Orthopaedics and Related Research, October 2011, 469:10: 2941-2947
- Cardone DA, & Tallia AF: Joint and Soft Tissue Injections: AAFP July 2002,66(2): 283-288
- Kirschke, Jones,Stratton,Barnett & Schaffner: Outbreak of Joint and Soft-Tissue Infections Associated with Injections form Multiple-dose medication Vials; Clinical Infectious Disease; Jan 2003, 36(11);1369-1373
- Dragoo, Braun, Kim,Phan & Golish: the In Vitro Chondrotoxicity of Single Dose Local Anesthetics, Am J Sports Med; April 2012:40(4): 794-799
- Polishcuk A: Skin Sterility after Application of Ethyl Chloride Spray,JBJS Jan 2012, 94:118