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Dawn Gulick, PT, PhD, ATC, CSCS

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Medical Screening[177, 178]

Have you ever experienced or been told you have any of the following conditions?	
Cancer	Chronic bronchitis
Diabetes	Pneumonia
High blood pressure	Emphysema
Fainting or dizziness	Migraine headaches
Chest pain	Anemia
Shortness of breath	Stomach ulcers
Blood clot	AIDS/HIV
Stroke	Hemophilia
Kidney disease	Guillain-Barré syndrome
Urinary tract infection	Gout
Allergies (latex, food, drug)	Thyroid problems
Asthma	Multiple sclerosis
Osteoporosis	Tuberculosis
Rheumatic/scarlet fever	Fibromyalgia
Hepatitis/jaundice	Pregnancy
Polio	Hernia
Head injury/concussion	Depression
Epilepsy/seizures	Frequent falls
Parkinson's disease	Bowel/bladder problems
Arthritis	
Have you ever had any of the following procedures?	
X-ray	Blood test(s)
CT scan	Biopsy
MRI	EMG or NCV
Bone scan	EKG or stress test
Urinalysis	Surgery

Normal Vital Signs & Pathologies That Influence Them[428]

Vital Sign	Infant	Child	Adolescent	Adult & Elderly	Increases Due to:	Decreases Due to:
T	98.2°F	98.6°F	98.6°F	98.6°F	Infection, exercise, ↑ blood sugar	↓ Hematocrit & hemoglobin, narcotics, ↓ blood sugar, aging
HR	80–180	75–140	50–100	60–100	Infection, ↓ hematocrit & hemoglobin, ↓ blood sugar, anxiety, anemia, pain, ↓ K^+, exercise	Narcotics, acute MI, ↑ K^+
RR	30–50	20–40	15–22	10–20	Infection, ↓ hematocrit & hemoglobin, ↑ blood sugar, anxiety, pain, acute MI, asthma, exercise	Narcotics
SBP	73	90	115	<130	↑ blood sugar, CAD, anxiety, pain, exercise (SBP only)	↓ Hematocrit & hemoglobin, ↓ K, narcotics, acute MI, anemia
DBP	55	57	70	<85		

Emergency Situations[188]

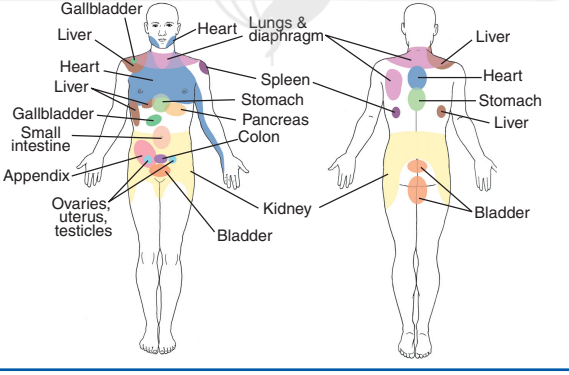
- SBP ≥180 mm Hg or ≤90 mm Hg
- DBP ≥110 mm Hg
- Resting HR >100 bpm
- Resting RR >30 bpm
- Sudden change in mentation
- Facial pain with intractable headache
- Sudden onset of angina or arrhythmia
- Abdominal rebound tenderness
- Black, tarry, or bloody stools

Generalized Systemic Red Flags[178]

- Insidious onset with no known mechanism of injury
- Symptoms out of proportion to injury
- No change in symptoms despite positioning or rest
- Symptoms persist beyond expected healing time
- Recent or current fever, chills, night sweats, infection
- Unexplained weight loss, pallor, nausea, B & B changes (constitutional symptoms)
- Headache or visual changes
- Bilateral symptoms
- Pigmentation changes, edema, rash, nail changes, weakness, numbness, tingling, burning
- Psoas test for pelvic pathology = supine, SLR to 30° & resist hip flexion; (+) test for pelvic inflammation or infection is lower quadrant abdominal pain; hip or back pain is (–) test
- Blumberg sign = rebound tenderness for visceral pathology—in supine select a site away from the painful area & place your hand perpendicular & push down deep & slow then lift up quickly; (–) = no pain; (+) = pain on release
- (+) McBurney point (appendix) = ⅓–½ the distance between the ® ASIS & umbilicus
- (+) Kehr sign (spleen) = violent Ⓛ shoulder pain

Visceral Innervation & Referral Patterns[428]

Segmental Innervation	Viscera	Referral Pattern(s)
C3–5	Diaphragm	C-spine
T1–5	Heart	Anterior neck, chest, left UE
T4–6	Esophagus	Substernal & upper abdominal
T5–6	Lungs	T-spine
T6–10	Stomach	Upper abdomen & T-spine
	Pancreas	Upper abdomen, low T-spine, & upper L-spine
	Bile duct	Upper abdomen, mid T-spine
T7–9	Gallbladder	Right UQ, right T-spine
	Liver	Right T-spine
T7–10	Small intestine	Mid T-spine
T10–11	Testes/ovaries	Lower abdomen & sacrum
T10–L1	Kidney	L-spine, abdomen
T10–L1 S2–4	Uterus/prostate	T/L & L/S junction sacrum, testes, T/L jct
T11–L2, S2–4	Ureter	Groin, suprapubic, medial thigh
	Bladder	Sacral apex, suprapubic



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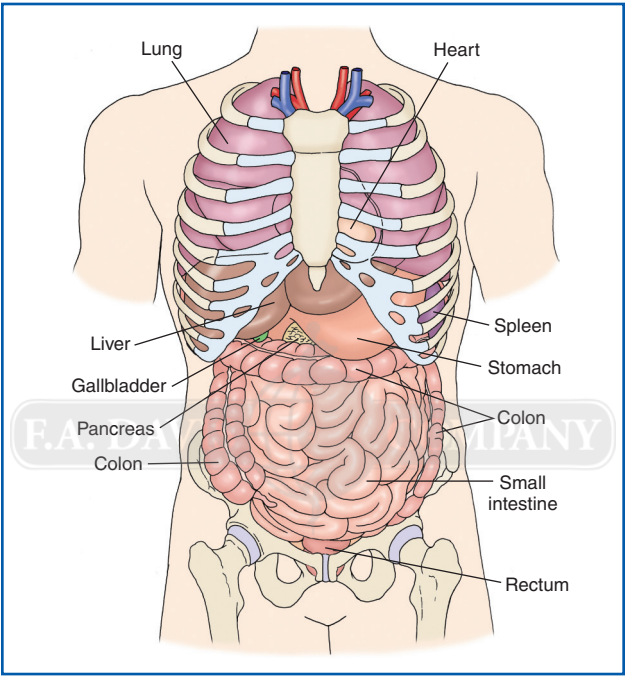


Source: From Gulick, D. Screening Notes: Rehabilitation Specialist's Pocket Guide. FA Davis, Philadelphia, 2006, pp 11-12.

Early Warning Signs of Cancer[177, 178, 397]

"CAUTIONS" = Red Flags of Cancer

C = Change in bowel & bladder lasting >7–10 days
A = A sore that fails to heal in 6 weeks
U = Unusual bleeding or discharge
T = Thickening/lump (breast or elsewhere)
I = Indigestion, difficulty swallowing, early satiety
O = Obvious change in wart or mole

- **A** = Asymmetrical shape
- **B** = Border irregularities
- **C** = Color—pigmentation is not uniform
- **D** = Diameter >6 mm (bigger than a pencil eraser)
- **E** = Evolution (change in status)

N = Nagging cough or hoarseness (rust-colored sputum)
S = Supplemental S & S

- 10–15 lb wt loss in 10–14 days
- Changes in vital signs
- Frequent infections (respiratory or urinary)
- + change in DTRs
- + proximal muscle weakness
- + night pain
- + pathological fracture
- >45 yo

Cardiovascular Signs to Discontinue Exercise[188]

- Resting HR <40 or >130
- Irregular pulse, palpitations
- >6 arrhythmias/hr
- Blood glucose >250 mg/dL
- O_2 saturation <90%
- Temp >100°F
- SBP >250 or DBP >120 mm Hg
- Fall in SBP >10 mm Hg
- Cognitive changes
- Cold, clammy, cyanotic
- PO_2 <60; hemoglobin <8 g/dL
- Dyspnea, orthopnea
- Dizziness, syncope
- Bilateral leg or foot edema
- Chest pain
- Isolated ® biceps or midthoracic pain in females

Organ Pathology[177, 178]

Pulmonary

- Cough with or without blood
- Sputum
- SOB or DOE
- Clubbing of nails
- Chest pain
- Wheezing
- Pain ↑ when recumbent & ↓ on involved side
- Pain with deep inspiration
- ↓ O_2 saturation
- Signs of PE
  - Pleural pain
  - SOB
  - Rapid RR
  - Rapid HR
  - Coughing up blood

Hepatic

- ® UQ pain
- Weight loss
- Ascites/LE edema
- Carpal tunnel syndrome (bilateral)
- Intermittent pruritus
- Weakness & fatigue
- Dark urine/clay-colored stools
- Pain referral to T-spine between scapula, ® shoulder, ® upper trap, ® subscapular region
- Jaundice, bruising, yellow sclera
- Asterixis (liver flap) = flapping tremor—inability to maintain wrist extension with forearm supported

Gastrointestinal

- Epigastric pain radiating to back
- Blood or dark, tarry stool
- Fecal incontinence or urgency
- McBurney's point tenderness
- Eating changes pain/symptoms
- Nausea, vomiting, bloating
- Diarrhea or absence of bowel mov't
- Food may help or aggravate Px
- Weight loss, loss of appetite

Renal

- (+) Murphy's test
- Painful percussion over kidney
- Fever, chills
- Blood in urine (hematuria)
- Cloudy or foul-smelling urine
- Painful or frequent urination
- Pain is constant (stones)
- Back pain at the level of kidneys
- Costovertebral angle tenderness

Prostate & Gynecological

- Men >50 yo
- Difficulty starting/stopping urine flow
- Change in frequency
- Nocturia
- Incontinence/dribbling
- Possible PSA level >4 ng/mL
- Sexual dysfunction
- Cyclic pain
- Abnormal bleeding
- Nausea, vomiting
- Vaginal discharge
- Chronic constipation
- Low BP (2° blood loss)
- Missed/irregular periods

Tasks That May Aggravate & Incriminate Visceral Pathology[177, 178]

- Heart = cold air or exertion
- Esophagus = swallowing
- GI = eating
- GB = forward bending
- Pancreas = sitting up or lean forward
- Kidney = lean to affected side

Hypoglycemia vs. Hyperglycemia[177, 178]

- Blood glucose <50–60 mg/dL
- Skin is pale, cool, diaphoretic
- Disoriented or agitated
- Headache
- Slurred speech
- Tachycardia
- Blood glucose >180 mg/dL
- Skin is dry & flushed
- Fruity breath odor
- Blurred vision, dizziness
- Weakness, cramping
- Nausea, vomiting
- Increased urination
- LOC/seizure

Asthmatic Response(s)[428]

- Coughing, wheezing, substernal chest tightness
- Use of accessory muscles of respiration
- RR >24 bpm
- Peak flow <80% predicted or baseline value
- After an asthma attack, FEV1 peak flow should ↑ by >15% within 5 min of using an inhaler. If this does not occur, seek emergency medical treatment.

Signs & Symptoms of Marfan's Syndrome (Inherited Autosomal Dominant Disorder)[428]

- Disproportionately long arms, legs, fingers, & toes
- Long skull with frontal prominence
- Kyphoscoliosis
- Pectus chest (concave)
- Slender, ↓ sub-q fat
- Weak tendons, ligaments, joint capsules (joint hypermobility)
- Defective heart valves (murmur)
- High incidence of dissecting aortic aneurysm
- Hernia
- Sleep apnea
- Dislocation of eye lens; myopia
- "Thumb sign" = oppose thumb across the palm, if thumb tip extends beyond palm, test is (+)

Signs & Symptoms of Lyme Disease[437]

Note: Multisystemic inflammatory condition that takes ~48 hours to transmit via a tick spirochete. Blood work is used to confirm the disease, not to diagnose it. Clinician should r/o GBS, MS, & FMS.

Early Localized Stage

- Rash with erythema within 7–14 days (range, 3–30 days)
- Solid red expanding rash or spot with rings (bull's-eye)
- 5"–6" diameter nonitchy rash
- Rash may or may not be warm to palpation
- Fever, malaise, headache
- Muscle aches, joint pain

Early Disseminated Stage

- ≥2 rashes not @ bite site
- Migrating pain
- Headache, stiff neck
- Facial palsy, visual changes
- Numb/tingling extremities
- Abnormal pulse
- Sore throat, 100°F–102°F fever
- Severe fatigue

Late Stage

- Arthritis of 1–2 large joints
- Visual impairment
- Cardiac irregularities
- Neurological changes—disorientation, confusion, dizziness, "mental fog," numbness in extremities

Deep Tendon Reflexes[313]

Grade	Response	Jendrassik's Maneuver
0	Absent; areflexia	For UE = patient crosses LEs at ankles & then isometrically abducts LEs For LE = patient interlocks fingertips & then isometrically pulls elbows apart
1+	Decreased; hyporeflexia	
2+	Normal	
3+	Hyperactive; brisk	
4+	Hyperactive with clonus	

Cranial Nerves[428]

Nerve	Function	Test
I. Olfactory	Smell	Identify odors with eyes closed
II. Optic	Vision	Test peripheral vision with 1 eye covered
III. Oculomotor	Eye movement & pupillary reaction	Peripheral vision, eye chart, reaction to light
IV. Trochlear	Eye movement	Test ability to depress & adduct eye
V. Trigeminal	Face sensation & mastication	Face sensation & clench teeth
VI. Abducens	Eye movement	Test ability to abduct eye past midline
VII. Facial	Facial muscles & taste	Close eyes & smile; detect various tastes—sweet, sour, salty, bitter
VIII. Vestibulocochlear (acoustic)	Hearing & balance	Hearing; feet together, eyes open/closed × 5 sec; test for past-pointing
IX. Glossopharyngeal	Swallow, voice, gag reflex	Swallow & say "ahh"; use tongue depressor to elicit gag reflex
X. Vagus	Swallow, voice, gag reflex	
XI. Spinal accessory	SCM & trapezius	Rotate/SB neck; shrug shoulders
XII. Hypoglossal	Tongue mov't	Protrude tongue (watch for lateral deviation)

Dementia Scales[153]

Score	Maximum	Task
	5 5	**Orientation:** What is the (year) (season) (date) (day) (month)? Where are we (state) (country) (town) (building) (floor)?
	3	**Registration:** Name 3 objects: 1 second to say each. Ask the patient all 3 after you have said them. Give 1 point for each correct answer. Repeat them until he/she learns all 3. Count & record trials: _____
	5	**Attention & Calculation:** Serial 7s. Score 1 point for each correct answer. Stop after 5 answers. (Alternative question: Spell "world" backward.)
	3	**Recall:** Ask for the 3 objects repeated above. Give 1 point for each correct answer.
	2 1 3 1 1 1	**Language:** Name a pencil & watch. Repeat the following, "No ifs, ands, or buts." Follow a 3-stage command: "Take a paper in your hand, fold it in half, & put it on the floor." Read & obey the following: "Close your eyes." Write a sentence. Copy the design shown: 
	30	**Total score (Normal ≥24)**

Pharmacological Summary by Drug Classification[17, 29, 78, 88, 97, 114, 218, 223, 336, 385, 390]

Nonnarcotic Analgesic

Indications = Pain, fever

Generic Name (Brand Names)	Adverse Reactions	Interactions
Acetaminophen (APAP) • Tylenol • Anacin–3 • Liquiprin • Panadol • Acephen • Tempra	Upset stomach, rash, bruising, anemia Doses >15 g are toxic to liver & kidney; may be fatal	Barbiturates = ↓ effects & ↑ liver toxicity Warfarin = ↑ anticoagulant effect (may necessitate a change in warfarin dose) Caffeine = ↑ analgesic effects Alcohol = ↑ risk of liver damage (not recommended if ≥3 glasses of alcohol/day consumed Green tea extract = 3 hr before may protect against liver toxicity but 6 hr after may ↑ liver damage

Analgesics & NSAIDs

Indications = RA, OA, JRA, pain, fever; anti-inflammatory doses > analgesic doses

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Acetylsalicylic acid (ASA) • Aspirin • Ecotrin • Empirin • Bayer • Aspergum	**Not recommended for children** **Tinnitus, nausea, prolonged bleeding time, rash,** GI distress, bruising	**All NSAIDs:** Can ↓ cardioprotective effects of low-dose ASA if taken before ASA; if ASA taken ≥2 hr before NSAID, cardioprotective effects are preserved. Can ↑ risk of bleeding when used with ginkgo, vitamin E, warfarin, clopidogrel (Plavix), heparin, or omega-3 fish oil. Can ↑BP (COX-2 inhibitors ↑ BP to a lesser extent than nonselectives). Can ↑ neurotoxicity when used with lithium. Can produce acute renal failure. Are gastric irritants & can produce nephrotoxicity.
Ibuprofen • Motrin • Nuprin • Advil	GI Px, dyspepsia, nausea, dizziness, rash, hepatitis, HA	
Sulindac • Clinoril	**Not recommended for children** **GI Px,** HA, rash, constipation, dizziness, liver damage, epidermal necrosis syndrome	
Meloxicam (preferential inhibition of COX-2 over COX-1)	Seizures, cardiac arrhythmias, MI, hemorrhage, asthma, erythema, anaphylactic reaction, anxiety, abdominal pain, coughing	
Exercise concerns: Negative effect on myogenesis & regeneration (anabolic effects), i.e., may delay muscle healing.		

Continued

Analgesics & NSAIDs—cont'd

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Naproxen • Naprosyn • Anaprox	**Not recommended for children** **Tinnitus,** GI Px, constipation, HA, dizziness, rash, edema, ecchymoses	**All NSAIDs:** Can ↓ cardioprotective effects of low-dose ASA if taken before ASA; if ASA taken ≥2 hr before NSAID, cardioprotective effects are preserved. Can ↑ risk of bleeding when used with ginkgo, vitamin E, warfarin, clopidogrel (Plavix), heparin, or omega-3 fish oil. Can ↑BP (COX-2 inhibitors ↑ BP to a lesser extent than nonselectives). Can ↑ neurotoxicity when used with lithium. Can produce acute renal failure. Are gastric irritants & can produce nephrotoxicity.
Diflunisal • Dolobid	**Not recommended for children** GI Px, diarrhea, dyspepsia, rash, HA, dizziness, insomnia	
Piroxicam • Feldene	**Not recommended for children** **Greater risk of GI bleeding than other NSAIDs** Dizziness, HA, edema, rash, pruritus, hepatitis	
Indomethacin • Indocin	**HA,** drowsiness, dizziness, nausea, GI Px, constipation, pancreatitis	
Etodolac Lodine	**Not recommended for children** **Dyspepsia,** GI Px slightly less than with other NSAIDs, nausea, diarrhea, CHF, dizziness, ↑ BP, blurred vision	

Exercise concerns: Negative effect on myogenesis & regeneration (anabolic effects), i.e., may delay muscle healing.

Continued

Analgesics & NSAIDs—cont'd

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Ketoprofen • Orudis	**Not recommended for children** **Dyspepsia,** HA, dizziness, insomnia, tinnitus, peripheral edema	**All NSAIDs:** Can ↓ cardioprotective effects of low-dose ASA if taken before ASA; if ASA taken ≥2 hr before NSAID, cardioprotective effects are preserved. Can ↑ risk of bleeding when used with ginkgo, vitamin E, warfarin, clopidogrel (Plavix), heparin, or omega-3 fish oil. Can ↑BP (COX-2 inhibitors ↑ BP to a lesser extent than nonselectives). Can ↑ neurotoxicity when used with lithium. Can produce acute renal failure. Are gastric irritants & can produce nephrotoxicity.
Diclofenac • Voltaren • Cataflam	**Not recommended for children** **Nephrotic Px,** GI Px, HA, edema, dizziness, hypoglycemia	
Nabumetone • Relafen	**Not recommended for children** **Abdominal pain, diarrhea, dyspepsia,** dizziness, HA, dyspnea, diaphoresis	
Celecoxib (COX-2 inhib) • Celebrex	**Not recommended for children** **HA,** GI Px, dizziness, ↑ BP, erythema	

Exercise concerns: Negative effect on myogenesis & regeneration (anabolic effects), i.e., may delay muscle healing.

Opiates*

Indication = Pain

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Morphine • MS Contin • Duramorph • Morphine SR • Astramorph	**Hypoventilation & respiratory depression, pruritus, constipation, dizziness, nausea, drowsiness, HA, restlessness, lightheadedness, sweating, vomiting,** rash, confusion, seizures	Hydrocodone, oxycodone, & all CNS depressors = overdose & death 2° hypoventilation & respiratory depression Fluoxetine, paroxetine = ↑ morphine level Linezolid (MRSA antibiotic) = ↑ serotonin level Selegiline (Parkinson disease) = ↑ risk of hypotension, hyperpyrexia, somnolence Cimetidine = ↑ morphine level
Fentanyl • Duragesic • Lazanda • Actiq	**Hypoventilation & respiratory depression, constipation, confusion, dry mouth, nausea/vomiting, sweating,** diarrhea, weakness, abdominal pain, HA, fatigue, weight loss, dizziness, nervousness, hallucinations, depression, flu-like symptoms, indigestion, SOB, urinary retention	Hydrocodone, oxycodone, & all CNS depressors = overdose & death 2° hypoventilation & respiratory depression Elavil, Prozac, Paxil, Buspar, & St. John's wort = ↑ serotonin levels Ca^{++} channel blockers = ↑ effects Cimetidine = ↑ fentanyl levels
Tramadol • Ultram • Rybix ODT • Ryzolt	**Dizziness, vertigo, constipation, nausea, somnolence, vomiting, pruritus, spasticity, euphoria,** diarrhea, dry mouth, urinary retention	Cimetidine = ↑ effects of tramadol Buspirone = may induce serotonin syndrome Baclofen = ↑ sedation

Exercise concerns: Monitor respiratory rate. Reduced exercise capacity due to respiratory depression especially with COPD; guard ambulation to prevent falls.

*__ALL__ opioids are addicting; withdrawal symptoms may appear in 6–10 hours & last 5 days. Symptoms may include body aches, diarrhea, fever, gooseflesh, insomnia, irritability, loss of appetite, nausea, vomiting, runny nose, shivering, & stomach cramps.

NSAID–Acetaminophen (APAP)–Opiate* Combinations

Indication = Pain

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
ASA/codeine† • Empirin with codeine **Take with food**	**Dizziness, nausea, ↓ respiration, constipation, tinnitus**, HA, vomiting, pruritus, rash	MAO inhibitors, insulin, anticoagulants, methotrexate, sulfonamides = ↑ effects NSAIDs = peptic ulcers Alcohol = ↑ CNS depression
ASA/oxycodone • Percodan	**Lightheadedness, nausea, dizziness,** vomiting, euphoria, pruritus, apnea, constipation, circulatory depression, hemorrhage, hypotension	Muscle relaxants = ↑ CNS effects, impaired judgment Analgesics, phenothiazines, tranquilizers, or alcohol = ↑ CNS depression ACE inhibitors = ↓ pain relief Anticoagulant or NSAID = ↑ bleeding Methotrexate = ↑ toxicity
Exercise concerns: Monitor respiratory rate. Reduced exercise capacity due to respiratory depression especially with COPD; guard ambulation to prevent falls.		

Continued

NSAID–Acetaminophen (APAP)–Opiate* Combinations—cont'd

Indication = Pain

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
APAP/hydrocodone† • Vicodin • Lortab	**Dizziness, nausea**, vomiting, confusion, constipation, rash, pruritus, depression	Antihistamines, antipsychotics, antianxiety agents = ↑ CNS depression MAO inhibitors = ↑ effects Celecoxib = ↑ levels of hydrocodone Alcohol = ↑ CNS depression
APAP/codeine† • Tylenol No. 3	**Nausea,** drowsiness, constipation, vomiting, SOB, pruritus, ↓ respiration (body builds up tolerance after 2 wk)	Antipsychotics, antianxiety agents, alcohol = ↑ CNS depression Anticholinergics with codeine = paralytic ileus
APAP/oxycodone • Percocet • Tylox	**Lightheadedness, dizziness, nausea, vomiting, apnea, respiratory distress, hypotension,** rash, constipation, pruritus	Muscle relaxers = ↑ CNS effects

Exercise concerns: Monitor respiratory rate. Reduced exercise capacity due to respiratory depression especially with COPD; guard ambulation to prevent falls.

*__ALL__ opioids are addicting; withdrawal symptoms may appear in 6–10 hours & last 5 days. Symptoms may include body aches, diarrhea, fever, gooseflesh, insomnia, irritability, loss of appetite, nausea, vomiting, runny nose, shivering, & stomach cramps.

†__Should not be taken with MAO inhibitors__.

Muscle Relaxers/Antispasmodics

Indications = Manage spasticity (muscle tone), reduce muscle guarding

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Baclofen • Lioresal	**Drowsiness, nausea, dizziness, weakness, confusion,** vomiting, HA, rash, paresthesias	CNS depressant, alcohol = ↑ depression
Carisoprodol • Soma (addictive)	**Orthostatic hypotension, drowsiness, dizziness,** HA, vertigo, agitation, insomnia	CNS depressant, alcohol = ↑ depression
Cyclobenzaprine • Flexeril (use not recommended for >2–3 wk)	**Drowsiness, dry mouth, dizziness,** arrhythmias, confusion, transient visual hallucinations	CNS depressant, alcohol = ↑ depression MAO inhibitors or tramadol = may cause seizures & death
Diazepam • Valium (long-term dependency)	**Drowsiness, pain, phlebitis at injection site,** dysarthria, constipation, ↓ HR, ↓ RR	CNS depressant, alcohol = ↑ depression Digoxin = risk of toxicity Smoking = may ↓ effects Cimetidine & clarithromycin = ↑ effects St. John's wort = ↓ effects
Tizanidine • Zanaflex	**Somnolence, sedation, hypotension, dry mouth, UTI,** dizziness, bradycardia, constipation	Antihypertensives = ↓ BP Baclofen, alcohol, or other CNS depressant = additive effect Oral contraceptive = ↓ tizanidine clearance

Exercise concerns: Interferes with strengthening goals.

ACE Inhibitors

Indication = High BP

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Captopril • Capoten	**Dry cough, chest pain, rash,** dizziness, abdominal pain, neutropenia	Antacids = ↑ effects Digoxin = ↑ digoxin levels Diuretics or phenothiazines = hypotension NSAIDs = ↓ antihypertensive effects, may ↓ renal function in elderly & dehydrated individuals Insulin, glipizide, glyburide = enhanced effects of antidiabetics → hypoglycemia Lithium = lithium toxicity
Enalapril • Vasotec	**Weakness, dry cough,** dizziness, HA, hypotension	
Lisinopril • Zestril • Prinivil	**Dizziness, nasal congestion, dry cough, orthostatic hypotension, diarrhea,** HA, fatigue, nausea	
Fosinopril • Monopril	**Dizziness, dry cough,** HA, fatigue, diarrhea, nausea	
Quinapril • Accupril	Somnolence, pruritus, dizziness, dry cough, hemorrhage	

Exercise concerns: No effect on exercise capacity.

ACE Receptor Blockers

Indication = High BP

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Losartan K^+ • Cozaar	Dizziness, HA, weakness, fatigue, chest pain, diarrhea, anemia, flu-like symptoms	Due to ↑ K^+ levels, should not be taken with K^+ supplements, salt substitutes containing K^+, or K^+-sparing diuretics NSAIDs & ASA = ↓ antihypertensive effects & ↓ renal function Beta blockers = ↑ effects Antihypertensives = ↑ effects Lithium = ↓ excretion → toxicity Digoxin = ↑ effects (↑ K^+ level) Ramipril & ramiprilat = ↑ effects
Candesartan • Atacand	Dizziness, HA, runny nose, URI	
Irbesartan • Avapro	Anxiety, chest pain, diarrhea, dizziness, flu, HA, fatigue, nausea, upset stomach, sore throat, UTI, vomiting	
Olmesartan • Benicar	**Dizziness,** swelling (face, throat, hands, feet), hoarseness, difficulty breathing/swallowing	
Telmisartan • Micardis	**Dizziness, fetal toxicity,** swelling (face, throat, hands, feet), hoarseness, difficulty breathing/swallowing	

Exercise concerns: No effect on exercise capacity.

Ca^{++} Channel Blockers

Indication = Angina

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Diltiazem • Cardizem • Dilacor • Diltiaz • Tiazac	**LE edema, HA, 1° heart block,** arrhythmia, bradycardia, nausea, rash, dizziness/syncope, fatigue, 1° heart block, CHF, drug-induced gingival hyperplasia	Digoxin = elevated digitalis levels Anesthetics = ↑ anesthetic effects & depression of cardiac contractility Cyclosporine = ↑ cyclosporine level Diazepam = ↑ CNS depression Statins = ↑ levels → muscle pain & rhabdomyolysis
Verapamil • Calan	**Hypotension, AV block, constipation,** dizziness, nausea, HA, arrhythmia, dyspnea	Beta blockers = heart failure Cardiac glycoside = ↑ digitalis levels Antihypertensives = hypotension Cyclosporine = ↑ levels Grapefruit juice = ↑ drug level St. John's wort = ↓ drug level Alcohol = ↑ alcohol level Statins = ↑ levels → muscle pain & rhabdomyolysis
Amlodipine • Norvasc • Amvaz	**Edema,** HA, fatigue, nausea, flushing, rash, LE edema, dizziness	When combined with another antihypertensive = hypotension When combined with alpha blocker = hypotension & reflex tachycardia Statins = ↑ levels → muscle pain & rhabdomyolysis

Continued

Ca^{++} Channel Blockers—cont'd

Indication = Angina

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Nifedipine • Procardia	**Dizziness, HA, weakness, flushing, peripheral edema, nausea**	Verapamil = ↓ effects Antifungals or erythromycin = ↑ effects Fentanyl = severe hypotension Cimetidine = ↑ plasma level of nifedipine Beta blockers = hypotension Ginkgo or grapefruit juice = ↑ effects St. John's wort = ↓ drug effect Statins = ↑ levels → muscle pain & rhabdomyolysis

Exercise concerns: May cause arthralgia/myalgia that may negatively influence exercise capacity.

*Beta Blockers/Antihypertensives

Indications = Angina, arrhythmias, hypertension

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Propranolol • Inderal • InnoPran	↑ **LDL cholesterol, bradycardia, fatigue, lethargy, hypotension,** light-headedness, abdominal cramping, rash, Raynaud's, bronchospasm in asthmatics	Verapamil or diltiazem = hypotension Epinephrine = severe peripheral vasoconstriction Insulin = delay recovery from & awareness of hypoglycemia Phenothiazines = ↑ adverse reactions NSAIDs = ↓ antihypertensive effect
Atenolol • Tenormin	↑ **LDL cholesterol, dizziness, fatigue, hypotension, bradycardia,** nausea, LE pain, rash, bronchospasm, orthostatic hypotension	Ca^{++} channel blockers or prazosin = ↑ hypotension Cardiac glycosides = severe bradycardia Insulin = may alter dosage NSAIDs = ↓ antihypertensive effects
Timolol • Blocadren	↑ **LDL cholesterol,** bronchospasm, fatigue, bradycardia, extremity pain, weakness, impotence	NSAIDs = ↓ antihypertensive effect
Metoprolol • Lopressor • Toprol	↑ **LDL cholesterol, fatigue, dizziness, depression, hypotension,** bradycardia, nausea, rash, bronchospasm	Cardiac glycosides = severe bradycardia MAO inhibitors, cimetidine, hydralazine, prazosin, or verapamil = additive effects; hypotension & bradycardia

Continued

*Beta Blockers/Antihypertensives—cont'd

Indications = Angina, arrhythmias, hypertension

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Labetalol • Normodyne • Trandate	↑ **LDL cholesterol,** dizziness, nausea, fatigue, hypotension	Cimetidine = ↑ labetalol plasma levels Verapamil = additive effects NSAIDs = ↓ antihypertensive effect
Carvedilol • Coreg	↑ **LDL cholesterol,** asthenia, dizziness, fatigue, hypotension, diarrhea, hyperglycemia, wt gain, URI May produce bronchoconstriction in patients with asthmatic conditions*	Cimetidine = ↑ carvedilol plasma levels MAO inhibitors = bradycardia & ↓ BP Ca^{++} channel blockers = conduction disturbances NSAIDs = ↓ antihypertensive effect

Exercise concerns: As a result of a blunting of HR, exercise to 20 bpm above resting HR; beta blockers mask symptoms of & delay recovery from hypoglycaemia.

*Should not be taken with MAO inhibitors.

Antilipemics

Indications = Reduce LDL, total cholesterol, & triglyceride levels

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Atorvastatin • Lipitor	Constipation, muscle pain, flatulence, ↑ liver transaminase, dyspepsia, rhabdomyolysis	Antacids = ↓ plasma level of atorvastatin Digoxin or erythromycin = ↑ plasma level of atorvastatin BCP = ↑ plasma level of BCP Erythromycin, niacin, or antifungals = ↑ risk of myopathy

Exercise concerns: Muscle weakness & cramping, myalgia, rhabdomyolysis.

Diuretics

Indications = Edema, hypertension

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Furosemide (loop diuretic) • Lasix	Dehydration, muscle cramps, hypokalemia, hypocalcemia (osteoporosis), cardiac arrhythmias	Antihypertensives or Ca^{++} channel blocker = ↑ risk of hypotension & arrhythmias Loop + thiazide diuretic = ↑ risk of hypotension & arrhythmias Cardiac glycosides = ↑ risk of digoxin toxicity with K^+ loss NSAIDs = inhibit diuretic response Sun = photosensitivity
Thiazide • Esidrix • HydroDIURIL • Lozol • Zaroxolyn	**Dizziness,** muscle weakness, cramps, thirst, hyperglycemia, stomach discomfort	
K^+ sparing • Aldactone • Dyrenium	**Dizziness,** weakness, fatigue, HA, diarrhea, dry mouth, muscle cramps	

Exercise concerns: Diminished exercise performance; limited muscle endurance; volume depletion; ↑ risk of heat-related illness; muscle cramps 2° hypokalemia.

Antidepressants

Indication = Depression, OCD, anxiety

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Amitriptyline • Elavil	**Orthostatic hypotension, tachycardia, dry mouth,** stroke, arrhythmia, lethargy, confusion, urinary retention, blurred vision, constipation	Contraceptives = ↑ antidepressant level & ↑ tricyclic-induced akathisia Clonidine or epinephrine = extreme hypertension MAO inhibitors = severe excitation Quinolones = life-threatening arrhythmias (↑ QTc interval) Alcohol = CNS depression Sun = photosensitivity
Doxepin • Sinequan • Adapin • Zonalon	**Drowsiness, dizziness, dry mouth, orthostatic hypotension, blurred vision, tachycardia, diaphoresis, constipation, seizures,** confusion, urinary retention	Contraceptives = ↑ antidepressant level Clonidine or epinephrine = extreme hypertension MAO inhibitors = severe excitation Quinolones = life-threatening arrhythmias Alcohol = CNS depression Sun = photosensitivity
Exercise concerns: Improved motor performance following ischemic stroke.		

*Should not be taken with MAO inhibitors.

Continued

Antidepressants—cont'd

Indication = Depression, OCD, anxiety

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Bupropion • Wellbutrin • Zyban	**Insomnia, agitation, dry mouth, tremor, abnormal dreams, HA, excess sweating, tachycardia, nausea, constipation, vomiting, dizziness, rhinitis, anorexia, blurred vision,** wt gain, seizures	MAO inhibitors = ↑ risk of toxicity Nicotine = hypertension Levodopa = ↑ risk of adverse reactions Sun = photosensitivity Prednisone or phenothiazine = ↑ risk of seizures
Fluoxetine* • Prozac	Nervousness, somnolence, insomnia, anxiety, drowsiness, HA, tremor, dizziness, weakness, nausea, diarrhea, dry mouth, anorexia, akathisia	Beta blockers = heart block, bradycardia MAO inhibitors or St. John's wort = serotonin syndrome Antipsychotics = ↑ concentration of antipsychotics (extrapyramidal signs) Warfarin = ↑ bleeding Alcohol = ↑ depression
Sertraline* • Zoloft	**Fatigue, HA, tremor, dizziness, insomnia, somnolence, dry mouth, nausea, diarrhea, male sexual dysfunction,** suicidal behavior, akathisia	Benzodiazepines = ↑ effects MAO inhibitors, triptans, isoniazid, or St. John's wort = serotonin syndrome Warfarin = ↑ bleeding
Exercise concerns: Improved motor performance following ischemic stroke.		

*Should not be taken with MAO inhibitors.

Decongestants, Antihistamines, & Bronchodilators

Indications = Bronchospasm, COPD, emphysema

Generic Name (Brand Names)	Adverse Reactions (Bold = Most Frequent)	Interactions
Albuterol • Proventil • Ventolin • Brethine	**Tremor, nervousness, HA, hyperactivity, tachycardia, nausea, vomiting,** muscle cramps, hypocalcemia, cough, hyperglycemia	CNS stimulant = ↑ CNS effects MAO inhibitors or antidepressants = ↑ adverse CV effects Beta blockers = contraindicated, may cause bronchoconstriction
Pirbuterol • Maxair	Tremor, nervousness, dizziness, tachycardia, nausea, vomiting, cough, hyperglycemia	Beta blockers = contraindicated, may cause bronchoconstriction MAO inhibitors or antidepressants = ↑ effects
Salmeterol • Serevent Diskus	**Nasopharyngitis, URI,** HA, tremor, nausea, nervousness, tachycardia, myalgia	Beta blockers = contraindicated, may cause bronchoconstriction MAO inhibitors or antidepressants = ↑ risk of severe CV effects

Exercise concerns: Diminished exercise performance; limited muscle endurance; systemic administration may ↑ hyperglycemia.

Abbreviations & Symbols Specific to Orthopedics

Please note: This list is not comprehensive & is subject to modification by various facilities to meet the needs of their patient population.

ā	before
A	assistance
AAA	abdominal aortic aneurysm
AAROM	active, assistive range of motion
Abd	abduction
ABG	arterial blood gases
A.C.	before meals
ACL	anterior cruciate ligament
Add	adduction
ad lib	as desired
ADLs	activities of daily living
AE	above elbow
AFib	atrial fibrillation
AFO	ankle foot orthosis
AK	above knee
AMA	against medical advice
amb	ambulation
ANS	autonomic nervous system
AP	anterior-posterior
APL	abductor pollicis longus
ARD	adult respiratory distress
AROM	active range of motion
ASA	aspirin
ASCVD	arteriosclerotic cardiovascular disease
ASIS	anterior superior iliac spine
ATFL	anterior talofibular ligament
A-V	arteriovenous
B	bilateral
B & B	bowel & bladder
BBB	bundle branch block
BE	below elbow
bid	twice daily
BK	below knee
BM	bowel movement
BMI	body mass index
BMR	basal metabolic rate
BOS	base of support
BP	blood pressure
BRP	bathroom privileges
BS	breath sounds
BUN	blood urea nitrogen
Bx	biopsy
c̄	with
Ca^{++}	calcium
CA	cancer
CABG	coronary artery bypass graft
CAD	coronary artery disease
CBC	complete blood count
CC	chief complaint
CCE	clubbing, claudication, edema
CHF	congestive heart failure
CHI	closed head injury

CKC . . . . . .closed kinetic chain
CN . . . . . .cranial nerve
CNS . . . . . .central nervous system
c/o . . . . . .complaints of
CO . . . . . .cardiac output
COPD . . . . . .chronic obstructive pulmonary disease
CP . . . . . .cerebral palsy
CP . . . . . .chest pain
CPK . . . . . .creatine phosphokinase
CPM . . . . . .continuous passive motion
CPP . . . . . .closed packed position
CPR . . . . . .cardiopulmonary resuscitation
CSF . . . . . .cerebrospinal fluid
CT . . . . . .computed tomography
CTS . . . . . .carpal tunnel syndrome
C-Tx . . . . . .cervical traction
CVA . . . . . .cerebrovascular accident
CXR . . . . . .chest x-ray
D/C . . . . . .discharge
DDD . . . . . .degenerative disc disease
DDX . . . . . .differential diagnosis
DF . . . . . .dorsiflexion
DIP . . . . . .distal interphalangeal
DJD . . . . . .degenerative joint disease
DM . . . . . .diabetes mellitus
DNR . . . . . .do not resuscitate
DOB . . . . . .date of birth
DOE . . . . . .dyspnea on exertion
DPT . . . . . .diphtheria, pertussis, tetanus
DSD . . . . . .dry sterile dressing
DTR . . . . . .deep tendon reflexes
DVT . . . . . .deep vein thrombosis
Dx . . . . . .diagnosis
EAA . . . . . .essential amino acids
EBL . . . . . .estimated blood loss
ECG/EKG . . . . . .electrocardiogram
EEG . . . . . .electroencephalogram
EMG . . . . . .electromyogram
ENT . . . . . .ear, nose, throat
EOMI . . . . . .extraocular motion intact
EPB . . . . . .extensor pollicis brevis
ER . . . . . .external rotation
ESR . . . . . .erythrocyte sedimentation rate
ETOH . . . . . .ethyl alcohol
ev . . . . . .eversion
Ex . . . . . .exercise
Ext . . . . . .extension
F . . . . . .frequency
FAQ . . . . . .full arc quads
f/b . . . . . .followed by
FB . . . . . .feedback
FCU . . . . . .flexor carpi ulnaris
FDP . . . . . .flexor digitorum profundus
FEV . . . . . .forced expiratory volume
flex . . . . . .flexion
FOOSH . . . . . .fall on outstretched hand
FPL . . . . . .flexor pollicis longus
FRC . . . . . .functional residual capacity
f/u . . . . . .follow-up
FUO . . . . . .fever of unknown origin
FVC . . . . . .forced vital capacity
FWB . . . . . .full weight bearing

Fx .....fracture
GB .....gallbladder
GI .....gastrointestinal
Grav. 1 .....number of pregnancies (para = births)
GSW .....gunshot wound
GTO .....Golgi tendon organ
GTT .....glucose tolerance test
GU .....genitourinary
GXT .....graded exercise tolerance
H & H .....hematocrit & hemoglobin
HA .....headache
Hct .....hematocrit
HDL .....high-density lipoprotein
HEENT .....head, ears, eyes, nose, throat
Hgb .....hemoglobin
HIV .....human immunodeficiency virus
HNP .....herniated nucleus pulposus
H/O .....history of
HOB .....head of bed
HP .....hot pack
HPI .....history of present illness
HR .....heart rate
HTN .....hypertension
Hx .....history
I .....independent
I + D .....incision & drainage
I + O .....input & output
ICS .....intercostal space
ICU .....intensive care unit
IDDM .....insulin-dependent diabetes mellitus
I/E ratio .....inspiratory/expiratory ratio
IM .....intramuscular
inv .....inversion
IP .....interphalangeal joint
IPPB .....intermittent positive pressure breathing
IR .....internal rotation
IRDM .....insulin-resistant diabetes mellitus
ITB .....iliotibial band
IV .....intravenous
JODM .....juvenile onset diabetes mellitus
JRA .....juvenile rheumatoid arthritis
JVD .....jugular vein distention
KAFO .....knee ankle foot orthosis
KUB .....kidney, ureter, bladder
L .....left
LBP .....low back pain
LBQC .....large-base quad cane
LCL .....lateral collateral ligament
LDH .....serum lactate dehydrogenase
LE .....lower extremity
LKS .....liver, kidney, spleen
LLB .....long leg brace
LLC .....long leg cast
LLQ .....left lower quadrant
LMN .....lower motor neuron
LMP .....last menstrual period
LOC .....loss of consciousness
LOS .....length of stay
LP .....lumbar puncture
LTG .....long-term goal
L-Tx .....lumbar traction

LUQ . . . . . .left upper quadrant
MAFO . . . . . .molded ankle foot orthosis
MAL . . . . . .midaxillary line
max . . . . . .maximum
MCL . . . . . .medial collateral ligament
MCL . . . . . .midclavicular line
MCP . . . . . .metacarpal phalangeal
MH . . . . . .moist heat
min . . . . . .minimum
MI . . . . . .myocardial infarction
mm . . . . . .muscle
MMR . . . . . .measles, mumps, rubella
MMT . . . . . .manual muscle test
mod . . . . . .moderate
MOI . . . . . .mechanism of injury
MRI . . . . . .magnetic resonance imaging
MRSA . . . . . .methicillin-resistant *Staph. aureus*
MS . . . . . .multiple sclerosis
MTP . . . . . .metatarsophalangeal
MTrP . . . . . .myofascial trigger point
MVA . . . . . .motor vehicle accident
MWD . . . . . .microwave diathermy
N + V . . . . . .nausea and vomiting
n/a . . . . . .not applicable
NAD . . . . . .no acute distress
NCV . . . . . .nerve conduction velocity
ng . . . . . .nasogastric
NIDDM . . . . . .non–insulin-dependent diabetes mellitus
NKA . . . . . .no known allergies
NKDA . . . . . .no known drug allergies
nn . . . . . .nerve
NPO . . . . . .nothing by mouth
NSA . . . . . .no significant abnormality
NSAID . . . . . .nonsteroidal anti-inflammatory drug
NSR . . . . . .normal sinus rhythm
NWB . . . . . .non–weight bearing
O_2 . . . . . .oxygen
OA . . . . . .osteoarthritis
OB . . . . . .obstetrics
OKC . . . . . .open kinetic chain
OOB . . . . . .out of bed
OPP . . . . . .open packed position
ORIF . . . . . .open reduction, internal fixation
OT . . . . . .occupational therapy
p̄ . . . . . .after
P + A . . . . . .percussion and auscultation
P + PD . . . . . .percussion + postural drainage
PA . . . . . .posterior-anterior
PAC . . . . . .premature atrial contraction
PaO_2 . . . . . .peripheral arterial oxygen content
PAO_2 . . . . . .alveolar oxygen
PAP . . . . . .pulmonary artery pressure
PCL . . . . . .posterior cruciate ligament
PD . . . . . .postural drainage
PDR . . . . . .*Physicians' Desk Reference*
PE . . . . . .pulmonary embolus
PEEP . . . . . .positive end expiratory pressure

PERLA . . . . . .pupils equal reactive to light accommodation
PF . . . . . .plantar flexion
PFT . . . . . .pulmonary function tests
PID . . . . . .pelvic inflammatory disease
PIP . . . . . .proximal interphalangeal
PMH . . . . . .past medical history
PNF . . . . . .proprioceptive neuromuscular facilitation
P.O. . . . . .by mouth
POD . . . . . .postoperative day
PR . . . . . .pulse rate
PRE . . . . . .progressive resistive exercises
prn . . . . . .as necessary
PROM . . . . . .passive range of motion
PSIS . . . . . .posterior superior iliac spine
pt . . . . . .patient
PTB . . . . . .patellar tendon bearing
PTFL . . . . . .posterior talofibular ligament
PVC . . . . . .premature ventricular contraction
PVD . . . . . .peripheral vascular disease
PWB . . . . . .partial weight bearing
Px . . . . . .problem
q2° . . . . . .every 2 hours
R . . . . . .right
RA . . . . . .rheumatoid arthritis
RBC . . . . . .red blood cells/count
RCL . . . . . .radial collateral ligament
RHD . . . . . .rheumatic heart disease
RLQ . . . . . .right lower quadrant
r/o . . . . . .rule out
ROM . . . . . .range of motion
ROS . . . . . .review of systems
RPE . . . . . .rate of perceived exertion
RR . . . . . .respiratory rate
RUQ . . . . . .right upper quadrant
RV . . . . . .residual volume
Rx . . . . . .treatment
s̄ . . . . . .without
S . . . . . .supervision
S_1 . . . . . .first heart sound
S_2 . . . . . .second heart sound
S & S . . . . . .signs and symptoms
SAQ . . . . . .short arc quad
SBQC . . . . . .small base quad cane
SC . . . . . .sternoclavicular
SC . . . . . .straight cane
SCI . . . . . .spinal cord injury
SCM . . . . . .sternocleidomastoid
SGOT . . . . . .serum glutamic-oxaloacetic transaminase
SI . . . . . .sacroiliac
SLB . . . . . .short leg brace
SLP . . . . . .speech & language pathology
SLR . . . . . .straight leg raises
SOAP . . . . . .subjective, objective, assessment, plan
SOB . . . . . .short of breath
s/p . . . . . .status post
SPC . . . . . .single-point cane
STG . . . . . .short-term goal
SV . . . . . .stroke volume
SWD . . . . . .short wave diathermy

Sx . . . . . .symptoms
UMN . . . . . .upper motor neuron
URI . . . . . .upper respiratory infection
US . . . . . .ultrasound
UTI . . . . . .urinary tract infection
UV . . . . . .ultraviolet
VC . . . . . .vital capacity
VMO . . . . . .vastus medialis obliquus
V/O . . . . . .verbal order
VPC . . . . . .ventricular precontraction
VS . . . . . .vital signs
VTO . . . . . .verbal telephone order
WBAT . . . . . .weight bearing as tolerated
WBC . . . . . .white blood cells/count
WBTT . . . . .weight bearing to tolerance
WBQC . . . . .wide-base quad cane
WC . . . . . .wheelchair
WFL . . . . . .within functional limits
WNL . . . . . .within normal limits
WP . . . . . .whirlpool
XCT . . . . . .chemotherapy
XRT . . . . . .radiation therapy
yo . . . . . .years old
1° . . . . . .primary
2° . . . . . .secondary
< . . . . . .less than
> . . . . . .greater than
↑ . . . . . .increase
↓ . . . . . .decrease
|| . . . . . .parallel

Interpretation of Statistics

Sensitivity (SeNout)

- True positive rate
- Proportion of patients who have a pathology that the test identifies as positive
- **SnNout** = **Sen**sitivity, a **N**egative test rules **out** the diagnosis
- Calculation = a/(a + c)

Specificity (SpPin)

- True negative rate
- Proportion of patients who have a pathology that the test identifies as negative
- **SpPin** = **Sp**ecificity, a **P**ositive test rules **in** the diagnosis
- Calculation = d/(b + d)

(–) Likelihood Ratio

- How much the odds of a disease decrease when a test is negative

(+) Likelihood Ratio

- How much the odds of a disease increase when a test is positive

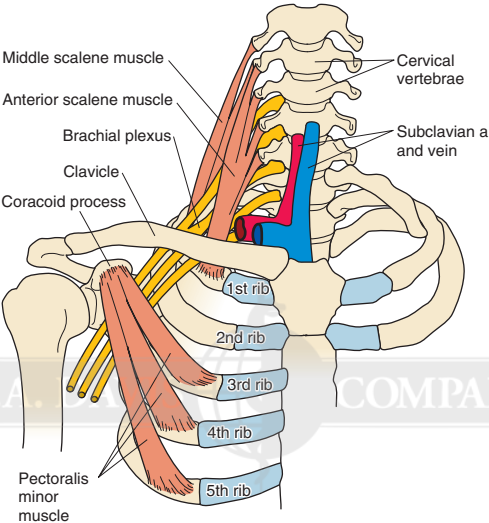
Statistics to Rule Out a Diagnosis

- High sensitivity ≥90
- (–) Likelihood ratio <0.10–0.20

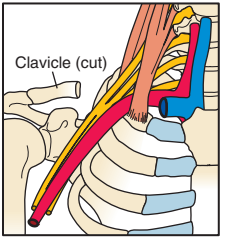
Statistics to Confirm a Diagnosis

- High specificity ≥90
- (+) Likelihood ratio >5–10

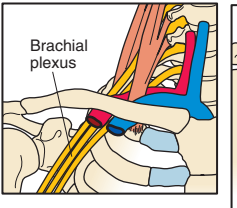
Anatomy[292, 425, 474]



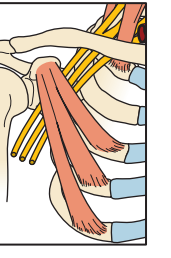
Scalene triangle

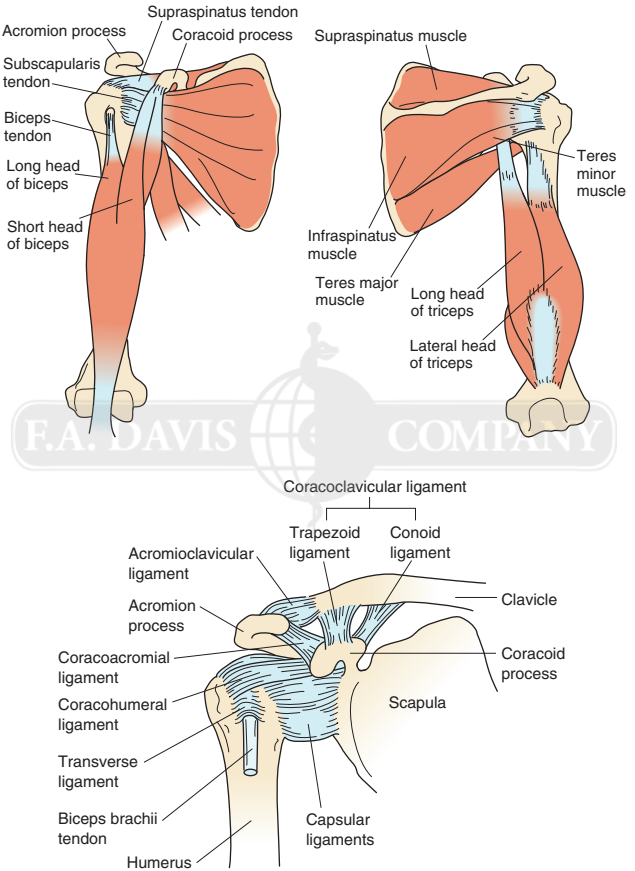


Costoclavicular space



Coracopectoral space





Medical Red Flags[177, 178]

- **Pericarditis**
  - Sharp anterior chest & shoulder pain
  - ↑ temp, HR, RR
- **Cardiac ischemia**
  - Neck, jaw, left arm, & chest pain
  - SOB
  - Palpitations
  - ↑ BP
  - Syncope
- **Pulmonary pathology**
  - Neck, shoulder, midthorax pain
  - Cough
  - Fever
  - Shallow & ↑ RR
- **Sources of right shoulder/scapula pain**
  - Gallstones—8 *F*s
    - Fertile = 3rd trimester of pregnancy
    - Female
    - Fat
    - Forty
    - Fair skin tone
    - Food—symptoms with fatty intake
    - Family history
    - Flatulence
  - Peptic ulcer (lateral border of scapula)
  - Diaphragm
  - Liver abscess, hepatic tumor
- **Sources of left shoulder pain**
  - MI
  - Diaphragm
  - Ruptured spleen
  - Pancreas

Toolbox Tests[286, 287]

Shoulder Pain & Disability Index (SPADI)[200, 423]

Pain Scale: How severe is your pain... **0 = no pain → 10 = worst pain imaginable**	
At its worst?	0 1 2 3 4 5 6 7 8 9 10
When lying on the involved side?	0 1 2 3 4 5 6 7 8 9 10
Reaching for something on a high shelf?	0 1 2 3 4 5 6 7 8 9 10
Touching the back of your neck?	0 1 2 3 4 5 6 7 8 9 10
Pushing with the involved arm?	0 1 2 3 4 5 6 7 8 9 10
Disability Scale: How much difficulty do you have... **0 = no pain → 10 = worst pain imaginable**	
Washing your hair?	0 1 2 3 4 5 6 7 8 9 10
Washing your back?	0 1 2 3 4 5 6 7 8 9 10
Putting on an undershirt or pullover sweater?	0 1 2 3 4 5 6 7 8 9 10
Putting on a shirt that buttons down the front?	0 1 2 3 4 5 6 7 8 9 10
Putting on your pants?	0 1 2 3 4 5 6 7 8 9 10
Placing an object on a high shelf?	0 1 2 3 4 5 6 7 8 9 10
Carrying a heavy object ≥10 lb?	0 1 2 3 4 5 6 7 8 9 10
Removing something from your back pocket?	0 1 2 3 4 5 6 7 8 9 10
Pain Scale Score: **Disability Scale Score:**	**Total Score:**

Scoring: Summate the scores & divide by the number of scores possible. If an item is deemed not applicable, no score is calculated. Multiple the total score by 100. The higher the score, the greater the impairment.

Penn Shoulder Score[277]

Part 1: Pain & Satisfaction	
	No Pain → Worst Possible
Pain at rest with arm by your side	0 1 2 3 4 5 6 7 8 9 10
Pain with normal activities (ADLs)	0 1 2 3 4 5 6 7 8 9 10
Pain with strenuous activities (reach, lift, push/pull, throw)	0 1 2 3 4 5 6 7 8 9 10
	Not → Very Satisfied
How satisfied are you with the current level of function of your shoulder?	0 1 2 3 4 5 6 7 8 9 10

Part 2: Function	No Difficulty or Did Not Do Before Injury	Some Difficulty	Much Difficulty	Can't Do at All
Reach the small of your back to tuck in shirt with hand	3	2	1	0
Wash the middle of your back/hook bra	3	2	1	0
Perform necessary toileting activities	3	2	1	0
Wash the back of opposite shoulder	3	2	1	0
Comb hair	3	2	1	0
Place hand behind head with elbow out to the side	3	2	1	0
Dress self (including put on coat & pull shirt overhead)	3	2	1	0

Continued

Part 2: Function				
	No Difficulty or Did Not Do Before Injury	Some Difficulty	Much Difficulty	Can't Do at All
Sleep on affected side	3	2	1	0
Open a door with affected side	3	2	1	0
Carry a bag of groceries with affected arm	3	2	1	0
Carry a briefcase/small suitcase with affected arm	3	2	1	0
Place a soup can (1–2 lb) on a shelf at shoulder level without bending elbow	3	2	1	0
Place a gallon container (8–10 lb) on a shelf at shoulder level without bending elbow	3	2	1	0
Reach a shelf above your head without bending your elbow	3	2	1	0
Place a soup can (1–2 lb) on a shelf overhead without bending elbow	3	2	1	0
Place a gallon container (8–10 lb) on a shelf overhead without bending elbow	3	2	1	0
Perform usual sport/hobby	3	2	1	0
Perform household chores (cleaning, laundry, cooking)	3	2	1	0

Continued

Part 2: Function				
	No Difficulty or Did Not Do Before Injury	Some Difficulty	Much Difficulty	Can't Do at All
Throw overhand, swim, perform overhead racquet sports	3	2	1	0
Work full-time at regular job	3	2	1	0

Scoring:

Pain = _____/30

Satisfaction = _____/10

Function = _____/60

Total score = _____/100

Quick DASH (Disabilities of the Arm, Shoulder, & Hand)[35]

Please rate your ability to perform the following activities in the last week by circling the number below the appropriate response.	No Difficulty	Mild Difficulty	Moderate Difficulty	Severe Difficulty	Unable
Open a tight or new jar	1	2	3	4	5
Do heavy household chores (wash walls, floors)	1	2	3	4	5
Carry a shopping bag or briefcase	1	2	3	4	5
Wash your back	1	2	3	4	5
Use a knife to cut food	1	2	3	4	5
Do recreational activities in which you take some force or impact through your arm, shoulder, or hand (e.g., golf, hammering, tennis)	1	2	3	4	5
	Not at All	**Slightly**	**Moderately**	**Quite a Bit**	**Extremely**
During the past week, to what extent has your arm, shoulder, or hand problem interfered with your normal social activities with family, friends, neighbors, or groups?	1	2	3	4	5

Continued

	Not Limited	Slightly Limited	Moderately Limited	Very Limited	Unable
During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder, or hand problem?	1	2	3	4	5
Please rate the severity of the following symptoms in the last week.	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
Arm, shoulder, or hand pain	1	2	3	4	5
Tingling ("pins & needles") in your arm, shoulder, or hand	1	2	3	4	5
	No Difficulty	**Mild Difficulty**	**Moderate Difficulty**	**Severe Difficulty**	**So Difficult, I Can't Sleep**
During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder, or hand?	1	2	3	4	5

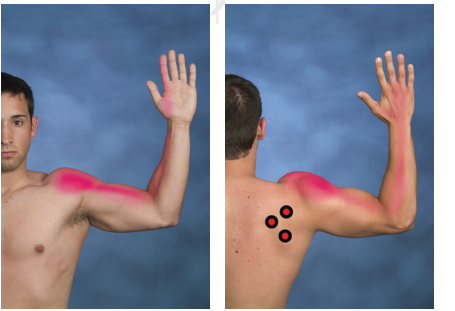
Quick DASH Score = [(sum of responses/number of responses) – 1] × 25A Quick DASH score cannot be calculated if >1 item is not answered.

Referral Patterns

Muscle Pain Referral Patterns[458]

Supraspinatus

Infraspinatus



Subscapularis

Teres Minor

Biceps Brachii

Palpation Pearls

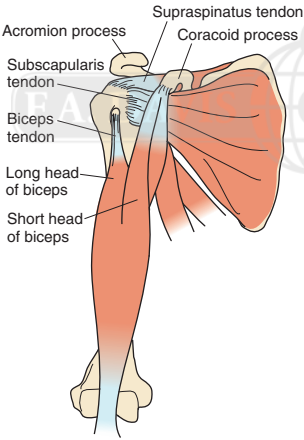
Rotator Cuff Muscles[45]

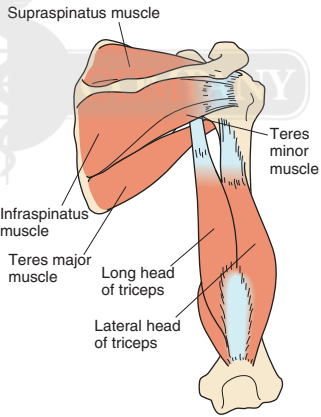
Supraspinatus With UE in maximal extension & IR, palpate from supraspinatus fossa to tendon anterior to A-C joint

Infraspinatus In prone on elbows, palpate posterior-lateral of acromion (just inferior to inferior angle of acromion)

Subscapularis In side-lying, maneuver relaxed UE to allow you to slide your thumb under the axillary/lateral border of scapula

Teres Minor In prone on elbows, palpate just inferior to infraspinatus

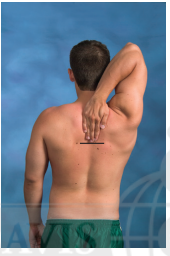




ROM

Rotational Lack[21, 185, 199]

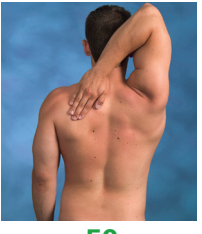
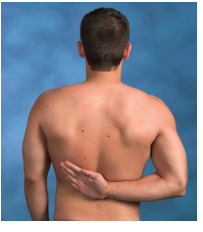
- Reach overhead (left Figure) as far as possible down the back & mark the most inferior point of the fingers.
- Reach up the back as far as possible (right Figure) & mark the most superior point of the fingers.
- Measure distance between the marks. This is the rotational lack.



Apley Scratch Test for Quick Screen[129, 215, 261]

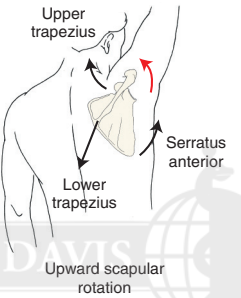
3 components:

1. Hand to opposite shoulder
2. Hand behind back to opposite scapula
3. Hand behind back to inferior angle of opposite scapula

Force Couples of the Shoulder[220, 247]

- Elevation = trapezius, rhomboid, SA
- Upward rotation = upper/lower trapezius & SA
- Abduction = supraspinatus, subscapularis, & deltoid
- Downward rotation = lower trapezius, latissimus, & pectoralis minor
- Stabilization of humeral head = RC & long head of biceps



Shoulder Osteokinematics[124, 129, 199, 217, 282, 362]

Normal ROM	OPP	CPP	Normal End-feel(s)	Abnormal End-feel(s)
Elevation 165°–175° IR/ER 180° total Scapulohumeral rhythm 2:1 (120° humeral: 60° scapular)	39° of elevation in scapular plane	Maximal abduction & ER	*Flexion* = elastic, firm—bony contact *Abduction* = elastic *Scaption* = elastic *IR/ER* = elastic/firm *Horiz add* = soft tissue *Extension* = firm *Horiz abd* = firm/elastic	Empty = subacromial bursitis Hard capsular = frozen shoulder Capsular = ER > abduction > IR

Shoulder Arthrokinematics[282]

Glenohumeral Joint	Concave surface: Glenoid fossa Convex surface: Humeral head	*To facilitate elevation:* Humeral head spins posterior	*To facilitate abduction:* Humeral head rolls superior & glides inferior/posterior
		To facilitate IR: Humeral head rolls posterior & glides anterior	*To facilitate ER:* Humeral head rolls anterior & glides posterior
		To facilitate horizontal adduction: Humeral head rolls medial & glides lateral on glenoid	*To facilitate horizontal abduction:* Humeral head rolls lateral & glides medial on glenoid
Sternoclavicular Joint	Convex surface: Medial clavicle Concave surface: Disk & manubrium	*To facilitate elevation:* Lateral clavicle rolls upward & medial clavicle glides inferior on disk & manubrium	*To facilitate depression:* Lateral clavicle rolls downward & medial clavicle glides superior on disk & manubrium
	Concave surface: Medial clavicle & disk Convex surface: Manubrium	*To facilitate retraction:* Medial clavicle & disk rolls & glides posterior on manubrium	*To facilitate protraction:* Medial clavicle & disk rolls & glides anterior on manubrium

Strength & Function

Neuromuscular Relationships of Cervical Spine[312]

Root	Nerve	Muscle	Sensation	Reflex
C3–4	Spinal accessory	Trapezius	∅	∅
C5	Dorsal scapular	Levator scapula Rhomboids	∅	∅
C5–6	Lateral pectoral	Pectoralis major Pectoralis minor	∅	∅
C5–6	Subscapular	Subscapular teres major	∅	∅
C5–6	Long thoracic	Serratus anterior	∅	∅
C5–6	Suprascapular	Supraspinatus Infraspinatus	Top of shoulder	∅
C5–6	Axillary	Deltoid teres minor	Deltoid anterior shoulder	∅
C5–7	Musculocutaneous	Coracobrachialis Biceps & brachialis	Lateral forearm	Biceps
C5–T1	Radial	Triceps wrist ext/finger flex	Dorsum of hand	Triceps
C6–7	Thoracodorsal	Latissimus dorsi	∅	∅

Brachial Plexus—Roots, Muscles, & Function[312]

Nerve	Root	Muscle	Function
Radial	C5–8, T1	Anconeus, brachioradialis, ECRL, ECRB, extensor digitorum, APL, ECU, extensor indices, extensor digiti minimi	• Weak supination, wrist extensors, finger flexors, & thumb abductors • Weak grip 2° loss of wrist stabilization
Median	C6–8, T1	Pronator teres, FCR, palmaris longus, FDS, FPL, pronator quadratus, henar eminence, lateral 2 lumbricales	• Weak pronation, wrist flexion, RD, thumb flexion, abduction, grip & pinch • Ape hand
Ulnar	C7–8, T1	FCU, palmaris brevis, hypothenar eminence, adductor pollicis, medial 2 lumbricales, interossei	• Weak wrist flexion, UD, 5th finger flexion & finger abd/adduction • Benediction sign

Shoulder Tests[202, 249, 329, 472, 481]

Rent Sign[300, 304, 481, 525]

Purpose: Assess RC tears
Position: Seated with UE in full ext & clinician's hand under flexed elbow
Technique: Stand behind client with fingertips in anterior margin of acromion; perform passive UE IR/ER & palpate for a defect (rent); compare bilaterally
Interpretation: (+) test = presence of a palpable defect in RC
Statistics: Sensitivity = 91%–96% & specificity = 75%–97%; (+) LR = 3.64–32.00 & (–) LR = 0.04–0.12

Empty Can Test[27, 225, 243, 294, 300, 345, 383, 391, 449, 481]

Purpose: Assess supraspinatus
Position: Seated
Technique: Elevate UE 30°–45° in plane of the scapula with IR, resist elevation
Interpretation: (+) test = reproduction of pain &/or weakness
Statistics: Pain: sensitivity = 64%–73% & specificity = 12%–37%; Weakness: sensitivity = 60%–75% & specificity = 13%–33%; (+) LR = 1.00–2.41 & (–) LR = 0.22–0.93

Source: From Gulick, D., 2008, p 108.

Full Can Test[225, 243, 300, 382, 481]

Purpose: Assess supraspinatus
Position: Seated
Technique: Elevate UE 30°–45° in plane of the scapula with ER, resist elevation
Interpretation: (+) test = reproduction of pain &/or weakness
Statistics: Pain: sensitivity = 65%–70% & specificity = 7%–30%; Weakness: sensitivity = 68%–70% & specificity = 7%–35%; (+) LR = 1.83–2.96 & (–) LR = 0.25–0.53

Source: From Gulick, D., 2008, p 109.

Drop Arm (Codman) Test[75, 312, 391]

Purpose: Assess supraspinatus
Position: Seated
Technique: Passively position shoulder at 90° abduction (palm down) & have client lower arm to side
Interpretation: (+) test = inability to lower arm in smooth manner
Statistics: Sensitivity = 8%–34% & specificity = 77%–97%; (+) LR = 2.80 & (–) LR = 0.95; (+) PV = 8%–65% & (–) PV = 66%–86%

Lateral Jobe Test[173]

Purpose: Assess supraspinatus
Position: Seated
Technique: Shoulder at 90° abduction & maximal IR, resist abduction
Interpretation: (+) test = reproduction of pain &/or weakness
Statistics: Sensitivity = 81% & specificity = 89%; (+) PV = 91% & (–) PV = 77%

ER Rotation Lag Sign[27, 207]

Purpose: Assess supraspinatus
Position: Seated
Technique: Shoulder in 20° of scaption & 5° less than max ER, pt holds position
Interpretation: (+) test = lag in ER
Statistics: Sensitivity = 45%–70% & specificity = 91%–100%; (+) LR = 5.00 & (–) LR = 0.30–0.60

Drop Sign[207, 329]

Purpose: Assess supraspinatus & infraspinatus
Position: Seated
Technique: Shoulder at 90° of abduction, pt to hold position
Interpretation: (+) test = supraspinatus: 5°–10° lag in position or supraspinatus + infraspinatus: >15° lag
Statistics: Sensitivity = 6%–50% & specificity = 100%; (+) PV = 100% & (–) PV = 32%

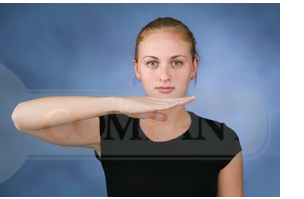
Dropping Sign[27, 207, 300, 345, 346, 361, 481, 512]

Purpose: Assess infraspinatus
Position: Seated
Technique: Shoulder at side with 45° of IR & 90° elbow flexion, resist ER
Interpretation: (+) test = reproduction of pain &/or weakness
Statistics: Sensitivity = 20%–100% & specificity = 69%–100%; (+) LR = 1.5–3.2 & (–) LR = 0.00–0.79; (+) PV = 10%–69% & (–) PV = 70%–87%

Source: From Gulick, D., 2008, p 109.

Hornblower (Patte) Test[300, 327, 481, 512]

Purpose: Assess teres minor
Position: Seated
Technique: Shoulder in 90° abd & elbow flexed so that hand comes to mouth (blowing a horn)
Interpretation: (+) test = reproduction of pain &/or inability to maintain UE in ER
Statistics: Sensitivity = 92%–100% & specificity = 30%–93%; (+) LR = 14.29 & (–) LR = 0.00



Source: From Gulick, D., 2008, p 110.

Lift-Off (Gerber) Sign[32, 79, 170, 181, 300, 305, 382, 421, 479, 480, 481]

Purpose: Assess subscapularis
Position: Seated
Technique: Hand in the curve of lumbar spine, resist IR
Interpretation: (+) test = reproduction of pain &/or weakness; inability to lift off
Statistics: Sensitivity = 18%–89% & specificity = 98%–100%; (+) LR = NT & (–) LR = 0.82; (+) PV = 50%–100% & (–) PV = 67%–69%; tears >75% are often required to produce (+) test

Source: From Gulick, D., 2008, p 110.

Belly Press (Napoleon) Sign[32, 79, 300, 421, 480, 481]

Purpose: Assess subscapularis
Position: Seated with hand on belly
Technique: Press hand into belly
Interpretation: (+) test = reproduction of pain &/or inability to IR; substitution may result in UE elevation or wrist flexion
Statistics: Sensitivity = 25%–80% & specificity = 71%–98%; (+) LR = 12.5–20 & (–) LR = 0.61–0.77; tears >50% are often required to produce (+) test

Source: From Gulick, D., 2008, p 111.

Belly-Off Test[32, 440]

Purpose: Assess subscapularis
Position: Seated
Technique: Hand held on belly as clinician applies force to pull hand off
Interpretation: (+) test = pain &/or weakness
Statistics: Sensitivity = 69%–90% & specificity = 66%

Bear-Hug Test[32, 80]

Purpose: Assess subscapularis
Position: Seated with palm of hand on opposite shoulder (elbow in front of body)
Technique: Resist IR by attempting to pull hand off shoulder
Interpretation: (+) test = inability to hold hand against shoulder or weakness >20% of contralateral UE
Statistics: Sensitivity = 60% & specificity = 92%; (+) LR = 7.5 & (–) LR = 0.43; tears of 30% can produce (+) test

Combination of RC Tests	(+) LR	(–) LR
• Supraspinatus weakness[357] • ER weakness • Impingement sign	All 3 = 48.00 2 of 3 = 7.60 1 of 3 = 1.90	All 3 = 0.76 2 of 3 = 0.42 1 of 3 = 0.01
• Supraspinatus weakness[305] • Infraspinatus weakness • Palpation of RC	All 3 = 3.64	All 3 = 0.12

Hawkins/Kennedy Test[26, 27, 75, 152, 154, 171, 197, 220, 243, 309, 345, 391, 431, 449, 472, 481]

Purpose: Assess for impingement &/or subacromial bursitis
Position: Seated
Technique: Place shoulder in 90° of flexion, slight horizontal adduction, & maximal IR
Interpretation: (+) test = shoulder pain due to impingement of supraspinatus between greater tuberosity & coracoacromial arch
Statistics: Impingement: Sensitivity = 55%–92% & specificity = 13%–100%; (+) LR = 0.9–3.33 & (–) LR = 0.21–1.18; (+) PV = 38%–78% & (–) PV = 72%–85%; Subacromial bursitis: Sensitivity = 92% & specificity = 44%; (+) LR = 1.64 & (–) LR = 0.18

Neer Test[26, 62, 75, 152, 243, 309, 345, 361, 391, 405, 450, 481, 495, 514]

Purpose: Assess for impingement &/or sub-acromial bursitis
Position: Seated
Technique: Passively take UE into full shoulder flexion with humerus in IR
Interpretation: (+) test = pain may be indicative of impingement of supraspinatus or long head of the biceps
Statistics: Impingement: Sensitivity = 45%–89% & specificity = 17%–31%; (+) LR = 0.92–1.44, (–) LR = 0.35–1.14; (+) PV = 86%, (–) PV = 78%; Subacromial bursitis: Sensitivity = 75% & specificity = 48%; (+) LR = 1.44, (–) LR = 0.52

Yocum Test[152, 449]

Purpose: Assess for impingement
Position: Seated
Technique: Place hand on opposite shoulder & raise elbow to forehead
Interpretation: (+) test = reproduction of pain
Statistics: Sensitivity = 70%–80% & specificity = 36%–92%; (+) LR = 1.2–1.3 & (–) LR = 0.53–0.56; (+) PV = 84% & (–) PV = 86%

Impingement Relief Test[103]

Purpose: Confirm impingement
Position: Seated
Technique: Perform inferior glide of GH joint while elevating UE to Neer position, i.e., IR
Interpretation: (+) test = reduction or no pain when elevation is accompanied by inferior glide
Statistics: Sensitivity = NT & specificity = NT

Sulcus Sign[46, 169, 323, 327, 358]

Purpose: Assess for inferior instability or AC Px
Position: Sitting with shoulder in neutral & elbow flexed to 90°
Technique: Palpate shoulder joint line while using proximal forearm as a lever to distract humerus inferiorly
Interpretation: (+) test = ≥1 finger-width gap @ shoulder joint line or AC joint
Statistics: Sensitivity = 17% & specificity = 93%; (+) LR = 2.43 & (–) LR = 0.89

Apprehension Test[27, 141, 154, 169, 183, 198, 268, 296, 302, 323, 352, 378, 451, 481]

Purpose: Assess for anterior instability
Position: Supine
Technique: Abduct shoulder to 90° & then begin to ER
Interpretation: (+) test = pain or apprehension to assume this position for fear of shoulder dislocation
Statistics: Sensitivity = 40%–92% & specificity = 39%–96%; (+) LR = 1.1–20.2 & (–) LR = 0.29–0.90

Anterior Fulcrum Test[141, 521]

Purpose: Assess for anterior GH instability
Position: Supine with shoulder in 90° of abduction
Technique: Stabilize elbow & translate proximal humerus anteriorly
Interpretation: (+) test = greater translation of involved UE
Statistics: Sensitivity = 28%–53% & specificity = 71%–85%; (+) LR = 1.0–3.6 & (–) LR = 0.56–1.01

Jerk Test[252]

Purpose: Assess posterior instability
Position: Sitting with UE in IR & flexed to 90°
Technique: Grasp elbow & load humerus proximal while passively moving UE into horizontal adduction
Interpretation: (+) test = sudden jerk/clunk as humeral head subluxes posteriorly; 2nd jerk/clunk may occur as UE returns to abducted position
Statistics: Sensitivity = 73% & specificity = 98%; (+) PV = 88% & (–) PV = 95%; Sensitivity of detecting a labral tear increases by 97% when Kim & Jerk tests are (+)

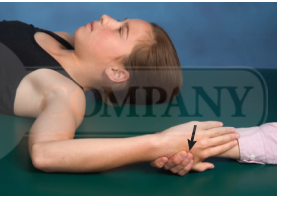
Yergason Test[183, 212, 237, 358, 378, 388, 391]

Purpose: Assess THL
Position: Seated with shoulder in neutral, elbow flexed to 90°, & forearm supinated
Technique: Resist elbow flexion with supination
Interpretation: (+) test = pain with tenosynovitis; clicking or snapping with resisted supination = torn THL
Statistics: Sensitivity = 9%–37% & specificity = 79%–96%; (+) LR = 2.05 & (–) LR = 0.72–0.73

Speed Test[40, 75, 127, 171, 183, 202, 212, 237, 278, 378, 391, 481]

Purpose: Assess for biceps tendonitis or labrum problem
Position: Seated with shoulder elevated 75°–90° in sagittal plane, elbow extended, & forearm supinated
Technique: Resist elevation
Interpretation: (+) test = pain with biceps tendonitis & sense of instability with labral Px
Statistics: Biceps: Sensitivity = 9%–100% & specificity = 14%–87%; (+) LR = 1.5 & (–) LR = 0.75; SLAP: Sensitivity = 9%–100% & specificity = 14%–79%; (+) LR = 0.8–1.27 & (–) LR = 0.11–1.11

Biceps Load Test[250, 251, 357, 522]



Purpose: Assess labrum
Position: Supine in 90°–120° of shoulder abduction & 90° of elbow flexion
Technique: Load the biceps by resisting elbow flexion/supination
Interpretation: (+) test = biceps tugs on labrum (SLAP) & reproduces pain
Statistics: Sensitivity = 78%–91% & specificity = 97%; (+) LR = 26–30 & (–) LR = 0.09–0.11

Pain Provocation Test[288, 348, 522]

Purpose: Assess labrum
Position: Supine in 90° shoulder abduction & 90° elbow flexion
Technique: Traction biceps via maximal passive forearm pronation & elbow ext
Interpretation: (+) test = biceps tugs on labrum & reproduces pain in superior region of joint line (superior labrum)
Statistics: Sensitivity = 17%–100% & specificity = 90%; (+) LR = 10.0 & (–) LR = 0.00

Crank Test[171, 183, 289, 295, 348, 357, 389, 458, 515]

Purpose: Assess labrum
Position: Seated with UE elevated to 160° & elbow flexed to 90°
Technique: Administer compression down humerus while performing IR/ER
Interpretation: (+) test = pain or clicking
Statistics: Sensitivity = 9%–91% & specificity = 56%–100%; (+) LR = 0.80–13.0 & (–) LR = 0.1–2.0 (greater accuracy than MRI)

Kim Test[252, 288]

Purpose: Assess labrum
Position: Seated with UE elevated to ~130° of scaption & elbow flexed to 90°
Technique: Apply compressive force through humerus
Interpretation: (+) test = pain or clicking
Statistics: Sensitivity = 80%–82% & specificity = 86%–94%; (+) LR = 13.3 & (–) LR = 0.21; sensitivity of detecting labral tear increases by 97% when Kim & Jerk tests are (+)

Compression Rotation Test[328, 358, 373, 378]

Purpose: Assess labrum
Position: Supine
Technique: UE in 90/90 position, compress & rotate shoulder joint using small & large circles
Interpretation: (+) test = reproduction of pain &/or clicking
Statistics: Sensitivity = 24%–100% & specificity = 54%–100%; (+) LR = 1.0–66.7 & (–) LR = 0.00–1.00

Clunk Test[14, 358, 522]

Purpose: Assess labrum
Position: Seated
Technique: In full shoulder abduction, translate humerus anteriorly & then passively ER
Interpretation: (+) test = clunk
Statistics: Sensitivity = 44% & specificity = 68%; (+) LR = 1.38 & (–) LR = 0.82

Anterior Slide (Kibler) Test[14, 171, 248, 249, 328, 378, 389, 515]

Purpose: Assess labrum
Position: Seated with hand on hip
Technique: Apply axial load to humerus
Interpretation: (+) test = anterior shoulder pain or click
Statistics: Sensitivity = 8%–78% & specificity = 70%–92%; (+) LR = 0.56–9.75 & (–) LR = 0.24–1.13

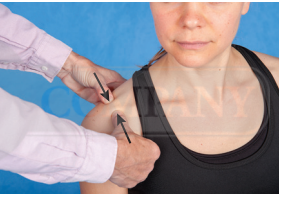
O'Brien Test[65, 127, 328, 357, 372, 378, 388, 458, 515, 522]

Purpose: Assess for labrum or AC joint problem
Position: Seated with UE in 90° of elevation, 10° of horizontal adduction, & maximal IR (pronation)
Technique: Resist elevation in IR then repeat in ER (supination)
Interpretation: (+) test = pain in IR > ER; pain "inside" shoulder is labrum & pain "on top" of shoulder is AC
Statistics: Sensitivity = 47%–100% & specificity = 11%–99%; (+) LR = 0.10–2.33 & (–) LR = 0.21–2.50

AC Shear Test[112, 373]

Purpose: Assess AC joint
Position: Seated; UE at side
Technique: Clinician interlaces fingers & surrounds AC joint; squeezing the hands together compresses AC joint
Interpretation: (+) test = pain or excessive mov't is indicative of damage to AC ligaments
Statistics: Sensitivity = 100% & specificity = 95%–98%; (+) PV = 88%–94% & (–) PV = 100%

Paxinos Sign[355, 516]



Purpose: Assess AC joint
Position: Seated
Technique: Compress AC via pressure on posterior acromion & lateral-anterior clavicle
Interpretation: (+) test = reproduction of pain
Statistics: Sensitivity = 79% & specificity = 50%; (+) LR = 1.58 & (–) LR = 0.42

Cross-Body Adduction Test[22, 75, 83, 91, 382, 391, 409, 444]

Purpose: Assess AC joint
Position: Seated
Technique: Shoulder flexed to 90°, horizontally adduct UE
Interpretation: (+) test = pain @ AC joint
Statistics: Sensitivity = 100% & specificity = 79%–97%

AC Resisted Extension Test[83, 125, 414]

Purpose: Assess AC joint
Position: Seated
Technique: Shoulder flexed to 90° with maximal IR & 90° of elbow flexion. Client is asked to resist horizontal abduction
Interpretation: (+) test = pain @ AC joint
Statistics: Sensitivity = NT & specificity = NT

Diagnostic Utility of 3 AC Test[83, 125, 414]
AC Shear, Cross-Body Adduction & AC Resisted Ext

	Sensitivity	Specificity	(+) LR	(–) LR	(+) PV	(–) PV
≥1 (+) test	0%	74%	0.0	1.4	0.17	1.00
≥2 (+) tests	81%	89%	7.4	0.2	0.28	0.99
=3 (+) tests	25%	97%	8.3	0.8	0.31	0.96

Coracoclavicular Ligament Test[77]

Purpose: Assess CC ligament
Position: Side-lying on unaffected side
Technique: Place affected UE behind back, palpate CC ligament while stabilizing clavicle; pull inferior angle of scapula away from ribs to stress conoid portion; pull medial border of scapula away from ribs to stress trapezoid portion
Interpretation: (+) test = pain
Statistics: Sensitivity = NT & specificity = NT

TOS Tests

"Rule of the Thumb"
Rotation of head follows direction of thumb

Adson Test[3, 275, 292, 321, 402, 414]

Purpose: Assess for TOS @ scalene triangle
Position: Seated
Technique: While palpating radial pulse, move UE into abd, ext, & ER, then client rotates head toward involved side & takes a deep breath & holds it
Interpretation: (+) test = absent or diminished radial pulse with symptoms reproduced
Statistics: Sensitivity = 32%–87% & specificity = 74%–100%

Wright (Hyperabduction) Test[292, 527]

Purpose: Assess for TOS @ coracoid/rib & under pectoralis minor
Position: Seated
Technique: While palpating radial pulse, passively abduct UE to 180° in ER & have client take a deep breath & hold it
Interpretation: (+) test = absent or diminished radial pulse with symptoms reproduced
Statistics: Pulse: Sensitivity = 70% & specificity = 53%; Pain: Sensitivity = 90% & specificity = 29%

Allen Test[172, 227]

Purpose: Assess for TOS @ pectoralis minor
Position: Seated
Technique: In 90° shoulder abduction & 90° elbow flexion, client turns head away & takes a deep breath & holds it
Interpretation: (+) test = absent or diminished radial pulse with symptoms reproduced
Statistics: Sensitivity = NT & specificity = 18%–43%

Military Brace Test[172, 292, 402, 414]

Purpose: Assess for TOS @ 1st rib & clavicle
Position: Seated
Technique: While palpating radial pulse, retract shoulders into extension & abduction with neck in hyperextension (exaggerated military posture)
Interpretation: (+) test = absent or diminished radial pulse or symptoms reproduced
Statistics: Sensitivity = NT & specificity = 53%–100%

Roos Test—Elevated Arm Stress Test[172, 216, 292, 425]

Purpose: Assess for TOS
Position: Seated with UEs at 90° of shoulder abduction, ER, & elbow flexion
Technique: Open & close hands × 3 min
Interpretation: (+) test = reproduction of symptoms or sensation of heaviness of UEs (record time of onset of symptoms)
Statistics: Sensitivity = 82%–84% & specificity = 30%–100%

Combination of TOS Tests	Sensitivity	Specificity
Adson + Roos	54%	94%
Adson + Wright (pain)	72%–79%	76%–88%
Adson + Wright (pulse)	54%	94%
Wright (pain) + Roos	83%	47%

TOS Differentiation[135, 172, 312, 437]	
Vascular Components	**Neural Components**
• (+) Adson, Wright, Allen, Roos, military press test • Hand or arm edema • Discoloration or UE claudication • Change in skin temperature or texture • Difference of UE DBP (>20 mm Hg) • Poor tolerance of cold & activity	• Muscle weakness • Pain with SB of C-spine • Sensory changes along neurological distribution, i.e., radial or ulnar nerve • (+) NTPT

Differential Diagnosis[55, 135, 165, 312]

	TOS	C-disc	Shoulder	Cubital Tunnel	Carpal Tunnel
Pain	Intermittent neck, shoulder, arm	Sharp, constant neck & UE	Shoulder & proximal UE	Elbow & medial hand	Intermittent lateral hand
Headache	(+)	(–)	(–)	(–)	(–)
Numbness	Whole UE	Respective dermatome	Uncommon	Ulnar distribution	Median distribution
Edema	Possible	Normal	Normal	Normal	Normal
Color	May be abnormal	May be abnormal	Normal	Normal	May be abnormal
Provocation	UE elevation	Neck positions	Activity	Elbow pressure	Muscle cramping w/sustained grasp
Muscle strength	Weak triceps & RC	Specific myotomes	Weak RC	Ulnar innervations	Median innervations
(+) Tests	NTPT, Adson, Allen, Wright, military press, Roos	Spurling, NTPT	RC & impingement	Tinel (elbow), Pressure-flexion, NTPT	Phalen, CTS, Tinel (wrist)

Differential Diagnosis[14, 104, 112, 143, 300, 361]

Pathology/Mechanism	Signs/Symptoms
Breast cancer[177]	• Palpable mass/nodule in breast tissue • Nipple discharge, retraction, & local skin dimpling • Erythema, local rash • Confirmed with mammogram; biopsy
Thoracic outlet syndrome[14, 55, 172, 402, 414, 527] Results from compression of any one of many sites, 2° postural or muscular imbalances, or osseous anomalies. May be due to vascular (only 5%–10%) or neural compression; locations of compression include sternocostovertebral space, scalene triangle, costoclavicular space, & coracopectoral space; most common in middle-aged female or after surgery See "Neural vs Vascular Table" on page 72 for differential diagnosis	• Kyphotic posture & forward head • Awakened @ night with pins & needles in hand • Poorly localized aching pain • Tenderness in suprascapular fossa • Pain with carrying heavy objects • (+) Tests: NTPT, Adson, Wright, military brace, Roos, & Allen • DBP >20 mm Hg difference between arms • A/P x-ray needed to r/o cervical rib (very rare) • EMG results are controversial • R/o CTS, radiculopathy, pronator syndrome
"SICK" scapula[128, 135] **S**capular malposition, **I**nferior medial scapular winging, **C**oracoid tenderness, & scapular dys**K**inesis	• Insidious onset, often overhead thrower • Prominent inferior medial border of scapula • Protracted scapula & TTP coracoid • Lack of prominence of acromion • ↓ Shoulder flexion & tight short head of biceps

Continued

Pathology/Mechanism	Signs/Symptoms
Clavicular fracture[104,135,312] Results from FOOSH, fall on the shoulder, or direct blow to clavicle	• Difficulty with UE elevation >60° & horizontal adduction • Visual deformity & TTP • Confirmed with x-ray
Acromioclavicular sprain[22, 62, 83, 91, 409, 444, 449] May result from fall on acromion & FOOSH See "Acromioclavicular Sprain Grades" on page 79	• Visual deformity may be present • Limited shoulder abduction & horizontal adduction • Pain with resisted ER & flexion • Crepitus on palpation • (+) Tests: Cross-body adduction, AC resisted extension test, O'Brien, AC shear, Paxinos, & sulcus • Confirmed with bilateral A/P x-ray in ER with & without a 10–15 lb weight (stress films) • R/o impingement
Glenohumeral dislocation[14, 104, 135, 169, 198, 267, 312, 323] Anterior is most common (90%); mechanism is FOOSH	• Prominent acromion, flattened shoulder silhouette, prominent humeral head • Injured posture: shoulder IR & slight abduction, elbow flexion, pronation, UE supported by contralateral limb • Sharp, stabbing pain, muscle guarding, humeral head is palpable anteriorly or inferiorly in the armpit • (+) Tests: apprehension & sulcus • X-ray—Hill-Sachs lesion may be visible in A/P view with UE in IR; Bankart lesion in Garth view • R/o humeral neck fracture in elderly

Continued

Pathology/Mechanism	Signs/Symptoms
Labral tear[14, 41, 65, 127, 150, 183, 295, 302, 348, 515, 522] May result from FOOSH, traction force on shoulder, or strong biceps contraction	• Pain with IR & adduction • Weakness with abduction & flexion • Client reports a sense of instability • (+) Tests: speed test, O'Brien, biceps load, pain provocation, crank, Kim, anterior slide, &/or compression rotation • Confirmed with CT or MRI; double-contrast CT is more accurate than MRI
Subacromial bursitis[14, 62, 75, 242, 449] Chronic irritation resulting from trauma or poor biomechanics; may occur in middle-aged or older clients after unusual bout of activity; hx of tendonitis	• Pain & limitation with active elevation • Pain with passive motions: abduction to 180°, IR, & horizontal adduction • (+) Tests: Hawkins/Kennedy, Neer, Yocum, & impingement relief • Subacromial bursa warm & TTP (position UE into passive extension to palpate bursa) • Imaging is of little value unless calcification has occurred; need to r/o RC tear, impingement, gouty or septic arthritis, fracture, or dislocation
Bicipital tendonitis[14, 135, 312] Chronic irritation resulting from trauma or poor biomechanics Forward head contributes to abnormal scapulohumeral rhythm	• Pain ↑ @ night; TTP localized to biceps tendon @ 10° of IR (places tendon anterior & ~6 cm below acromion) • Active elevation results in painful arc • Crepitus • (+) Speed test; (–) Yergason for click but painful • X-ray: bicipital groove view reveals medial wall angle, spurs, degenerative changes; caudal tilt view reveals spurring • Often associated with RC impingement

Continued

Pathology/Mechanism	Signs/Symptoms
Calcific tendinopathy[14, 312] Cyclic problem of calcification = deposition & resorption with unknown etiology (may be related to tissue hypoxia); deposits are located 1–2 cm from distal attachment on greater tuberosity Occurs in ♀ > ♂; R > L; 40–50 yo	• ↓ ROM with painful arc 70°–110° & sensation of catching through ROM • (+) Speed & impingement tests • *During deposition:* chronic mild-moderate discomfort, throbbing unrelieved by rest • *During resorption:* acute ↑ in pain; sharp & localized • Confirmed by A/P film in neutral • R/o impingement & adhesive capsulitis
Rotator cuff strain[14, 27, 32, 125, 294, 304, 312] Results from mechanical compression or tensile overload (eccentric microtears); partial-thickness tears occur 25–40 yo & full-thickness tears >60 yo RC has limited resiliency for self-repair *Contributing factors:* Posture—forward head influences GH alignment Anterior-inferior capsule tightness = ↓ ER Posterior capsule tightness = ↑ superior & anterior translation of humeral head	• Painful arc, night pain, deep ache • Crepitus, painful arc 70°–110° abduction • Weakness: abduction +/or ER, protective shoulder hike • (+) Special tests depending on muscle involved—empty/full can, lateral Jobe, ER rotation (supraspinatus), lift-off, belly press/Napoleon, belly-off (subscapularis), hornblower (teres minor), dropping sign (infraspinatus) • Strength imbalance (ER MMT should be 60%–70% of IR) • X-ray may be normal with small tears; partial tears = superior humeral displacement may be evident with ER; full-thickness tear = narrowed acromiohumeral interval & osteophytes on anterior/inferior acromion • Diagnostic ultrasound reliable for tears >1 cm • Arthrography with contrast = Geyser sign (painful) • MRI is noninvasive, but double-contrast CT is more accurate than MRI for full-thickness RC tears

Continued

Pathology/Mechanism	Signs/Symptoms
Supraspinatus impingement[14, 27, 103, 152, 197, 312, 405] Results from progressive loss of humeral depressor mechanism (infraspinatus, subscapularis, teres minor, & long head of biceps) 2° overuse, cervical Px, postural Px, abnormal biomechanics, or structural Px with acromion	• Pain (especially when sleeping on affected side) • Painful arc (60°–120° of elevation) • Pain & weakness in supraspinatus & biceps • "Catching" with flexion in IR • Pain referral pattern = deltoid insertion & anterior/proximal humerus • Little to no TTP • ROM ↓ IR & horizontal adduction • Posterior capsule tightness; pain with PROM
Microtrauma results from IR during overhead tennis stroke, swim, throwing; shoulder instability; tight pectoralis minor or weak lower trap & SA allows tipping of scapula with shoulder elevation to ↓ subacromial space to impingement	• (+) Tests: Neer, Hawkins-Kennedy, speed, empty/full can, & Yocum • X-rays may reveal ↓ joint space, arthritis, calcific tendonitis, hooked acromion; early dx is via MRI • R/o RC tear, TOS, labral tear, & calcific tendonitis
Coracoid impingement[14, 135, 312] Subacromial arch boundaries = acromion, coracoid, & coracoacromial ligament; houses supraspinatus, long head of biceps, subacromial bursa, coracohumeral ligament; hooked acromion; results from repetitive tasks with UE IR; poor posture	• Dull pain in front of shoulder provoked by flexion & IR or abduction & IR • Weak downward rotators of scapula • Forward head & kyphosis influences GH alignment • (+) Tests: Neer, Hawkins-Kennedy, & impingement relief • X-ray detects ↓ joint space & hooked acromion • R/o RC tear, TOS, labral tear, & calcific tendonitis

Continued

Pathology/Mechanism	Signs/Symptoms
Adhesive capsulitis[77, 135, 312] Self-limiting disorder of unknown etiology; high incidence in DM & associated with old Colles fx; proliferation of collagen results in thickening of inferior capsule & loss of capsular folds; most common in ♀ 40–70 yo See "Stages & Presentation of Adhesive Capsulitis" on page 80	• Pain radiating to elbow, night pain • Kyphotic posture, shoulder hiking, low-grade inflammatory response • Empty end-feel, ↓ accessory movement • ROM limitations: ER > abduction > IR & reverse scapulohumeral rhythm (scapular 2: humeral 1) • Unable to sleep on affected side; MTrP subscapularis • Contrast arthrography = 50% reduction in shoulder joint volume (5–10 mL instead of 20–30 mL); plain films reveal only osteoporosis 2° to disuse atrophy

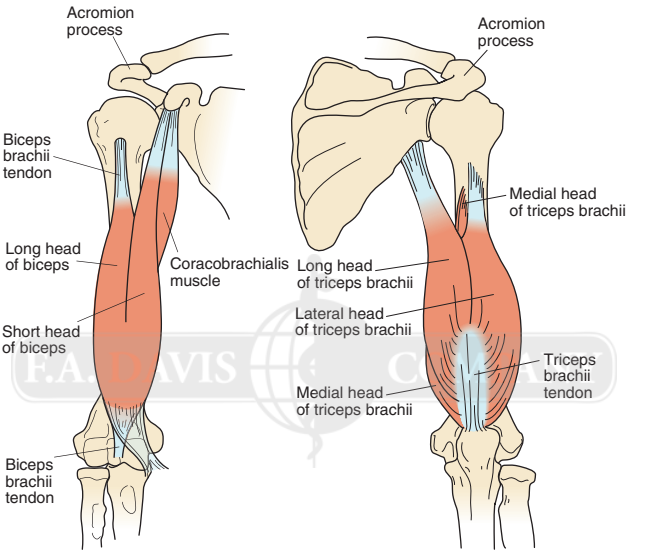
Acromioclavicular Sprain Grades[22, 52, 62, 91]

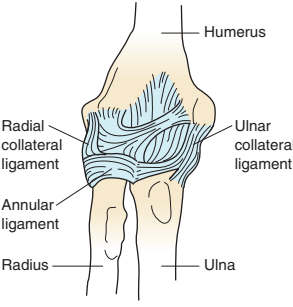
Grade	Presentation
Normal	Acromion-to-clavicle space should be ~0.3–0.8 cm Inferior clavicle-to-coracoid distance should be 1.0–1.3 cm
1st degree injury	AC joint space >0.8 cm & pain with horizontal adduction injury & elevation; (+) AC shear test
2nd degree injury	AC joint space 1.0–1.5 cm & CC distance increased by 25%–50%
3rd degree injury	AC joint space >1.5 cm & CC distance increased by >50% with step deformity

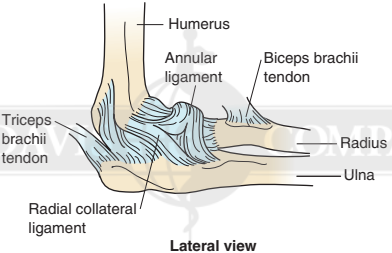
Stages & Presentation of Adhesive Capsulitis[77]

Stage	Clinical Findings	Arthroscopic Findings	Intervention
I—Freezing	• Continual increase in pain (before end-range) • ↓ AROM & PROM	Erythematous, fibrinous pannus over synovium in axillary fold	*Least aggressive:* • Modalities • Gentle AROM—Codman's • Grade I & II mobilizations
II—Frozen	• ↓ pain • ↓ AROM & PROM • Impaired GH accessory & physiological mov't • Impaired SH rhythm	Thickened synovium with adhesions developing across folds	*Moderately aggressive:* • Modalities • AROM • Gentle PROM • Grade III & IV mobilizations
III—Thawing	• Pain with stretching only, ↑ accessory & physiological motion, return of SH rhythm & ADLs	Loss of joint space, humeral head is compressed against glenoid, & axillary fold is reduced by 50%	*Most aggressive:* • Modalities • PROM • Grade III & IV mobilizations • PREs

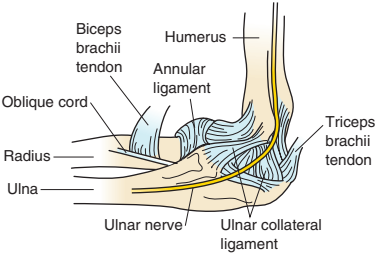
Anatomy[474]


Acromion process
Biceps brachii tendon
Long head of biceps
Coracobrachialis muscle
Short head of biceps
Biceps brachii tendon
Acromion process
Medial head of triceps brachii
Long head of triceps brachii
Lateral head of triceps brachii
Triceps brachii tendon
Medial head of triceps brachii





Lateral view

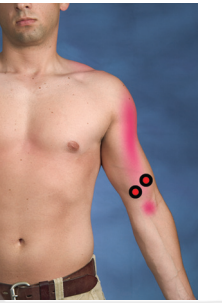


Medial view

Referral Patterns

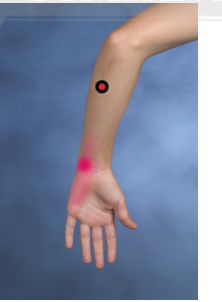
Muscle Pain Referral Patterns[488]

Brachioradialis



Biceps brachii

Flexor carpi radialis



Flexor carpi ulnaris

Muscle Pain Referral Patterns[488]

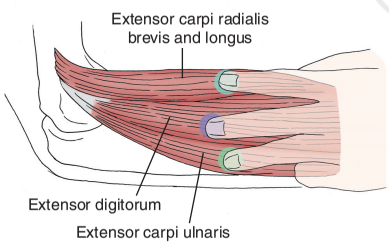
Extensor carpi ulnaris

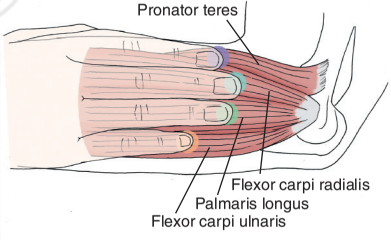
Extensor carpi radialis longus

Extensor carpi radialis brevis

Palpation Pearls[45]

Elbow Supinators/Wrist Extensors & Elbow Pronators/Wrist Flexors





Carrying angle of the elbow: 10°–15° valgus in females & 5°–10° valgus in males

Elbow Osteokinematics[125, 199, 282, 362]

Normal ROM		OPP	CPP	Normal End-feel(s)	Abnormal End-feel(s)
Flexion >135°	Humeroulnar	70° flex 10° sup	full ext full sup	Flexion = soft tissue or bony approximation Extension = bony approximation	Boggy = joint effusion Capsular = flex > ext
	Humeroradial	full ext full sup	90° flex 5° sup		
Pronation & supination 80°–90° each	Superior radio-ulnar	70° flex 35° sup	5° sup	Supination = ligamentous Pronation = bony approximation or ligamentous	Capsular = pronation & supination equally limited

Elbow Arthrokinematics[282]

Humeroulnar	Concave surface: Trochlear notch of ulna Convex surface: Trochlea of humerus	*To facilitate flexion:* **OKC** = radius & ulna roll & glide anterior & medial on humerus	*To facilitate extension:* **OKC** = radius & ulna roll & glide posterior & lateral on humerus
Humeroradial	Concave surface: Radial head Convex surface: Capitulum of humerus		
Superior/ proximal radioulnar	Concave surface: Radial notch of ulna Convex surface: Radial head	*To facilitate pronation:* Radius spins medially & glides anterior on ulna	*To facilitate supination:* Radius spins laterally & glides posterior on ulna

Brachial Plexus—Roots, Muscles, Deficits, & Deformities[282]

Nerve & Root	Muscles	Functional Deficits	Postural Deformity
Radial C5–8, T1	Anconeus, brachioradialis, ECRL, ECRB, extensor digitorum, APL, ECU, extensor indicis, extensor digiti minimi	• Weak supination, wrist ext, finger flex, thumb abd • Weak grip due to loss of wrist stabilization	
Median C6–8, T1	Pronator teres, FCR, palmaris long, FDS, FPL, pronator quadratus, thenar eminence, lateral 2 lumbricales	• Weak pronation, wrist flex, & RD • Weak thumb flex & abd • Weak grip & pinch • Ape hand	
Ulnar C7–8, T1	FCU, palmaris brevis, hypothenar eminence, adductor pollicis, medial 2 lumbricales, interossei	• Weak wrist flex & UD • Weak 5th finger flex • Weak finger abd/add • Benediction sign (bishop deformity)	

Source for top figure: From Levangie, PK & Norkin, CC. Joint Structure & Function: A Comprehensive Analysis, 5th ed. FA Davis, Philadelphia, 2011, p 129.

Elbow Tests

Varus Stress[125, 135, 312, 417]

Purpose: Assess LCL/RCL
Position: Elbow slightly flexed, humerus stabilized proximal to elbow (testing in prone enhances stabilization)
Technique: Apply varus force to joint line to stress LCL
Interpretation: (+) test = pain or joint gapping/instability
Statistics: Sensitivity = NT & specificity = NT

Valgus Stress[125, 135, 312, 376, 417]

Purpose: Assess MCL/UCL
Position: Elbow slightly flexed, humerus stabilized proximal to elbow (testing in prone enhances stabilization)
Technique: Apply valgus force to joint line to stress MCL
Interpretation: (+) test = pain or joint gapping/instability
Statistics: Sensitivity = NT & specificity = NT

Active Elbow (Moving Valgus) Test[375]

Purpose: Assess MCL/UCL
Position: Sitting with shoulder in 90° abduction & elbow in full flexion
Technique: Apply valgus force to elbow to take shoulder into full ER & while maintaining valgus force, quickly extend elbow
Interpretation: (+) test = medial elbow pain between 120° & 70° of elbow motion
Statistics: Sensitivity = 100% & specificity = 75%; (+) LR = 4.00 & (–) LR = 0.04

Pronator Teres Test[125, 135, 312]

Purpose: Assess for median nerve entrapment
Position: UE relaxed in supported position
Technique: Resist pronation of forearm
Interpretation: (+) test = pain along palmar aspect of digits 1, 2, & 3 (median nerve distribution)
Statistics: Sensitivity = NT & specificity = NT

Mill Test[125, 135, 312]

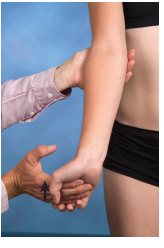
Purpose: Assess for lateral epicondylitis
Position: UE relaxed, elbow extended
Technique: Passively stretch into wrist flexion & pronation
Interpretation: (+) test = pain @ lateral epicondyle or proximal musculotendinous junction of wrist extensors
Statistics: Sensitivity = NT & specificity = NT

Cozen Sign[125, 135, 312]

Purpose: Assess for lateral epicondylitis
Position: UE relaxed, elbow extended
Technique: Resist supination & wrist extension *or* resist middle finger extension (extensor digitorum)
Interpretation: (+) test = pain @ lateral epicondyle or proximal musculotendinous junction of wrist extensors
Statistics: Sensitivity = 100% & specificity = 75%; (+) LR = 4.00 & (–) LR = 0.04

Passive Test[125, 135, 312]

Purpose: Assess for medial epicondylitis
Position: UE relaxed, elbow extended
Technique: Stretch into wrist extension & supination
Interpretation: (+) test = pain @ medial epicondyle or proximal musculotendinous junction of wrist flexors
Statistics: Sensitivity = NT & specificity = NT



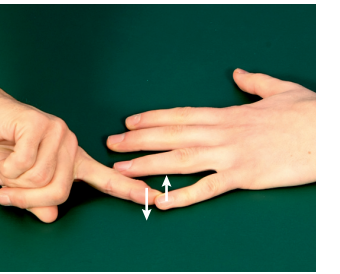
Resistive Test[125, 135, 312]

Purpose: Assess for medial epicondylitis
Position: UE relaxed, elbow extended
Technique: Resist pronation & wrist flexion
Interpretation: (+) test = pain @ medial epicondyle or proximal musculotendinous junction of wrist flexors
Statistics: Sensitivity = NT & specificity = NT

Pressure-Flexion Test[175, 370]

Purpose: Assess for ulnar nerve entrapment
Position: Flex elbow to end range
Technique: Apply firm pressure proximal to cubital tunnel. Maintain pressure for 30–60 sec
Interpretation: (+) = reproduction of neurologic symptoms along ulnar nerve distribution
Statistics: 30 sec: Sensitivity = 91% & specificity = 97%
60 sec: Sensitivity = 89%–98% & specificity = 95%–98%
(+) LR = 19.6–44.5, (–) LR = 0.02–0.11

Wartenberg Test[125, 135, 312]



Purpose: Assess for ulnar nerve entrapment
Position: UE relaxed in supported position
Technique: Resist 5th digit adduction
Interpretation: (+) test = weakness of 5th digit adductors
Statistics: Sensitivity = NT & specificity = NT

Posterolateral-Rotatory Instability[125, 135, 312]

Purpose: Assess for elbow instability
Position: Elbow extended
Technique: Apply an axial load with valgus stress & supination
Interpretation: (+) test = elbow subluxes with extension & relocates with flexion
Statistics: Sensitivity = NT & specificity = NT

Tinel Test[175, 254, 370]

Purpose: Assess ulnar nerve
Position: Elbow in slight flexion
Technique: Tap groove between olecranon & lateral epicondyle
Interpretation: (+) test = pain & tingling in distribution of ulnar nerve (4th & 5th digits)
Statistics: Sensitivity = 68%–70% & specificity = 76%–98%; (+) LR = 2.8–35 & (–) LR = 0.31–0.42

Differential Diagnosis[376, 417]

Pathology/Mechanism	Signs/Symptoms
Reflex Sympathetic Dystrophy or Complex Regional Pain Syndrome[125, 135, 312] May be linked to previous trauma, but a large percentage have no precipitating factor	• Abnormal reflexes • Pain, burning, &/or edema • Nerve adhesions = (+) NTPT • Vasomotor instability & trophic changes span from warmth, redness over dorsum of MP & IP joints, & excessive moisture to coldness, pallor, &/or dryness of hand • Osteoporosis • MRI may or may not be helpful
Elbow Dislocation (Posterior)[104, 468] Common in children & young adults due to FOOSH	• Pain, inability to flex elbow, deformity • Confirmed by x-ray • R/o fx & check distal pulses • Beware of possible development of myositis ossificans in brachialis muscle
Radial Head Subluxation ("Nursemaid Elbow")[1, 104, 468] Common in children 2–4 yo resulting from child being picked up or swung by the hand or forearm & creating a distraction force	• Child autosplints in pronation & flexion • Radial head is TTP & child reports wrist discomfort from pressure when radial head is displaced distally • X-ray if fx is suspected • Reduction process = thumb in cubital fossa to serve as a fulcrum, supinate & flex forearm (will "pop" in)
Olecranon Bursitis ("Student Elbow")[125, 135, 312] May result from direct trauma or repetitive UE activity	• Defined swelling @ olecranon that is warm, thick, & "gritty" to palpation • ↓ Elbow extension with TTP • MRI used to confirm

Continued

Differential Diagnosis[376, 417]—cont'd

Pathology/Mechanism	Signs/Symptoms
Osteochondritis Dissecans[125, 135, 312] Results from repetitive valgus stresses, such as throwing or gymnastics, or frequent compressive forces (avascularity of subchondral bone = Panner's disease)	• Confirm with MRI • Diffuse lateral elbow pain with ↓ elbow extension • Catching/locking of elbow; pain with UE WB • Crepitus with pronation/supination • X-ray, MRI, & CT may identify flattening of capitellum & loose bodies
Ulnar Neuritis/Cubital Tunnel Syndrome[54, 175] Results from repetitive activity, trauma, or valgus instability	• AP & lateral plain film to confirm • Weak UD, 4th & 5th finger flexion • Pain with elbow flexion (↓ canal ht) • (+) Tests: Tinel, Wartenberg, Pressure-Flexion, & NTPT • Paresthesia into forearm & 5th digit • R/o C-spine pathology & TOS
MCL Sprain[125, 135, 321] Elongation/tear of ligament(s); common in throwing athletes 2° valgus stress	• Acute trauma may experience a "pop" • TTP @ medial joint line • Valgus instability • Confirm with MRI; r/o avulsion
Medial Epicondyle Avulsion/Stress Fracture ("Little League Elbow")[468] 2° repetitive throwing; UE flexion acceleration in valgus	• Progressive pain & TTP @ medial epicondyle • ↓ ROM • (+) Valgus stress test • Confirm with x-ray or MRI
Medial Epicondylitis ("Golfer Elbow")[125, 135, 312] Insidious onset 2° to repetitive forces on elbow; affects pronator teres & FCR	• Pain with resisted wrist flexion & UD &/or passive wrist extension & supination with RD • TTP at proximal musculotendinous jct of wrist flexors & pronators • (+) Passive & resistive tests • MRI may confirm diagnosis & r/o fx or avulsion

Continued

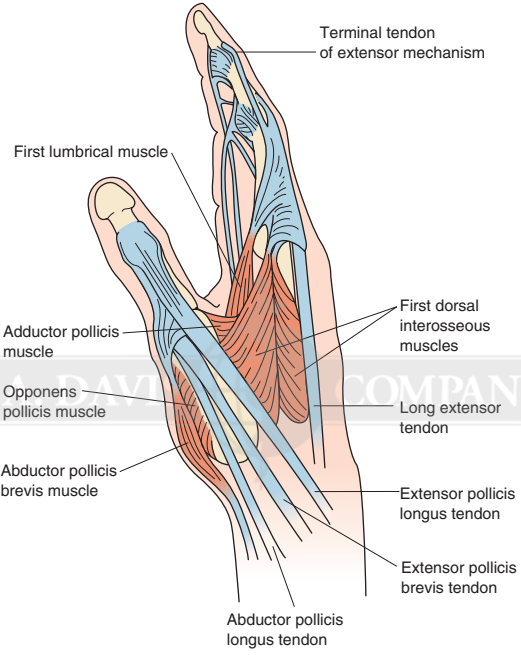
Differential Diagnosis[376, 417]—cont'd

Pathology/Mechanism	Signs/Symptoms
Lateral Epicondylitis ("Tennis Elbow")[125, 135, 312] Overuse or microtrauma to lateral musculature (usually ECRB); may result from small racket grip, a racket that is too stiff or heavy, or a small sweet spot	• Morning stiffness • Pain with resisted wrist extension, supination, & RD &/or passive wrist flexion, pronation, & UD • (+) Tests: Cozen & Mill • TTP at proximal musculotendinous jct of wrist extensors & supinators • MRI may confirm diagnosis & r/o fx or avulsion

Clinical Prediction Rules

Condition	Intervention	Rule Features	Predictability
Lateral epicondylalgia	Manual therapy & exercise	• <49 yo • Affected pain-free grip >112 N • Unaffected pain-free grip <336 N	≥3: (+) LR = 8.8 ≥2: (+) LR = 2.2 ≥1: (+) LR = 1.6

Anatomy474



Medical Red Flags[177, 178]

- Digital clubbing
  - Acute pulmonary abscess
  - Pulmonary malignancy
  - Cirrhosis
  - Heart disease
  - Ulcerative colitis
  - COPD
- Spoon nails
  - Anemia
  - Thyroid Px
  - Syphilis
  - Rheumatic fever
- Eggshell nails = thinning/semitransparent = syphilis
- Nail inflammation, infection, biting
- Paresthesia in glove distribution
  - DM
  - Lead/mercury poisoning
- Hand tremor
  - Parkinsonism
  - Hypoglycemia
  - Hyperthyroidism
  - ETOH
  - MS
- Causes of CTS
  - Hx of statins (cholesterol drugs: simvastatin [Zocor] or atorvastatin [Lipitor])
  - Liver disease
  - Hypothyroidism
  - Gout
  - DM
  - Pregnancy/oral contraceptives
  - B_6 vitamin deficiency

Toolbox Tests[286, 287]

Rheumatoid Hand Functional Disability Scale That Assesses Functional Handicap[124]

Answer the following questions regarding your ability without the help of any assistive devices:

Answers to the questions:	0 = Yes, without difficulty 1 = Yes, with a little difficulty 2 = Yes, with some difficulty 3 = Yes, with much difficulty 4 = Nearly impossible to do 5 = Impossible	
• Can you hold a bowl?		
• Can you seize a full bottle & raise it?		
• Can you hold a plate full of food?		
• Can you pour liquid from a bottle into a glass?		
• Can you unscrew the lid from a jar opened before?		
• Can you cut meat with a knife?		
• Can you prick things well with a fork?		
• Can you peel fruit?		
• Can you button your shirt?		
• Can you open & close a zipper?		
• Can you squeeze a new tube of toothpaste?		
• Can you hold a toothbrush efficiently?		
• Can you write a short sentence with a pencil or ordinary pen?		
• Can you write a letter with a pencil or ordinary pen?		
• Can you turn a round doorknob?		
• Can you cut a piece of paper with scissors?		
• Can you pick up coins from a table top?		
• Can you turn a key in a lock?		

Score:

Scoring: Add all scores—the higher the score, the greater the disability

Patient Rated Wrist Evaluation[287, 308]

Rate the average amount of pain/difficulty you have had in your wrist over the past week by circling the number from 0 (no pain or difficulty) to 10 (the worse pain you have ever experienced or you could not do the task).

Pain	
• At rest	0 1 2 3 4 5 6 7 8 9 10
• When doing a task with repeat wrist movement	0 1 2 3 4 5 6 7 8 9 10
• When lifting a heavy object	0 1 2 3 4 5 6 7 8 9 10
• When it is at its worst	0 1 2 3 4 5 6 7 8 9 10
• How often do you have pain?	0 1 2 3 4 5 6 7 8 9 10
Function—Specific Activities	
• Turn a doorknob using my affected hand	0 1 2 3 4 5 6 7 8 9 10
• Cut meat using a knife in my affected hand	0 1 2 3 4 5 6 7 8 9 10
• Fasten buttons on my shirt	0 1 2 3 4 5 6 7 8 9 10
• Use my affected hand to push up from a chair	0 1 2 3 4 5 6 7 8 9 10
• Carry a 10-lb object in my affected hand	0 1 2 3 4 5 6 7 8 9 10
• Use bathroom tissue with my affected hand	0 1 2 3 4 5 6 7 8 9 10
Function—Usual Activities	
• Personal care activities (dressing, washing)	0 1 2 3 4 5 6 7 8 9 10
• Household work (cleaning)	0 1 2 3 4 5 6 7 8 9 10
• Work (your job or everyday work)	0 1 2 3 4 5 6 7 8 9 10
• Recreational activities	0 1 2 3 4 5 6 7 8 9 10

Score:
Pain = /50
Function (total divided by 2) = /50
Total PRWE = /100

Scoring: Each section can be added individually or the total scores can be calculated & scored as percentages. For either method, the higher the score, the poorer the outcome.

Severity of Symptoms & Functional Status in Carpal Tunnel Syndrome[285]

The following questions refer to your symptoms for a typical 24-hour period during the past 2 weeks. Circle 1 answer for each question.

How severe is the hand or wrist pain you have at night? 1. No pain 2. Mild pain 3. Moderate pain 4. Severe pain 5. Very severe pain	How often did hand or wrist pain wake you up during a typical night in the past 2 weeks? 1. Never 2. 1 time 3. 2–3 times 4. 4–5 times 5. >5 times	Do you typically have pain in your hand or wrist during the daytime? 1. No pain 2. Mild pain 3. Moderate pain 4. Severe pain 5. Very severe pain
How often do you have hand or wrist pain during the daytime? 1. Never 2. 1 time 3. 2–3 times 4. 4–5 times 5. >5 times	How long, on average, does an episode of pain last during the daytime? 1. Never have pain 2. <10 minutes 3. 10–60 minutes 4. >60 minutes 5. Constantly	Do you have numbness (loss of sensation) in your hand? 1. No numbness 2. Mild numbness 3. Moderate numbness 4. Severe numbness 5. Very severe numbness
Do you have weakness in your hand or wrist? 1. No weakness 2. Mild weakness 3. Moderate weakness 4. Severe weakness 5. Very severe weakness	Do you have tingling sensation in your hand? 1. No tingling 2. Mild tingling 3. Moderate tingling 4. Severe tingling 5. Very severe tingling	How severe is the numbness or tingling at night? 1. No numbness/tingling 2. Mild numbness/tingling 3. Moderate numbness/tingling 4. Severe numbness/tingling 5. Very severe numbness/tingling
How often did hand numbness or tingling wake you up during a typical night in the past 2 weeks? 1. Never 2. 1 time 3. 2–3 times 4. 4–5 times 5. >5 times	Do you have difficulty with grasping & using small objects, such as keys or pencils? 1. No difficulty 2. Mild difficulty 3. Moderate difficulty 4. Severe difficulty 5. Very severe difficulty	***Scoring:*** Summate the scores & divide by 11. The higher the mean score, the more severe the impairment. **Score:** _____

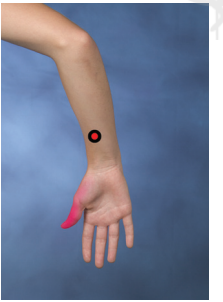
Referral Patterns

Muscle Pain Referral Patterns[488]

Flexor digitorum

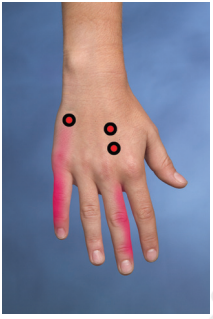
Pronator teres

Flexor pollicis longus



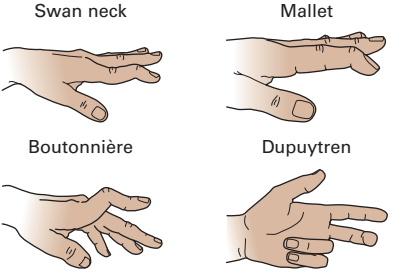
1st dorsal interossei

Abductor digiti minimi
& 2nd dorsal interossei



Opponens pollicis

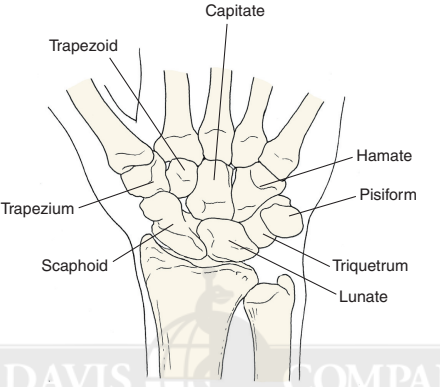
Adductor pollicis

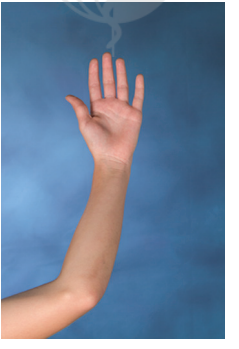


Pathological Observations[89, 125, 135, 165, 261, 456]

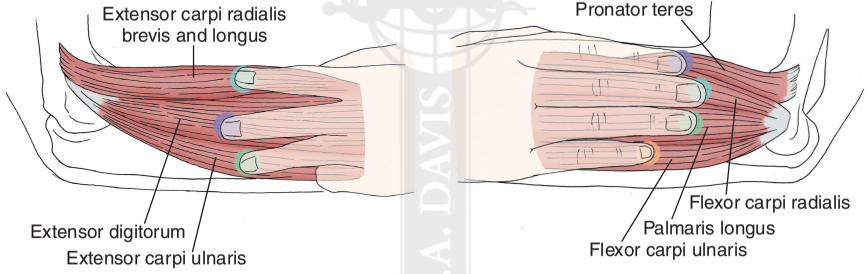
- When fist is clenched, all fingers should point to scaphoid
- Heberden node = DJD of DIP
- Bouchard node = DJD of PIP
- Swan neck = MCP & DIP flexion with PIP hyperextension
- Boutonnière = MCP & DIP extension with PIP flex
- Mallet finger = flexion of DIP (avulsion or fracture)
- Dupuytren's contracture = flexion of 4th & 5th digits
- Ganglion cyst = defined mass on dorsum of hand
- Pill-rolling tremor = parkinsonism
- Liver flap = asterixis = flapping tremor resulting from inability to maintain wrist extension with elbow flexed & forearm supported

Palpation Pearls[45]





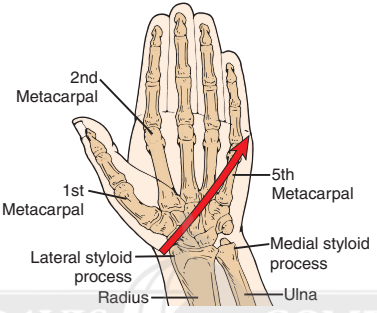
Wrist Extensor Muscles/Wrist Flexor Muscles[45]



Edema Assessment

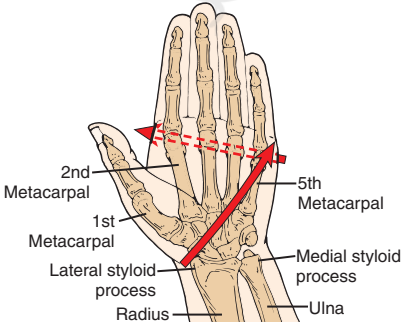
Figure-8 Method to Assess Hand Edema (Palmar Surface)

1. Start distal to lateral styloid process; go medial across the palm of the hand to 5th MCP joint



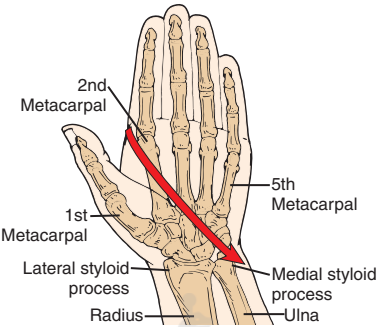
Source: Gulick, D. Sport Notes: Field & Clinical Examination Guide. FA Davis, Philadelphia, 2008, p 171.

2. Over the knuckles to 2nd MCP joint



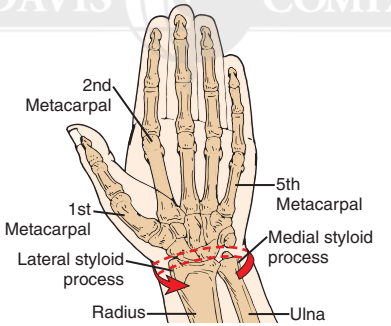
Source: Gulick, D. 2008, p 171.

3. Across palm to medial styloid process



Source: Gulick, D. 2008, p 172.

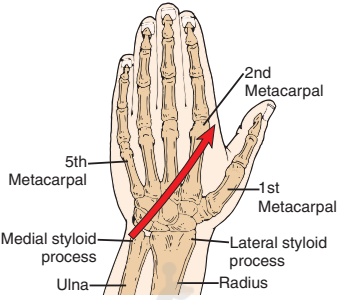
4. Around back of wrist to lateral styloid process



Source: Gulick, D. 2008, p 172.

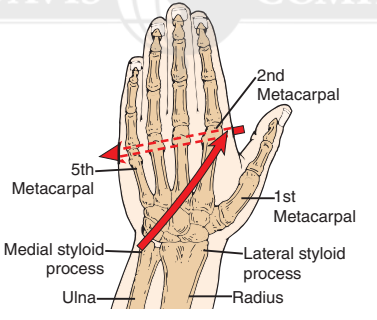
Figure-8 Method to Assess Hand Edema (Dorsal Surface)

1. Start distal to medial styloid process; go lateral across back of hand to 2nd MCP joint



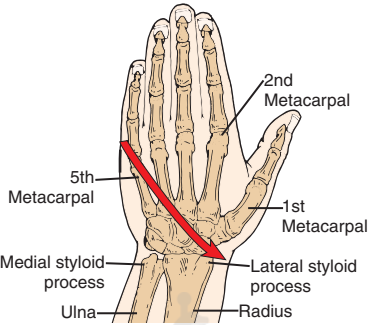
Source: Gulick, D. 2008, p 173.

2. Over palmar aspect of MCP joints to 5th MCP joint



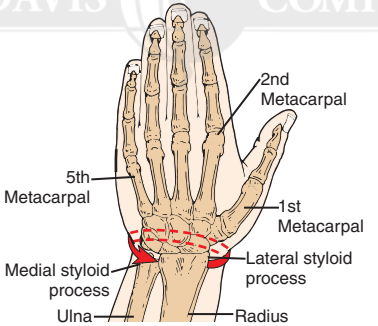
Source: Gulick, D. 2008, p 173.

3. Across back of hand to lateral styloid process



Source: Gulick, D. 2008, p 174.

4. Around front of wrist to medial styloid process



Source: Gulick, D. 2008, p 174.

Sensory Testing[312]

2-Point Discrimination

Use a Disk-criminator to assess minimal distance at which client can distinguish the presence of 2 stimuli. The client should be able to distinguish 4 out of 5 or 7 out of 10 trials.

Grade	Distance
Normal	<6 mm
Fair	6–10 mm
Poor	11–15 mm

Semmes-Weinstein Monofilament Test

With client's eyes closed, clinician applies a perpendicular force to each test location beginning with the lowest monofilament & records the number of the monofilament that the client feels before or just as the monofilament bends.

Test Locations

- Base of palm/wrist
- Between central palm & distal palm crease
- Between distal palm crease & web of finger
- Between web of finger & PIP joint
- Between PIP joint & DIP joint
- Between DIP joint & fingertip

Normal Values

Monofilament #	*Result*
2.44–2.83	Normal sensation
3.22–4.56	Diminished light touch
4.74–6.10	Minimal light touch
6.10–6.65	Poor localization

Wrist & Hand Osteokinematics[125, 199, 282, 362]

Joint	Normal ROM	Normal End-feel(s)	Abnormal End-feel(s)
Radiocarpal	60°–80° flex 60°–70° ext 20°–30° RD/UD	Flex = firm/ligamentous/elastic Ext = firm/ligamentous/elastic RD = bony UD = firm/bony	Capsular = pronation & supination equally restricted
CMC thumb	70° abd 45°–50° flex	Elastic	Capsular = abd > ext
MCP 2–5	90° flex	Ext = elastic/capsular/ligamentous Flex = elastic/bony/firm/ligamentous Abd = firm/ligamentous	
MCP thumb	75°–90° flex	Flex = bony/firm/ligamentous/elastic Ext = firm/elastic	
IPs 2–5	100° PIP flex 80° DIP flex	PIP flex = firm/bony/elastic PIP ext = firm/ligamentous/elastic DIP flex = firm/ligamentous/elastic DIP ext = firm/ligamentous/elastic	

Wrist & Hand Arthrokinematics[282]

Radiocarpal	Concave surface: Radius & radioulnar disk Convex surface: Proximal carpals	*To facilitate flexion:* Proximal carpal rolls anterior & glides posterior on radius with distal carpal rolling anterior & gliding posterior on proximal carpal	*To facilitate extension:* Proximal carpal rolls posterior & glides anterior & on radius with distal carpal rolling posterior & gliding anterior on proximal carpal
		To facilitate radial deviation: Proximal carpal rolls lateral & glides medial on radius with distal carpal rolling lateral & gliding medial on proximal carpal	*To facilitate ulnar deviation:* Proximal carpal rolls medial & glides lateral on radius with distal carpal rolling medial & gliding lateral on proximal carpal
Distal radioulnar	Concave surface: Ulnar notch of radius Convex surface: Head of ulna	*To facilitate pronation:* Radius rolls & glides medially over ulna	*To facilitate supination:* Radius rolls & glides laterally over ulna
CMC thumb	Concave surface: Trapezii Convex surface: Metacarpal	*To facilitate thumb flexion:* Metacarpal rolls & glides medial on trapezium	*To facilitate thumb extension:* Metacarpal rolls & glides lateral on trapezium
		To facilitate thumb abduction: Metacarpal rolls proximal & glides distal on trapezium	*To facilitate thumb adduction:* Metacarpal rolls distal & glides proximal on trapezium

Continued

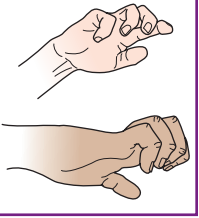
MCP 2–5	Concave surface: Base of proximal phalanx Convex surface: Head of metacarpal	*To facilitate flexion:* Proximal phalanx rolls & glides anterior on metacarpal	*To facilitate extension:* Proximal phalanx rolls & glides posterior on metacarpal
MCP thumb	Concave surface: Base of proximal phalanx Convex surface: Head of metacarpal	*To facilitate thumb flexion:* Distal phalanx rolls & glides anterior on proximal phalanx	*To facilitate thumb extension:* Distal phalanx rolls & glides posterior on proximal phalanx
IP 2–5	Concave surface: Base of proximal phalanx Convex surface: Head of distal phalanx	*To facilitate flexion:* Distal phalanx rolls & glides anterior on proximal phalanx	*To facilitate extension:* Distal phalanx rolls & glides posterior on proximal phalanx

Strength & Function

Muscle Function

- Dorsal interossei = "divide" or separate fingers
- Palmar interossei & lumbricales = "pull" fingers together
- Flexor digitorum superficialis = finger in extension, isolate PIP flexion
- Flexor digitorum profundus = finger in extension, isolate DIP flexion
- Lumbrical = flex MCP with IPs extended
- Power grips:
  - Cylindrical grip = FDP, FDS, FPL, FPB, OP, lumbricales, palmar interossei
  - Spherical grip = FDP, FDS, FPL, FPB, OP, lumbricales, dorsal interossei
  - Hook grip = FDS, FDP

Brachial Plexus—Roots, Muscles, Deficits, & Deformities[282]

Nerve & Root	Muscles	Functional Deficits	Postural Deformity
Radial C5–8, T1	Anconeus, brachioradialis, ECRL, ECRB, extensor digitorum, APL, ECU, extensor indicis, extensor digiti minimi	• Weak supination, wrist ext, finger flex, thumb abd • Weak grip due to loss of wrist stabilization	
Median C6–8, T1	Pronator teres, FCR, palmaris long, FDS, FPL, pronator quadratus, thenar eminence, lateral 2 lumbricales	• Weak pronation, wrist flex & RD • Weak thumb flex & abd • Weak grip & pinch • Ape hand	
Ulnar C7–8, T1	FCU, palmaris brevis, hypothenar eminence, adductor pollicis, medial 2 lumbricales, interossei	• Weak wrist flex & UD • Weak 5th finger flex • Weak finger abd/add • Benediction sign (bishop deformity)	Claw hand = median & ulnar 

Source for top figure: Levangie, PK & Norkin, CC. Joint Structure & Function: A Comprehensive Analysis, 5th ed. FA Davis, Philadelphia, 2011, p 129.

Wrist & Hand Tests

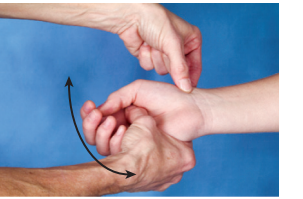
Clamp Sign[125, 408]

Purpose: Assess for scaphoid fx
Position: Wrist in pronation & extension
Technique: Grasp client's web space of thumb between clinician's thumb & index finger & gently stress wrist into UD
Interpretation: (+) test = pain in anatomical snuff box
Statistics: Sensitivity = 52%–100% & specificity = 34%–100%; (+) LR = 1.52 & (–) LR = 0

Axial Load[510]

Purpose: Assess for scaphoid fx
Position: Forearm supported, neutral wrist
Technique: Passively abduct & extend MCP; apply axial load to CMC
Interpretation: (+) test = pain in anatomical snuff box
Statistics: Sensitivity = 89% & specificity = 98%; (+) LR = 49 & (–) LR = 0.02

Watson (Scaphoid Shift) Test[270, 470, 519, 530, 531]



Purpose: Assess for scaphoid instability
Position: Supinated in neutral
Technique: From client's radial side, clinician uses thumb on palmar side & index finger on dorsal side to apply pressure to distal scaphoid while moving wrist from UD to RD
Interpretation: (+) test = removal of pressure produces a palpable click & wrist pain
Statistics: Sensitivity = 69% & specificity = 64%–68%; (+) LR = 2.03 & (–) LR = 0.47

Fovea Sign[273, 471]

Purpose: Assess foveal & ulnotriquetral ligament integrity
Position: Elbow flexed to 90°, forearm & wrist in neutral
Technique: Apply pressure to conjunction of pisiform & ulnar styloid
Interpretation: (+) test = pain
Statistics: Sensitivity = 66%–95% & specificity = 64%–87%; (+) LR = 1.69–7.1 & (–) LR = 0.06–0.56

Wrist Varus Test[273]

Source: Gulick, D., 2008, p 125.

Purpose: Assess RCL
Position: Stabilize radius/ulna proximal to wrist in neutral position
Technique: Apply varus stress to wrist
Interpretation: (+) test = joint line pain or gapping/instability
Statistics: Sensitivity = NT & specificity = NT

Wrist Valgus Test[273]

Purpose: Assess UCL
Position: Stabilize radius/ulna proximal to wrist in neutral position
Technique: Apply valgus stress to wrist
Interpretation: (+) test = joint line pain or gapping/instability
Statistics: Sensitivity = NT & specificity = NT

Phalanx Varus/Valgus Test[125, 135, 312]

Purpose: Assess MCL & LCL
Position: With finger(s) in neutral, stabilize more proximal phalanx
Technique: Apply varus/valgus stress via more distal phalanx
Interpretation: (+) test = joint line pain or gapping/instability
Statistics: Sensitivity = NT & specificity = NT

Finkelstein Test[8, 33, 148]

Purpose: Assess for de Quervain syndrome
Position: Form a fist around thumb
Technique: Ulnarly deviate wrist
Interpretation: (+) test = pain along EPB & APL
Statistics: Sensitivity = 81%–100% & specificity = 50%–100%; (+) LR = 1.62 & (–) LR = 0.38

Phalen Test[5, 12, 13, 61, 131, 146, 176, 186, 191, 203, 240, 264, 269, 273, 307, 321, 468, 474, 510]

Purpose: Assess for CTS
Position: Hands relaxed
Technique: Maximally flex wrists so dorsal surfaces of hands are in full contact with each other; hold for up to 1 minute
Interpretation: (+) test = numbness or tingling into median nerve distribution
Statistics: Sensitivity = 34%–77% & specificity = 40%–100%; (+) LR = 0.60–9.88 & (–) LR = 0.09–3.12

Reverse Phalen Test (Prayer Sign)[12, 13, 61, 131, 264, 273, 510]

Purpose: Assess for CTS
Position: Hands relaxed
Technique: Maximally extend wrists so palms of hands are in full contact with each other; hold for up to 1 minute
Interpretation: (+) test = numbness or tingling into median nerve distribution
Statistics: Sensitivity = 42%–88% & specificity = 35%–93%; (+) LR = 0.6 & (–) LR = 1.66

Carpal Compression Test[123, 131, 146, 176, 241, 264, 273, 468, 474, 511]

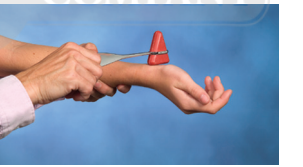
Purpose: Assess for CTS
Position: Forearm supported in supination hand relaxed
Technique: Flex wrist to 60° & apply pressure over carpal tunnel × 30 seconds
Interpretation: (+) test = numbness or tingling into median nerve distribution
Statistics: Sensitivity = 28%–89% & specificity = 25%–95%; (+) LR = 0.6–22 & (–) LR = 0.13–2.16

Flick Maneuver[115, 186, 191, 263, 410, 510]

Purpose: Assess for CTS
Position: Hands relaxed
Technique: Vigorously shake hands repeatedly
Interpretation: (+) test = paresthesia into median nerve distribution
Statistics: Sensitivity = 37%–90% & specificity = 30%–92%; (+) LR = 1.3–23 & (–) LR = 0.3–0.9

Tinel Sign[5, 13, 61, 131, 176, 191, 203, 240, 264, 269, 307, 321, 353, 468, 474, 510]

Purpose: Assess for CTS
Position: UE supported in supination
Technique: Tap volar surface of wrist
Interpretation: (+) test = tingling into median nerve distribution
Statistics: CTS: Sensitivity = 23%–90% & specificity = 55%–100%; (+) LR = 0.9–6.8 & (–) LR = 0.12–1.1

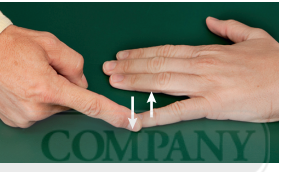


Wrist Tests	Sensitivity	Specificity
Flick + Phalen	49%	62%
Flick + Tinel	46%	68%
Phalen + Tinel	41%	72%

Froment Sign[23, 49, 175]

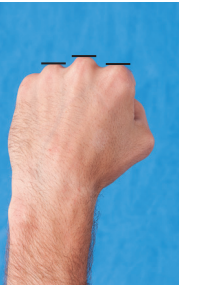
Purpose: Assess for adductor pollicis weakness 2° ulnar nerve paralysis
Position: Client holds a paper between thumb & index finger
Technique: Clinician tugs paper away
Interpretation: (+) test = flexion of thumb DIP via FPL results if adductor pollicis muscle is impaired by ulnar nerve Px
Statistics: Sensitivity = NT & specificity = NT

Wartenberg Test[54, 144, 312, 347, 404, 518]



Purpose: Assess ulnar nerve for entrapment at the elbow
Position: UE relaxed & supported
Technique: Resist 5th digit adduction
Interpretation: (+) test = weakness of 5th digit adduction
Statistics: Sensitivity = NT & specificity = NT

Murphy Sign[52]



Purpose: Assess for lunate dislocation
Position: Make a fist
Technique: Observe alignment of MC joints
Interpretation: (+) test = 3rd MCP is level with 2nd & 4th (normally 3rd MCP should project beyond 2nd & 4th)
Statistics: Sensitivity = NT & specificity = NT

Allen Test[9, 10, 227]

Purpose: Test for occlusion of radial or ulnar artery
Position: Hand relaxed, supported in supination
Technique: Compress both radial & ulnar arteries at wrist while client clenches hand several times to drain blood out. With client's hand open, release pressure on radial artery—normal hand coloration should return in <5 seconds. Repeat & release ulnar artery
Interpretation: (+) test = difference between the 2 vessels with respect to refill time or taking >5 seconds for coloration of tissue to return to normal
Statistics: Sensitivity = NT & specificity = NT

TFCC Load Test[273]

Purpose: Assess TFCC
Position: Wrist in ulnar deviation
Technique: Apply a longitudinal load through 5th metacarpal bone to TFCC
Interpretation: (+) test = pain @ TFCC
Statistics: Sensitivity = 100% & specificity = NT

TFCC Press Test/Supinated Lift Test[273, 280]

Purpose: Assess TFCC
Position: Elbow flexed at 90° & forearm supinated
Technique: Ask client to lift up against resistance (such as lifting a table via wrist flexion)
Interpretation: (+) test = compression with UD will ↑ pain @ TFCC
Statistics: Sensitivity = 100% & specificity = NT

Gripping Rotatory Impaction Test (GRIT)[273]

Purpose: Assess for ulnar impaction
Position: 1 = supination; 2 = pronation
Technique: Measure grip in supinated & pronated wrist position
Interpretation: (+) test if supinated grip is > pronated grip
Statistics: Sensitivity = NT & specificity = NT

Complex Regional Pain Syndrome[12]

Stage 1	• Burning, aching, tenderness, joint stiffness • Swelling (vasomotor instability), temperature changes • ↑ Nail growth & ↑ hair on hands
Stage 2	• ↑ Pain, swelling, joint stiffness • Pain becomes less localized • Change in skin color & texture
Stage 3	• Pain radiates all the way up the arm • ↓ NCV • Muscle atrophy

Differential Diagnosis[71, 125, 312]

Pathology/Mechanism	Signs/Symptoms
Colles or Smith Fracture[104] Distal radial fractures 2° FOOSH with extreme wrist extension; common in adults >50 yo, whereas children = greenstick or epiphyseal growth plate	• TTP in anatomical snuffbox • Edema & ecchymosis • Structural deformity with limited ROM • Confirmed via PA, oblique, & lateral x-rays (Colles fx = distal fragment angles dorsal & Smith fx = distal fragment angles palmar)
Scaphoid Fracture[125] Most commonly fractured carpal; mechanism is FOOSH with pronation	• Early diagnosis is critical 2° scant blood supply • TTP @ anatomical snuff box • Minimal swelling but loss of concavity of snuff box • (+) Clamp, axial load, Watson test
Lunate Dislocation[104] Results from FOOSH	• (+) Murphy sign • TTP @ lunate with localized swelling • Painful wrist ROM • May cause paresthesia if median nerve is involved • Confirmed with x-ray, r/o fx
Guyon's (Pisohamate) Canal[312] Compression of ulnar nerve via fx to hook of hamate, use of crutches, pressure on bike handlebars	• Sensory loss of little & 1/2 of ring finger • Motor loss of little finger, adductor pollicis, interossei • (+) Froment sign
Dupuytren Contracture[125, 135, 312] Flexion contracture with thickening of palmar fascia of 4th & 5th digits; etiology associated with ETOH, DM, epilepsy, trauma, (+) family hx; most common in ♂ >40 yo	• Nodule in palmar aponeurosis of ulnar side & tightening of natatory ligament • Usually no pain but MCPs can't extend • Flexion contracture of MCP > PIP • Inability to place palm flat on surface • May reappear weeks or years later • Confirmed with CT or MRI

Continued

Pathology/Mechanism	Signs/Symptoms
Trigger Finger[125, 135, 312] Results when demand for manual dexterity & fist clenching tasks exceed lubricating capacity of synovial fluid; ↑ incidence in DM & people >40 yo	• Tender nodules in flexor tendon @ MC head that moves with the tendon • No active finger flexion • Finger locks in flexion in AM; extension can be performed passively only & there is pain with clicking/grating when passively moved • Diagnosis confirmed with CT or MRI
de Quervain's Syndrome[8, 33, 125] Tenosynovitis of APL & EPB > EPL; onset related to pinching or grasping tasks with radial deviation	• No numbness or tingling • Lateral wrist/thumb edema • Pain with resisted abduction & extension • Pulses are normal • (+) Finkelstein test (flex & UD) • Confirmed with CT or MRI; r/o gout
Carpal Tunnel Syndrome (CTS)[5, 13, 61, 115, 123, 125, 131, 146, 176, 186, 240, 410, 467, 473] Overuse injury related to repetitive trauma; occurs in 20% of pregnancies	• Thenar atrophy but no swelling or trophic changes • Nighttime numbness, burning, tingling of hand (median nerve pattern) • Thumb weakness & loss of opposition/abduction—specifically APB (beware of substitution of APL, innervated by radial nerve) • (+) Tests: Phalen, reverse Phalen, flick, NTPT, & Tinel sign; (–) TOS • Normal pulses (radial & ulnar arteries do not pass through tunnel) • Sensation of palm is spared • R/o C-spine problem • Confirmed with CT or MRI
Pronator Syndrome[125, 135, 313] Compression of median nerve via pronator muscle	• Client c/o "heaviness" in the UE • Pain with overpressure into pronation (median nerve distribution) • (–) Phalen & Tinel sign, ↓ NCV • TTP over pronator teres (~ 4 cm distal to cubital crease) • Mimics CTS, but there is no night pain or weakness • Confirmed with MRI or CT

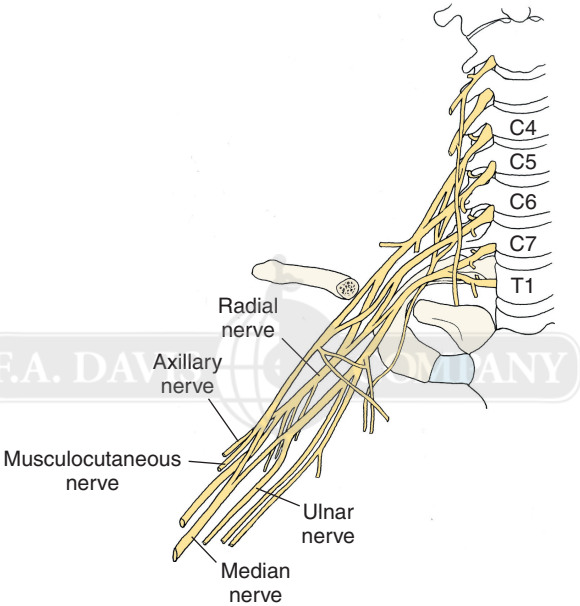
Pathology/Mechanism	Signs/Symptoms
Gamekeeper Thumb[125, 135, 312] Ulnar collateral ligament injury 2° forceful extension/ abduction of thumb MCP	• Swelling @ ulnar side of thumb MCP • TTP @ UCL of MCP • (+) Valgus stress • Pain with passive hyperextension & hyperabduction of thumb • Confirmed with MRI, r/o fx & avulsion
Triangular Fibrocartilage Complex (TFCC)[125, 135, 312] Injury is result of forceful rotation of forearm or FOOSH in pronation	• (+) Tests: load & press test • >1 grip ratio of supination:pronation • TTP @ TFCC • Confirmed with MRI or arthrogram
Ganglion Cyst[125, 135, 312] Most common mass in wrist, may be associated with repetitive motions	• Defined round mass in wrist • May be painful with motion or compression • Not revealed on x-ray, MRI, CT

Tendon Rupture[125, 135, 312]
From trauma
	• Edema & TTP are tendon specific
	• Failure to actively move a joint:
	  • EPL = no thumb IP ext (mallet finger)
	  • FPL = no thumb IP flex
	  • ED = no isolated long finger ext (mallet finger)
	  • FDP = no DIP flexion (jersey finger)
	  • FS = no PIP flexion
	• Confirmed with MRI or CT; r/o fx or avulsion

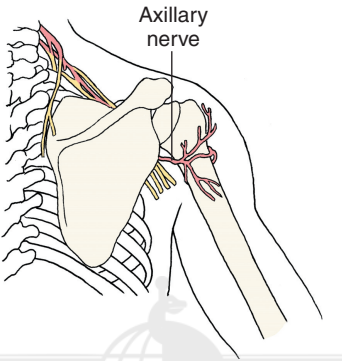
Raynaud Syndrome[10] Cold-induced reflex digital vasoconstriction & ischemia	• Pallor, cyanosis then redness of digits (cyclic) • (–) TOS test(s) • Clear C-spine • ROM, strength, & sensation = WNL • Confirmed via Doppler

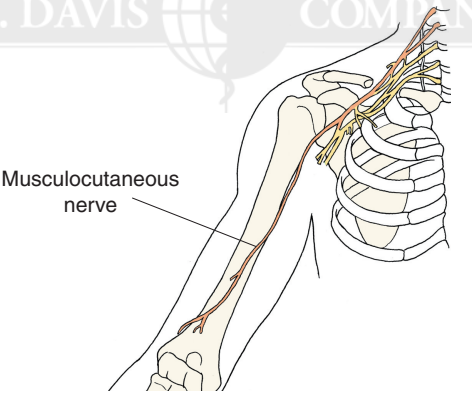
Anatomy

Brachial plexus[73, 474]

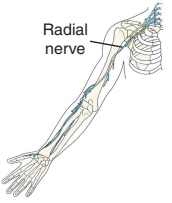


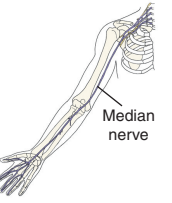
Axillary & musculocutaneous nerves[474]

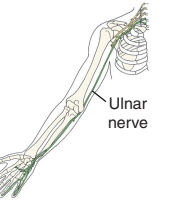




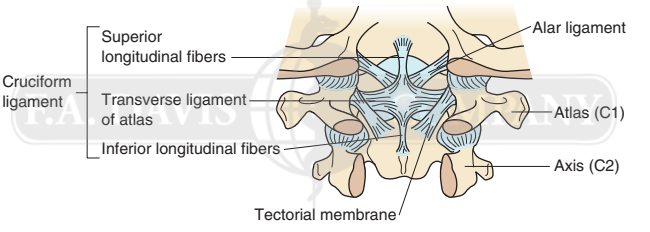
Radial, median, & ulnar nerves[474]



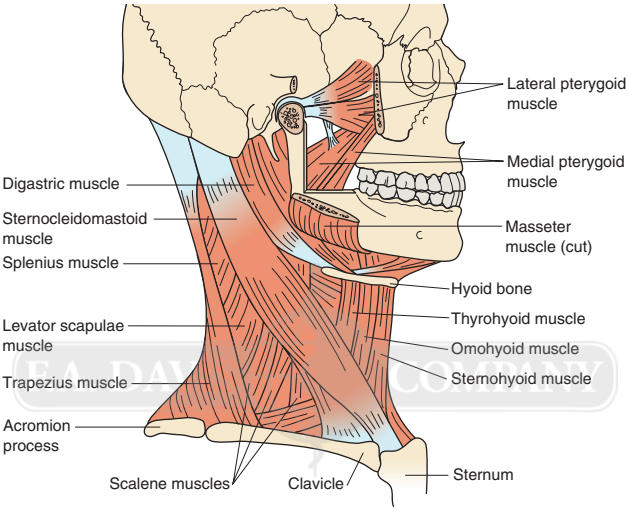




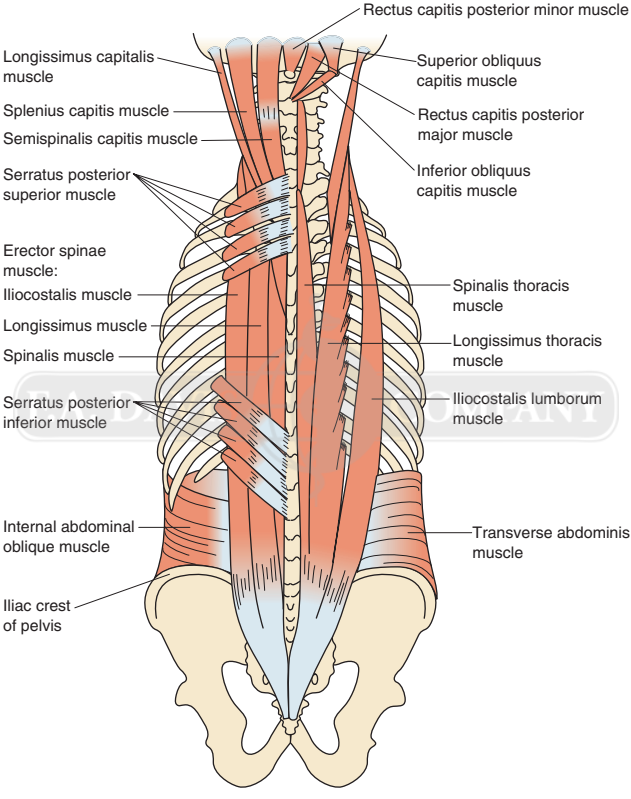
Ligaments of the neck[73]



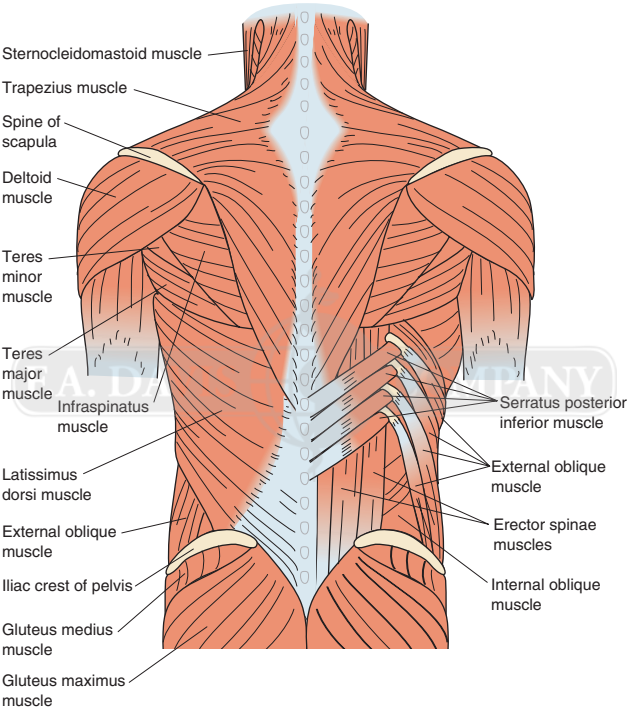
Muscles of the neck & face (lateral view)[73]



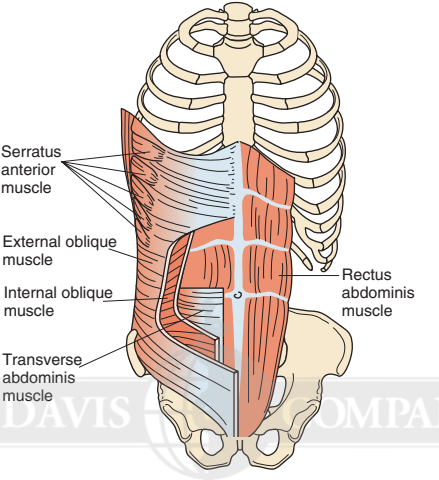
Deep muscles of the neck & back[69]



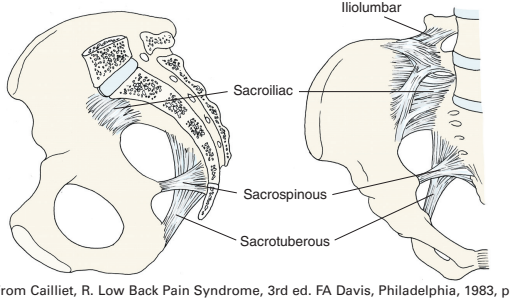
Superficial muscles of the neck & back[73]



Abdominal muscles[73]

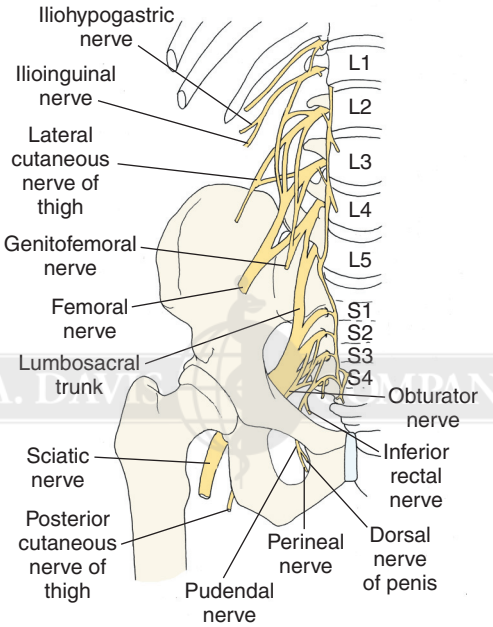


Ligaments of the pelvis[73]

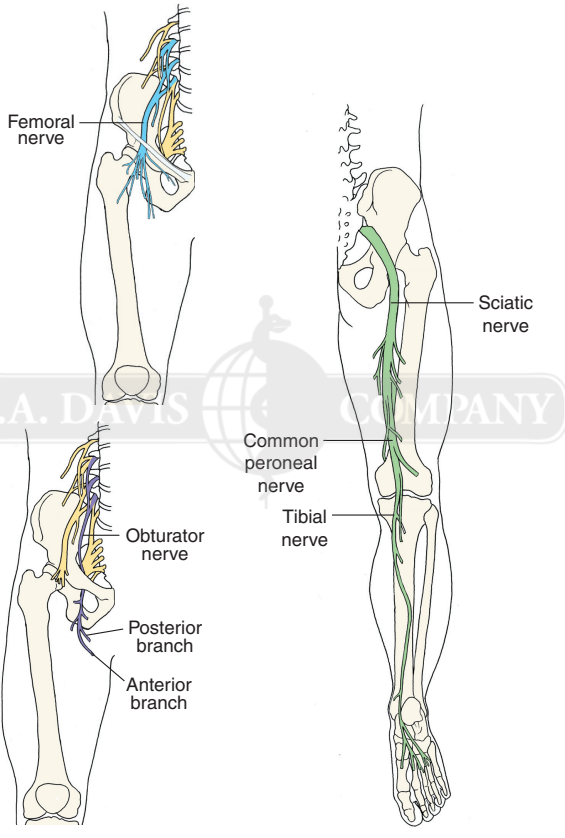


Source: From Cailliet, R. Low Back Pain Syndrome, 3rd ed. FA Davis, Philadelphia, 1983, p 196.

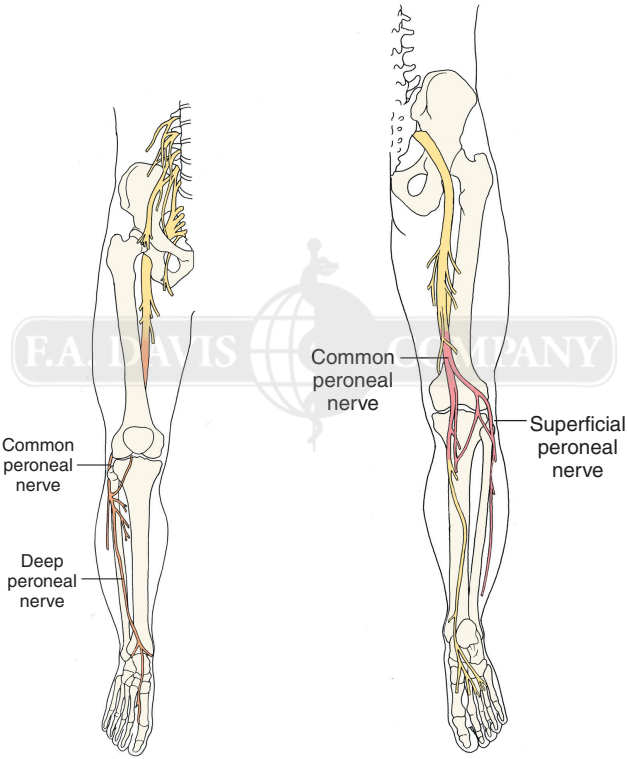
Lumbosacral plexus[474]



Femoral, obturator, sciatic, tibial, & common peroneal nerve[474]



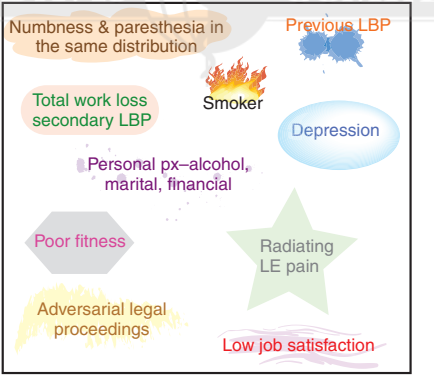
Deep & superficial peroneal nerves[474]



Medical Red Flags[177, 178]

- Individuals <20 & >55 yo with persistent night pain, change in B&B control, (B) LE signs, PMH of CA, nonmechanical pain, SED rate >25
- Midthoracic pain = MI, GB
- Pain from 6th–10th thoracic vertebra = peptic ulcer
- History of prostate CA
- Pulsing LBP = vascular problem (aortic aneurysm)
- Faun's beard = spina bifida
- Café au lait spots = neurofibromatosis
- Upper back/neck pain that ↑ with deep breathing, coughing, laughing & ↓ with breath holding; recent hx may include fever, URI, flu, MI = pericarditis
- Enlarged cervical lymph nodes, severe pruritus, irregular fever = Hodgkin's disease
- Pain at McBurney's point = ⅓–½ the distance from Ⓡ ASIS to umbilicus; tenderness = appendicitis

Risk Factors for Chronicity of Spinal Dysfunction



Toolbox Tests[111, 286, 287]

Neck Disability Index for Chronic Pain[500]

Pain Intensity
__ I have no pain at the moment.
__ The pain is very mild at the moment.
__ The pain is moderate at the moment.
__ The pain is fairly severe at the moment.
__ The pain is very severe at the moment.
__ The pain is the worst imaginable at the moment.

Work
__ I can do as much as I want to.
__ I can do my usual work but not more.
__ I can do most of my usual work, but not more.
__ I cannot do my usual work.
__ I can hardly do any usual work at all.
__ I can't do any work at all.

Personal Care (e.g., washing, dressing)
__ I can look after myself normally w/o causing extra pain.
__ I can look after myself normally, but it causes extra pain.
__ It is painful to look after myself & I am slow & careful.
__ I need some help but manage most of my personal care.
__ I need help every day in most aspects of self-care.
__ I cannot get dressed, wash with difficulty, & stay in bed.

Concentration
__ I can concentrate fully when I want to with no difficulty.
__ I can concentrate fully when I want to with slight difficulty.
__ I have a fair degree of difficulty concentrating when I want.
__ I have a lot of difficulty concentrating when I want.
__ I have a great deal of difficulty concentrating when I want.
__ I cannot concentrate at all.

Lifting
__ I can lift heavy weights without extra pain.
__ I can lift heavy weights, but it gives extra pain.
__ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are on a table.
__ Pain prevents me from lifting heavy weights, but I can manage if they are conveniently placed.
__ I can lift only very light weights.
__ I cannot lift or carry anything at all.

Driving
__ I can drive my car without neck pain.
__ I can drive my car as long as I want with slight neck pain.
__ I can drive my car as long as I want with moderate neck pain.
__ I can't drive my car as long as I want because of moderate neck pain.
__ I can hardly drive at all because of severe neck pain.
__ I can't drive my car at all.

Continued

Neck Disability Index for Chronic Pain[500]—cont'd

Reading
__ I can read as much as I want with no pain in my neck.
__ I can read as much as I want with slight pain in my neck.
__ I can read as much as I want with moderate pain in my neck.
__ I can't read as much as I want because of moderate pain in my neck.
__ I can hardly read at all because of severe pain in my neck.
__ I cannot read at all.

Recreation
__ I am able to engage in all my recreational activities with no neck pain.
__ I am able to engage in all my recreational activities with some neck pain.
__ I am able to engage in most but not all of my usual recreational activities because of neck pain.
__ I am able to engage in a few of my usual recreational activities with some neck pain.
__ I can hardly do any recreational activities because of neck pain.
__ I can't do any recreational activities at all.

Headache
I have no headaches at all.
I have slight headaches that come in frequently.
I have moderate headaches that come infrequently.
I have moderate headaches that come frequently.
I have severe headaches that come infrequently.
I have headaches almost all the time.

Sleeping
I have no trouble sleeping.
My sleep is slightly disturbed (<1-hr sleep loss).
My sleep is mildly disturbed (1- to 2-hr sleep loss).
My sleep is moderately disturbed (2- to 3-hr sleep loss).
My sleep is greatly disturbed (3- to 5-hr sleep loss).
My sleep is completely disturbed (5- to 7-hr sleep loss).

Score:

Scoring: The items are scored in descending order with the top statement = 0 & the bottom statement = 5. All subsections are added together for a cumulative score. The higher the score, the greater the disability.

Oswestry Low Back Pain Questionnaire[139]

In every section, please mark the one response that most closely describes your problem:

Pain Intensity
__ I can tolerate the pain without using painkillers.
__ The pain is bad, but I manage without painkillers.
__ Painkillers give complete relief from pain.
__ Painkillers give moderate relief from pain.
__ Painkillers give very little relief from pain.
__ Painkillers have no effect on the pain; I don't use them.

Personal Care (washing, dressing, etc.)
__ I can look after myself normally without causing extra pain.
__ I can look after myself normally, but it causes extra pain.
__ It is painful to look after myself & I am slow & careful.
__ I need some help but manage most of my personal care.
__ I need help every day in most aspects of self-care.
__ I cannot get dressed, wash with difficulty, & stay in bed.

Standing
__ I can stand as long as I want without extra pain.
__ I can stand as long as I want, but it gives me extra pain.
__ Pain prevents me from standing for >1 hour.
__ Pain prevents me from standing >1/2 hour.
__ Pain prevents me from standing >10 minutes.
__ Pain prevents me from standing at all.

Sleeping
__ Pain does not prevent me from sleeping well.
__ I can sleep well only by using tablets.
__ Even when I take tablets, I have <6 hours sleep.
__ Even when I take tablets, I have <4 hours sleep.
__ Even when I take tablets, I have <2 hours sleep.
__ Pain prevents me from sleeping at all.

Continued

Lifting
__ I can lift heavy weights without extra pain.
__ I can lift heavy weights, but it gives extra pain.
__ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are on a table.
__ Pain prevents me from lifting heavy weights, but I can manage if they are conveniently placed.
__ I can lift only very light weights.
__ I cannot lift or carry anything at all.

Sex Life
__ My sex life is normal & causes no extra pain.
__ My sex life is normal but causes some extra pain.
__ My sex life is nearly normal but is very painful.
__ My sex life is severely restricted by pain.
__ My sex life is nearly absent because of pain.
__ Pain prevents any sex life at all.

Walking
__ Pain does not prevent me walking any distances.
__ Pain prevents me walking >1 mile.
__ Pain prevents me walking >1/2 mile.
__ Pain prevents me walking >1/4 mile.
__ I can walk only using a stick or crutches.
__ I am in bed most of the time & have to crawl to the toilet.

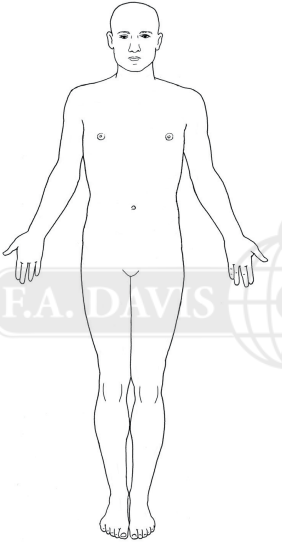
Social Life
__ My social life is normal & gives me no extra pain.
__ My social life is normal but increases the degree of pain.
__ Pain has no significant effect on my social life apart from limiting my more energetic interests (e.g., dancing).
__ Pain has restricted my social life & I do not go out as often.
__ Pain has restricted my social life to my home.
__ I have no social life because of pain.

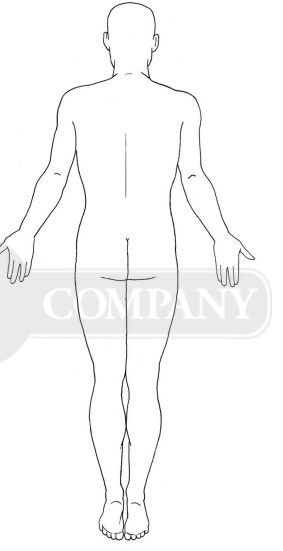
Continued

Sitting	Traveling
__ I can sit in any chair as long as I like. __ I can sit only in my favorite chair as long as I like. __ Pain prevents me sitting >1 hour. __ Pain prevents me sitting >1/2 hour. __ Pain prevents me sitting >10 minutes. __ Pain prevents me sitting at all.	__ I can travel anywhere without extra pain. __ I can travel anywhere, but it gives me extra pain. __ Pain is bad, but I manage journeys >2 hours. __ Pain restricts me to journeys <1 hour. __ Pain restricts me to short necessary journeys <30 minutes. __ Pain prevents me from traveling except to the doctor or hospital.
Score:	
Scoring: The items are scored in descending order with the top statement = 0 & the bottom statement = 5. The sum of the score is multiplied by 2.	
Results: 0%–20% = minimal disability; 20%–40% = moderate disability; 40%–60% = severe disability; 60%–80% = crippled; 80%–100% = bed bound or symptom magnification.	

Ransford Pain Drawings[413]

Indicate where your pain is located & what type of pain you feel at the present time. Use the symbols shown to describe your pain. Do not indicate areas of pain that are not related to your present injury or condition.





///	Stabbing	XXX	Burning
000	Pins & Needles	= = =	Numbness

Ransford Scoring System

- Unreal drawings (score 2 points for any of the following)
  - Total leg pain
  - Front of leg pain
  - Anterior tibial pain
  - Back of leg & knee pain
  - Circumferential thigh pain
  - Lateral whole leg pain
  - Bilateral foot pain
  - Circumferential foot pain
  - Anterior knee & ankle pain
  - Scattered pain throughout whole leg
  - Entire abdomen pain
- Drawings with "expansion" or "magnification" of pain (1–2 points)
  - Back pain radiating into iliac crest, groin, & anterior perineum
  - Pain drawn outside of diagram
- Additional explanations, circles, lines, arrows (1 point each)
- Painful areas drawn in (score 1 for small areas & 2 for large areas)

Interpretation: A score of ≥3 points is thought to represent a pain perception that may be influenced by psychological factors.

Score:

Short Form McGill Pain Questionnaire[340, 341]

Instructions: Read the following descriptions of pain & mark the number that indicates the level of pain you feel in each category according to the following scale:

	1 = None	2 = Mild	3 = Moderate	4 = Severe
Throbbing				
Shooting				
Stabbing				
Sharp				
Cramping				
Gnawing				
Hot-burning				
Aching				
Heavy				
Tender				
Splitting				
Tiring-exhausting				
Sickening				
Fearful				
Punishing-cruel				

Total Score: _____

Scoring: The higher the score, the more intense the pain.

Present Pain Intensity Index

Instructions: Use the following descriptors to indicate your current level of pain.

0 = No pain
1 = Mild
2 = Discomforting
3 = Distressing
4 = Horrible
5 = Excruciating

Canadian C-Spine Rules[30, 76, 459]

Rule does not apply if:

- No history of trauma
- Vital signs unstable
- Acute paralysis
- Known vertebral disease
- Glasgow Coma Scale score <15
- <16 yo
- Previous C-spine surgery

1. Any high-risk factor:
   - ≥65 yo **or**
   - Paresthesias in extremities **or**
   - Dangerous mechanisms
     - Fall from height ≥3′ (5 steps)
     - Axial load to head (diving)
     - MVA @ 100 mph, rollover, ejection
     - ATV accident
     - Bicycle collision

No ↓ — Yes → Radiography

2. Any low-risk factor that allows safe assessment of ROM:
   - Ambulatory at any time **or**
   - Delayed (no immediate) onset of pain **or**
   - Absence of midline C-spine tenderness **or**
   - Sitting position in ED **or**
   - Simple rear-end MVA
     - Pushed into traffic, hit by bus/truck
     - Rollover
     - Hit by high-speed vehicleNot Able

No → Radiography

Yes ↓ — Not able → Radiography

3. Able to actively rotate neck 45° to right & left

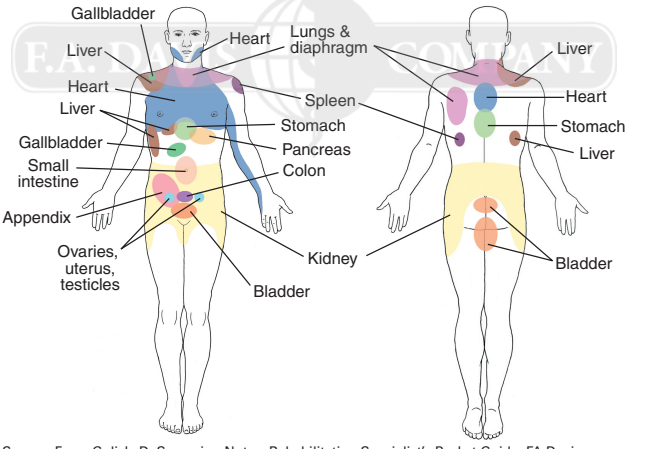
→ No Radiography

Able

Referral Patterns[177, 178]

Cutaneous Pain Referral Patterns From the Viscera

Viscera	Segmental Level	Referral Pattern
Pharynx		Ipsilateral ear
Heart	T1–5	Sternum, neck
Bronchi—lungs	T2–4	Shoulder, pectoral, arm L>R
Esophagus	T5–6	Neck, arms, sternum (level of the nipple)
Gastric	T6–10	Lower thoracic to upper abdomen
GB	T7–9	Upper abdomen (epigastric area), lower scapula, T/L
Pancreas	T8–9	Upper lumbar, upper abdomen
Kidneys	T10–L1	Upper lumbar, umbilical area
Bladder	T11–12	Lower abdomen, lower lumbar, groin

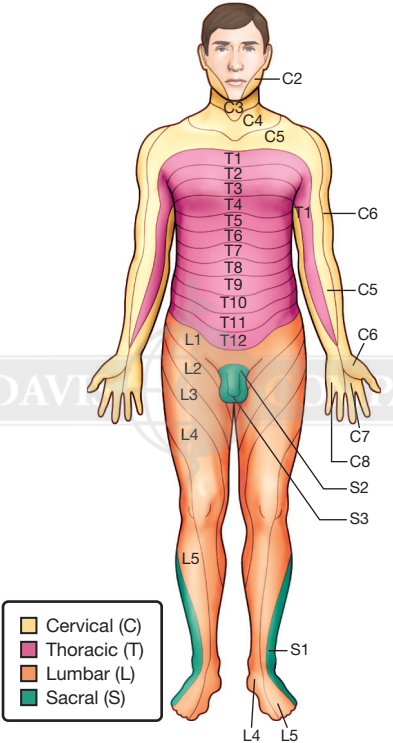


Source: From Gulick, D. Screening Notes: Rehabilitation Specialist's Pocket Guide. FA Davis, Philadelphia, 2006, p 11.

Headaches[233, 234]

Type of Pain	Possible Etiology
Acute	Trauma, infection, impending CVA
Chronic	Eye strain, ETOH, inadequate ventilation
Severe & intense	Meningitis, aneurysm, brain tumor
Throbbing/pulsating	Migraine, fever, hypertension, aortic insufficiency
Constant	Muscle contraction/guarding
Morning pain	Sinusitis (with discharge), ETOH, hypertension, sleeping position
Afternoon pain	Eye strain, muscle tension
Night	Intracranial disease, nephritis
Forehead	Sinusitis, nephritis
Temporal	Eye or ear Px, migraine
Occipital	Herniated disk, eye strain, hypertension
Parietal	Meningitis, constipation, tumor
Face	Sinusitis, trigeminal neuralgia, dental Px, tumor
Stabbing pain	With ear fullness, tinnitus, vertigo = otitis media
Severe pain	With fever, (+) Kernig sign = meningitis
Severe, sudden pain	With ↑ BP = subarachnoid hemorrhage
Intermittent pain	With fluctuating consciousness = subdural hematoma

Dermatomes[312]

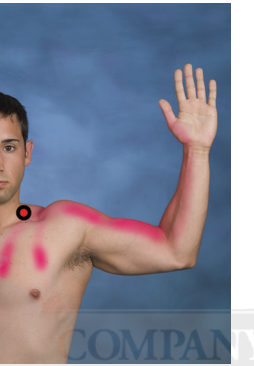


Source: From Taber's Cyclopedic Medical Dictionary, 22nd ed. FA Davis, Philadelphia, 2013, p 658.

Muscle Pain Referral Patterns[488]

Scalenes posterior

Scalenes anterior



Sternocleidomastoid

Trapezius

Latissimus dorsi

Quadratus lumborum

Gluteus maximus

151
Piriformis

Palpation Pearls[45]

Landmarks

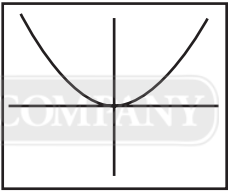
Vertebral Level	Identification Strategy
C1	1 fingerwidth below mastoid process 2 fingerwidths below occipital protuberance
C2	Angle of mandible 3 fingerwidths below occipital protuberance
C3–4	Posterior to hyoid bone
C7	Base of neck (prominent posterior spinous process)
T2	Superior angle of scapula & jugular notch
T7	Inferior angle of the scapula
T10	Xiphoid process
T12	12th rib
L3	Posterior to umbilicus
L4	Iliac crest
S2	Level of PSIS
Tip of coccyx	Ischial tuberosities

- **Anterior neck muscles** (medial & anterior to lateral & posterior) = sternal branch of SCM, sternohyoid, clavicular branch of SCM, subclavian vein, anterior scalene, subclavian artery, brachial plexus, middle scalene, posterior scalene, levator scapula
- **Posterior neck muscles** (medial to lateral) = rectus capitis, semispinalis, splenius capitis, longissimus capitis
- **Posterior thoracic & lumbar spine** (medial to lateral) = spinalis, longissimus, iliocostalis

ROM

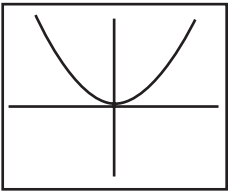
Cervical Normal Ranges

Motion	Segment(s)	Degrees
FB/BB	Suboccipital (nod)	20°–25°
	Midcervical	30°–35°
SB	Suboccipital (primarily A/A)	20°
	Midcervical	25°
Rot	Suboccipital	35°
	Midcervical	45°



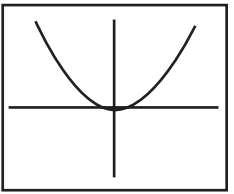
Thoracic Normal Ranges

Motion	Degrees
FB	20°–40°
BB	15°–30°
SB	25°–30°
Rot	5°–20°



Lumbar Normal Ranges

Motion	Degrees
FB = greatest @ L4–5	40°–60°
BB	20°–25°
SB = greatest @ L3–4	15°–35°
Rot = greatest @ L4–S1	5°–20°



Assessment Methods for Lumbar ROM:

- **Schober's test** = find L4 & mark 5 cm above & 10 cm below. Have client FB & measure distance between 2 points; normal >5 cm increase
- **Modified Schober's test** = initial landmark is a mark between the PSIS & marks at 5 cm & 10 cm above. Measure the distance between the points to reflect the amount of flexion at each lumbar region
- **Inclinometer** = (BROM) in standing—place 1 inclinometer on the sacrum & 1 inclinometer over T12 spinous process. Have client FB; amount of lumbar flexion is calculated by subtracting sacral angles from T12 angles

Pathology & Compensatory Strategies That Influence Limb Length

Lengthening of LE	Shortening of LE
Anterior rotation of SI	Posterior rotation of SI
Extension of hip	Hike/flex hip; IR of hip
ER of hip	Circumduct LE
Supination of foot	Flexion of knee
	Varus/valgus of knee
	Pronation of foot

Spine Osteokinematics[125, 199, 283, 360]

Coupled Joint Motions

Basic Principles

- Hip motion is coupled with innominate motion
- Lumbar motion is coupled with sacral motion
- Nutation means "to nod" = anterior tilt in sagittal plane
- Counternutation = posterior tilt in sagittal plane

Joint Motion	Innominate	Sacrum
Hip flexion	Ipsilateral posterior rotation	∅
Hip extension	Ipsilateral anterior rotation	∅
Hip IR	Ipsilateral IR or inflare	∅
Hip ER	Ipsilateral ER or outflare	∅
Lumbar FB	Anterior rotation	Nutation then counternutation
Lumbar BB	Slight posterior rotation	Nutation
Lumbar rotation	Ipsilateral posterior rotation & contralateral anterior rotation	Nutation ipsilaterally
Lumbar SB	Ipsilateral anterior rotation & contralateral posterior rotation	Ipsilateral SB ipsilateral & contralateral SB contralateral

Spine Arthrokinematics[282, 360]

Atlanto-occipital joint	Concave surface: Superior atlas facet Convex surface: Occiput	*To facilitate FB:* Occiput rolls anterior & glides posterior	*To facilitate BB:* Occiput rolls posterior & glides anterior *To facilitate SB:* Occiput rolls contralateral
Atlantoaxial joint	Concave surface: Inferior atlas facet Convex surface: Superior axis facet	*To facilitate FB:* Atlas pivots on axis *To facilitate rotation:* Atlas rotates ipsilateral on axis	*To facilitate BB:* Atlas pivots on axis
Intracervical segments*	Facets are oriented @ 45° in horizontal & frontal planes	*To facilitate FB:* Inferior facet of superior vertebra glides up & FW on superior facet of inferior vertebra	*To facilitate BB:* Inferior facet of superior vertebra glides down & back on superior facet of inferior vertebra
		To facilitate rotation: Inferior facet of superior vertebra glides posterior & inferior on ipsilateral side & anterior & superior on contralateral side	*To facilitate SB:* Inferior facet of superior vertebra glides inferior & posterior on ipsilateral side & superior & anterior on contralateral side

Continued

Intracervical segments*	Facets are oriented @ 45° in horizontal & frontal planes	*To facilitate protraction:* Craniocervical segments extend, while mid-low cervical segments flex	*To facilitate retraction:* Craniocervical segments flex while mid-low cervical segments extend
Thoracic & lumbar†	Thoracic facets are oriented in frontal plane	*To facilitate flexion:* Inferior facet of superior vertebra glides up & FW on superior facet of inferior vertebra	*To facilitate extension:* Inferior facet of superior vertebra glides down & BW on superior facet of inferior vertebra
	Lumbar facets are oriented in sagittal plane	*To facilitate rotation:* Inferior facet of contralateral superior vertebra compresses against superior facet of inferior facet, & inferior facet of ipsilateral superior vertebra separates from superior facet of inferior vertebra	*To facilitate SB:* Inferior facet of superior vertebra slides up on contralateral side of SB & down on ipsilateral side of SB motion

*Left SB & left rotation are coupled motions in the cervical spine.
†Right rotation & left SB are coupled motions in the lumbar spine.

Posture

Cervical

- ↑FH = ↑ compression forces on anterior, lower c-vertebra, & posterior facets; levator scapula can help to resist these stresses but may result in MTrP or adaptive shortening
- Shoulder protraction may result from GH or AC instability

Swayback (↑ Kyphosis & ↓ Lordosis)

- Alters resting position of the scapula & alters GH rhythm
- Tight hip extensors
- Weak hip flexors or lower abdominals
- Generalized ↓ strength
- Genu recurvatum = ↑ stress on posterior knee & compression of anterior knee
- Posterior pelvic tilt
- ↑ stress/elongation of anterior hip joint & posterior T-spine
- Shortening of posterior hip ligaments & anterior T-spine ligaments
- Forward head & shoulders

Lordosis

- Tight hip flexors or back extensors
- Weak hip extensors or abdominals
- Anterior pelvic tilt
- ↑ shear forces on lumbar vertebra
- ↑ compression forces on lumbar facets
- Stress & elongation of anterior spinal ligaments
- Narrowing of L-intervertebral foramen

Flatback (↓ Kyphosis & ↓ Lordosis)

- Forward head, posterior pelvic tilt, knee flexion
- Tight hip extensors
- Weak hip flexors & back extensors
- Compressive forces in posterior hip joint, anterior L-spine & posterior T-spine

Neuromuscular Relationships

Motion Segment	Nerve Root	Test Action & Myotome	Dermatome	Reflex
Occ–C1	C1	∅	Skull vertex	∅
C1–2	C2	Neck flexion—rectus capitis & SCM	Temple, forehead, occiput	∅
C2–3	C3	Neck SB—trapezius & longus capitis	Cheek, neck	∅
C3–4	C4	Shoulder elevation—levator scapula & trapezius	Clavicle & upper scapula	∅
C4–5	C5	Shoulder abd—deltoid, supra/infraspinatus, biceps	Anterior arm—shoulder to base of 1st digit	Biceps
C5–6	C6	Elbow flex/wrist ext—biceps, brachioradialis, ECRL, supinator	Anterior arm to lateral forearm, 1st & 2nd digit	Brachioradialis
C6–7	C7	Elbow ext/wrist flex—triceps, pronator teres, FCR	Lateral forearm, 2nd, 3rd, & 4th digits	Triceps
C7–T1	C8	Thumb ext/UD—EPL, EPB, FCU, ECU	Medial arm & forearm to 4th & 5th digits	Triceps
T1–2	T1	Hand intrinsic—FDP, FPB, opponens pollicis	Medial forearm to base of 5th digit	∅
T2–3	T2	∅	Pectoralis & midscapula to medial upper arm & elbow	

Continued

Motion Segment	Nerve Root	Test Action & Myotome	Dermatome	Reflex
T3–5	T3-5	∅	Upper thorax	∅
T5–7	T5-7	∅	Costal margins	∅
T8–12	T8-12	∅	Abdominal & lumbar regions	∅
T12–L1	L1	Iliacus	Back to trochanter & inguinal region	∅
L1–2	L2	Hip flexion—psoas, iliacus, & adductor longus	Back to mid-anterior thigh to knee	Cremasteric
L2–3	L3	Knee extension—quads, adductors	Back & upper buttock to distal anterior thigh & knee	Adductor
L3–4	L4	Ankle dorsiflexion—anterior tibialis, quads, TFL	Medial buttock to lateral thigh, medial tibia, & big toe	Patella
L4–5	L5	Toe extension—EHL, EDL, gluteus med/min, semimembranosus & tendinosus	Posterior lateral thigh, lateral leg, dorsum of foot, & toes 1, 2, 3	Tib posterior, med hamstring
L5–S2	S1–2	Ankle plantar flexion & knee flexion—hamstrings, peroneals, gastroc-soleus	Posterior thigh & leg, lateral foot & heel	Achilles
S2–3	S3	∅	Groin, medial thigh to knee	∅
S3–4	S4	Bladder & rectum	Perineum & genitals	∅

Neural Tissue Provocation Tests (NTPT)

Median Nerve Test[67, 99, 100, 215, 244, 257, 325, 326, 511]

Position: Supine or sitting with contralateral cervical SB & ipsilateral shoulder depressed
Technique: Extend UE in plane of scapula with elbow extended, forearm supinated, & wrist/fingers extended
Interpretation: (+) test = pain or paresthesia into median nerve distribution of UE
Statistics: Sensitivity = 94%; specificity = 22%

Radial Nerve Test[67, 99, 100, 215, 244, 257]

Position: Supine or sitting with contralateral cervical SB & ipsilateral shoulder depressed
Technique: Extend UE with elbow extended, forearm pronated, wrist flexed, & fingers extended
Interpretation: (+) test = pain or paresthesia into radial nerve distribution of UE
Statistics: Sensitivity = 97%; specificity = 33%

Ulnar Nerve Test[67, 99, 100, 166, 215, 244, 257]

Position: Supine or sitting with ipsilateral shoulder depressed
Technique: Abduct shoulder to 90° with ER, flex elbow, pronate forearm, extend wrist/fingers in an attempt to place the palm of the hand on the ipsilateral ear
Interpretation: (+) test = pain or paresthesia into ulnar nerve distribution of UE
Statistics: Sensitivity = NT & specificity = NT

Spine Tests

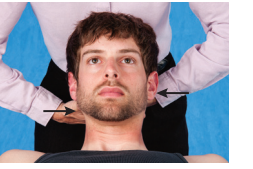
Spurling Test/Cervical Quadrant Sign[42, 446, 453, 483, 504, 511]

Purpose: Assess nerve roots & IVF
Position: Seated
Technique: Stand behind client with clinician's fingers interlocked on top of head & compress (axial load) with C-spine in slight extension & lateral flexion
Interpretation: (+) test = referred or reproduction of pain; implicates various structures related to compromise of IVF
Statistics: Sensitivity = 30%–60% & specificity = 74%–100%

Cervical Foraminal Distraction Test[396, 446, 453, 504, 511]

Purpose: Assess cervical mobility, foraminal size, & nerve root impingement
Position: Supine or sitting
Technique: Impart a controlled distraction force of C-spine to ↑ IVF space & decompress facet joints
Interpretation: (+) test = ↓ or centralization of symptoms implies effective means of intervention; pain = spinal ligament tear, annulus fibrosis tear/inflammation, large disk herniation, muscle guarding
Statistics: Sensitivity = 40%–44% & specificity = 90%–100%s

Odontoid Fracture Test

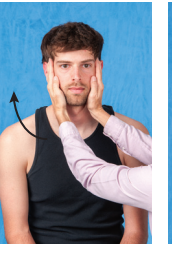


Purpose: Assess integrity of odontoid process
Position: Supine
Technique: While using index fingers to palpate lateral mass of atlas, apply a medial-directed force in each direction
Interpretation: (+) test = ↑ translation of lateral mass
Statistics: Sensitivity = NT & specificity = NT

Vertebral Artery Test[179, 242, 265, 315, 423]

Purpose: Assess integrity of internal carotid arteries
Position: Supine
Technique: Place hands under client's occiput to passively extend & SB C-spine then rotate to ~45° & hold × 30 sec; engage client in conversation while monitoring pupils & affect; repeat with rotation to opposite direction
Interpretation: (+) test = occlusion of vertebral artery inhibits normal blood flow & may result in nystagmus, dizziness, diplopia, nausea, tinnitus, confusion, unilateral pupil changes
Statistics: Sensitivity = NT & specificity = NT

Neck Torsion Test[146, 344, 370, 469]



Purpose: Assess for vertebrobasilar ischemia
Position: Sitting in a rotating stool
Technique: Sit in front of client & hold head with both hands; client rotates stool while head remains facing forward
Interpretation: (+) test = VBI symptoms; if test is (–) but vertebral artery test is (+), suspect positional vertigo
Statistics: Sensitivity = NT & specificity = NT

Dix-Hallpike Maneuver[84, 136, 179]

Note: Perform this test only if vertebral artery & ligament tests are (–).
Purpose: Assess vestibular system
Position: Sitting with clinician holding client's head in 45° rotation & 20° extension
Technique: While maintaining this position, quickly lower client to supine with head over edge of table
Interpretation: (+) test = vertigo, nystagmus
Statistics: Sensitivity = NT & specificity = NT

Alar Ligament Test[334, 380, 396]

Purpose: Assess alar ligament integrity
Position: Supine
Technique: While palpating spinous process (SP) of C2, slightly SB head
Interpretation: Normal = Ⓡ rotation & SB tightens Ⓛ alar ligament & flexion tightens both. SP should move immediately in contralateral direction to SB (+) test = delay in C2 SP movement may indicate pathology of alar ligament (most common with RA)
Statistics: Sensitivity = NT & specificity = NT

Sharp-Purser Test[494]

Purpose: Assess atlas-axis instability
Position: Sitting with head flexed on neck
Technique: Stabilize SP of C2 with thumb & apply posteriorly directed force via hand on forehead
Interpretation: (+) test = head slides posterior or soft endfeel
Statistics: Sensitivity = 69% & specificity = 96%–98%; (+) LR = 17.25 & (–) LR = 0.32

Transverse Ligament Test[334, 396]

Purpose: Assess transverse portion of cruciform ligament
Position: Supine with head cradled in clinician's hands
Technique: Anterior & posterior glides are used to locate anterior arches of C2. Stabilize C2 arches posteriorly with clinician's thumbs & client's occiput is lifted with cupped hands to translate head forward. This glides head & C1 anterior on C2. Hold for 15–30 sec
Interpretation: (+) test = nystagmus, vertigo, paresthesia into face or UE
Statistics: Sensitivity = NT & specificity = NT

Aspinall Test[18]

Note: Perform this test only if Sharp-Purser test is (–).
Purpose: Assess transverse ligament integrity
Position: Supine
Technique: Stabilize occiput on atlas & apply anterior force to atlas
Interpretation: (+) test = soft endfeel or client reports esophageal pressure or neural cord compression symptoms
Statistics: Sensitivity = NT & specificity = NT

Craniocervical Flexion Test[140, 233, 234]

Purpose: Assess recruitment of deep neck flexors
Position: Supine, head in neutral
Technique: With biofeedback unit or BP cuff inflated to 20 mm Hg under midcervical region, instruct client to nod head (as if saying "yes")
Interpretation: (+) test = inability to maintain pressure for 10 sec or form fatigue
Statistics: Sensitivity = NT & specificity = NT

Lateral & AP Rib Compression[261]

Purpose: Assess ribs for fx
Position: Supine
Technique: With clinician's hands on the lateral aspect of rib cage, compress bilaterally; repeat with hands on the front & back of chest
Interpretation: (+) test = pain 2° rib fracture or costochondral separation
Statistics: Sensitivity = NT & specificity = NT

Rib Motion Test

Purpose: Assess costal mobility
Position: Supine
Technique: Palpate AP mov't of ribs as client inhales/exhales
Interpretation: During inspiration, ribs 1–6 should ↑ in AP dimension, while ribs 7–10 should ↑ in lateral dimension via bucket-handle action & ribs 8–12 should ↑ in lateral dimension via caliper action; (+) test = inhibited rib movement with exhalation suggests an elevated rib; inhibited rib movement with inhalation suggests a depressed rib
Statistics: Sensitivity = NT & specificity = NT

Beevor Sign

Purpose: Assess abdominal musculature
Position: Supine with knees flexed & feet on mat
Technique: Head & shoulders are raised off the mat while movement of the umbilicus is observed
Interpretation: Umbilicus should remain in a straight line. (+) test depends on direction of movement. Movement distally = weak upper abdominals, movement proximally = weak lower abdominals, movement up & Ⓡ = weak muscles in Ⓛ lower quadrant, movement down &Ⓛ= weak muscles in the Ⓡ upper quadrant
Statistics: Sensitivity = NT & specificity = NT

Transverse Abdominis Test[182, 210, 211]

Purpose: Assess transverse abdominis recruitment
Position: Prone with biofeedback unit or BP cuff inflated to 70 mm Hg under umbilicus
Technique: Client instructed to perform a drawing in maneuver (bring belly button up & under ribs)
Interpretation: (+) test = inability to reduce & hold pressure by 7–10 mm Hg
Statistics: Sensitivity = NT & specificity = NT

Quadratus Test[303]

Purpose: Assess quadratus lumborum muscle strength
Position: Ipsilateral side-lying on elbow
Technique: Lift ipsilateral hip to align back & lower extremities
Interpretation: (+) test = inability to lift hip = weakness
Statistics: Sensitivity = NT & specificity = NT

Bike Test[126]

Purpose: Assess neurogenic vs. vascular intermittent claudication

Position: Sitting on a stationary bicycle
Technique: Pedal in an erect & then slumped posture
Interpretation: (+) test = LE pain/paresthesia that reduces with slumped cycling = neurogenic claudication; no change = vascular claudication
Statistics: Sensitivity = NT & specificity = NT

Stoop Test[261]

Purpose: Assess neurogenic vs. vascular intermittent claudication
Position: Standing
Technique: Client walks briskly until symptoms appear & then flexes forward or sits
Interpretation: (+) test = if symptoms are quickly relieved with FB, claudication is neurogenic
Statistics: Sensitivity = NT & specificity = NT

Slump Test[67, 147, 164, 230, 398, 456, 488]

Purpose: Assess neural mobility
Position: Sitting with trunk in slumped posture
Technique: While sustaining neck flexion, sequentially add knee extension of 1 LE & then dorsiflexion; repeat with other LE
Interpretation: (+) test = reproduction of symptoms; compare bilaterally
Statistics: Sensitivity = 83% & specificity = 55%

Lumbar Quadrant Test[102, 228, 303]

Purpose: Assess nerve roots & IVF
Position: Standing or sitting
Technique: Assist client in extending spine & SB ipsilaterally with rotation contralaterally & then apply overpressure through the shoulders; repeat to other side
Interpretation: (+) test = radicular symptoms are due to nerve root compression, whereas local pain incriminates facet joints
Statistics: Sensitivity = NT & specificity = NT

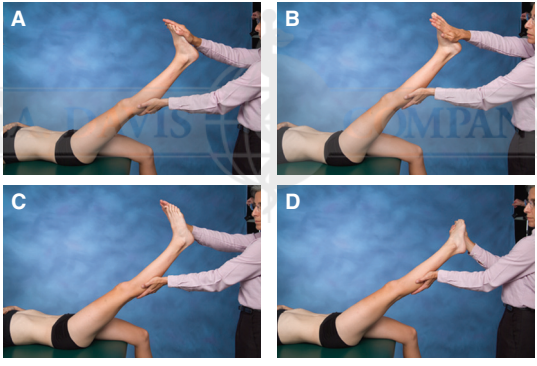
Brudzinski-Kernig Test[89]

Purpose: Assess for dural irritation, nerve root involvement
Position: Supine with hands behind head
Technique: Client flexes neck & performs active SLR
Interpretation: (+) test = reproduction of symptoms that are revealed with knee flexion
Statistics: Sensitivity = NT & specificity = NT

SLR Test[56, 81, 117, 118, 128, 137, 174, 231, 262, 266, 316, 342, 427, 440, 495, 497, 504, 507, 524]

Purpose: Assess neural mobility
Position: Basic SLR test position = hip flexion, adduction, IR with knee extended
Technique: Add each of the following motions to implicate specific nerves

	Modification for nerve bias:	Nerve implicated:
A	Dorsiflexion	Sciatic nerve
B	Dorsiflexion, eversion, & toe extension	Tibial nerve
C	Dorsiflexion & inversion	Sural nerve
D	Plantar flexion & inversion	Common peroneal nerve



Interpretation: (+) test = reproduction of symptoms; normal SLR = 70°–90°
Statistics: Overall: sensitivity = 40%–98% & specificity = 10%–100%; (+) LR = 1.00–1.98 & (–) LR = 0.05–0.86; (+) PV = 83% & (–) PV = 64%
For L4-L5 herniation: sensitivity = 78% & specificity = 86%; (+) PV = 72% & (–) PV = 90%
For L5-S1 herniation: Sensitivity = 75% & specificity = 95%; (+) PV = 56% & (–) PV = 94%

Crossed SLR (Well Leg) Test[497]

Purpose: Assess LE neural mobility
Position: Supine
Technique: Perform active SLR with uninvolved leg
Interpretation: (+) test = reproduction of radicular pain in opposite leg
Statistics: Sensitivity = 28% & specificity = 90%

Prone Knee Bending[151, 406, 407, 421, 487, 506]

Purpose: Assess neural mobility
Position: Basic test position = prone with hips extended
Technique: Add each of the following motions to implicate a specific nerve
Interpretation: (+) test = reproduction of symptoms
Statistics: Sensitivity = NT & specificity = 84%

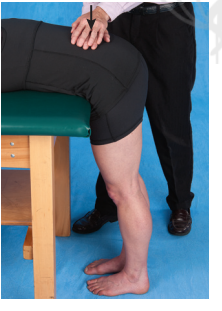
Modification for nerve bias:	Nerve implicated:
Knee flexion	Femoral nerve (L2–4)
Hip adduction with knee flexion	Lateral femoral cutaneous nerve
Hip abduction, ER, knee extension, & ankle dorsiflexion & eversion	Saphenous nerve

Bowstring Test[60, 105, 118, 136, 310, 333]

Purpose: Assess sciatic nerve tension
Position: Supine
Technique: Perform SLR to angle of discomfort & then flex the knee to 20°; apply pressure to popliteal area
Interpretation: (+) test = reproduction of radicular symptoms when popliteal fossa is palpated
Statistics: Sensitivity = NT & specificity = NT

Prone Instability Test[160, 162, 208, 209, 441]

Purpose: Assess lumbar stability
Position: Prone, bent over the edge of a table
Technique: Perform segmental anterior glides with & without client's feet on floor
Interpretation: (+) test = ↓ stability & reproduction of symptoms with feet on floor that is relieved when feet are lifted (muscle activation stabilizes spinal segment)
Statistics: Sensitivity = 61%–72% & specificity = 57%–58%; (+) LR = 1.41 & (–) LR = 0.69



Spine Torsion Test[120, 333]

Purpose: Assess spinal segmental instability
Position: Side-lying with pelvis stabilized
Technique: Rotate trunk to segmental level to be tested & provide overpressure to that segment
Interpretation: (+) test = tissue laxity & reproduction of symptoms
Statistics: Sensitivity = NT & specificity = NT

Farfan Torsion Test[142, 531]

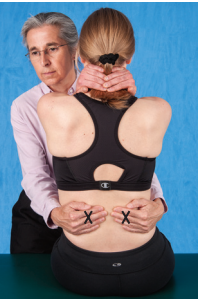
Purpose: Assess spinal segmental instability
Position: Prone with hand stabilizing segmental level
Technique: With hand on opposite ilium, lift up to create rotation
Interpretation: (+) test = tissue laxity & reproduction of symptoms
Statistics: Sensitivity = NT & specificity = NT

Anterior Instability Test[120]

Purpose: Assess spinal segmental instability
Position: Side-lying with hips/knees flexed to 90°
Technique: Clinician applies long axis force through the femurs while the segment superior to the tested segment is palpated
Interpretation: (+) test = ↑ segmental mobility
Statistics: Sensitivity = NT & specificity = NT

Posterior Instability Test[120]

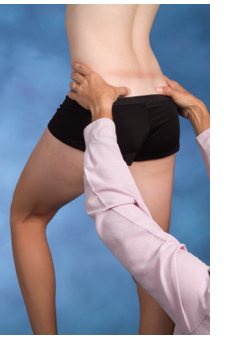
Purpose: Assess spinal segmental instability
Position: Sitting with elbows flexed on clinician's chest
Technique: Clinician stabilizes vertebral segment & applies pressure through client's flexed elbows
Interpretation: (+) test = ↑ segmental mobility
Statistics: Sensitivity = NT & specificity = NT



Pheasant Test[225]

Purpose: Assess spinal segmental instability
Position: Prone
Technique: Apply anterior pressure to desired segment as knee is passively flexed
Interpretation: (+) test = ↑ segmental mobility & reproduction of symptoms
Statistics: Sensitivity = NT & specificity = NT

Gillet March Test[122, 151, 284, 337, 407, 420]



Purpose: Assess innominate mobility
Position: Standing
Technique: While clinician palpates inferior aspect of Ⓡ PSIS with 1 thumb & medial sacral crest (S2 @ level of PSIS) with 1 thumb, client is asked to flex Ⓡ hip to 90°–120°; repeat other side
Interpretation: Normal = L-spine Ⓛ SB & Ⓡ rotation should be accompanied by Ⓡ innominate rotating posterior & sacrum rotating Ⓛ ; (+) test = asymmetrical PSIS movement, pop/click, or reproduction of pain
Statistics: Sensitivity = 8%–47% & specificity = 61%–93%; (+) LR = 1.07–1.34 & (–) LR = 0.83–0.99

Supine to Sit Test[7, 38, 151, 284, 387, 407, 421]

Purpose: Assess position of ilium
Position: Supine with both LEs extended
Technique: Palpate medial malleolus as client performs a long sit-up (be careful not to rotate trunk while sitting up)
Interpretation: (+) test = a short-to-long leg position = posterior ilium rotation; a long-to-short leg position = anterior ilium rotation
Statistics: Sensitivity = 44%–62% & specificity = 64%–83%; (+) LR = 1.22–3.60 & (–) LR = 0.46–0.88

Standing/Sitting Forward Flexion Test[15, 122, 151, 284, 337, 421, 484, 486, 506]

Purpose: Assess mobility of ilium or sacrum
Position: Standing or sitting
Technique: Palpate PSIS while client slowly FB with LE straight & hands reaching toward floor
Interpretation: Segmental movement should begin with L-spine, then sacrum, & then innominate; (+) test = asymmetrical movement with pathologic side being the one that moves more
Statistics: Sensitivity = 3%–17% & specificity = 79%–93%; (+) LR = 0.3–1.01 & (–) LR = 0.98–1.08

Faber (Patrick) Test[15, 57, 94, 122, 151, 259, 320, 322, 350, 384, 425]

Purpose: Assess for SI pathology
Position: Supine—passively flex, abduct, & ER hip (figure-4 position) so that lateral malleolus of involved LE is on knee of uninvolved LE
Technique: Apply overpressure to medial aspect of flexed knee
Interpretation: (+) test = hip pain 2° to OA, osteophytes, intracapsular fx, or LBP 2° SI Px; tightness without pain is (–) test; pain experienced assuming this position may indicate a problem with sartorius muscle; labral pathology may be suspected if lateral aspect of knee is >4 cm from the surface & asymmetrical
Statistics: Sensitivity = 41%–77% & specificity = 16%–100%; (+) LR = 0.82, (–) LR = 0.23–1.94

Flare Test[204]

Purpose: Assess for SI pathology
Position: Standing
Technique: While palpating PSIS, client performs IR/ER of hip with foot on ground
Interpretation: (+) test = reproduction of symptoms
Statistics: Sensitivity = NT & specificity = NT

Gaenslen Test[57, 122, 151, 259, 271, 272, 384]

Purpose: Assess for SI pathology
Position: Supine with 1 knee to chest & other leg off edge of table
Technique: Clinician applies over-pressure to both knees in opposite directions
Interpretation: (+) test = reproduction of symptoms
Statistics: Sensitivity = 21%–71% & specificity = 26%–80%; (+) LR = 0.75–2.29 & (–) LR = 0.65–1.12

SI Posterior Compression Test (Anterior Gapping)[7, 50, 87, 151, 158, 190, 259, 271, 272, 384, 425, 433, 498, 500]

Purpose: Assess for SI pathology
Position: Supine with clinician's hands crossed over client's pelvis on ASISs
Technique: Apply a lateral force to ASISs through the hands
Interpretation: (+) test = reproduction of SI joint pain
Statistics: Sensitivity = 7%–69% & specificity = 63%–100%; (+) LR = 0.7–3.95 & (–) LR = 0.33–1.03

SI Posterior Distraction Test (Anterior Compression)[7, 50, 87, 151, 158, 190, 259, 271, 272, 384, 425, 433, 498, 500]

Purpose: Assess for SI pathology
Position: Side-lying
Technique: Apply a downward force through anterior aspect of ASIS to create posterior gapping of SI
Interpretation: (+) test = reproduction of SI joint pain
Statistics: Sensitivity = 4%–60% & specificity = 74%–100%; (+) LR = 1.1–3.2 & (–) LR = 0.49–0.98

Posterior Shear (Posh) Test[57, 151, 208, 272]

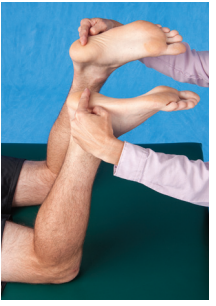
Purpose: Assess for SI pathology
Position: Supine with hip in flexion, abduction, & ER
Technique: Clinician applies long axis force to femur
Interpretation: (+) test = reproduction of pain at SI joint
Statistics: Sensitivity = 42%–80% & specificity = 45%–100%; (+) LR = NT & (–) LR = 0.2

Mennell Test[498, 500]

Purpose: Assess for SI pathology
Position: Side-lying on affected side with uninvolved leg extended & involved leg flexed to chest
Technique: While palpating posterior pelvic crest, clinician places hand on involved knee to push LE into extension
Interpretation: (+) test = reproduction of symptoms
Statistics: Sensitivity = 45%–86% & specificity = 80%–86%; (+) LR = 3.29–3.44 & (–) LR = 0.41–0.63

SI Cluster Tests[15, 259, 271, 272, 499]	Sensitivity (%)	Specificity (%)
Standing flexion, PSIS palpation, supine to long-sit, & prone knee flexion	82	88
Distraction, thigh thrust, Gaenslen, compression, & sacral thrust	91	78
Thigh thrust, distraction, sacral thrust, & compression	88	78
Thigh thrust (POSH), Gaenslen, FABER, SI distraction, SI compression—when 3 of 5 tests are (+)	85	79

Prone Knee Bend Test[87, 151, 406, 407, 421, 486, 506]



Purpose: Assess leg length discrepancy vs. positional impairment of SI
Position: Prone with LE extended
Technique: Assess leg length in extension & then flex knees to 90° & reassess leg length
Interpretation: (+) test = difference in leg length in 2 positions; short-to-long leg position = posterior ilium rotation; long-to-short leg position = anterior ilium rotation
Statistics: Sensitivity = 82% & specificity = 88%; (+) LR = 6.83 & (–) LR = 0.20

Hoover Test[312]

Purpose: Assess malingering
Position: Supine
Technique: Hold client's heels of (B) LEs in clinician's hands, ask client to lift 1 leg out of a hand
Interpretation: (+) test = client does not lift leg & there is no downward force exerted by contralateral limb
Statistics: Sensitivity = NT & specificity = NT

Waddell Nonorganic Signs[507, 508]

Sign	Description
Tenderness—superficial or nonanatomical	Tenderness is not related to a particular structure. It may be superficial (tender to a light pinch over a wide area) or deep tenderness felt over a wide area (may extend over many segmental levels).
Simulation tests—axial loading in rotation	These tests give the client the impression that diagnostic tests are being performed. Slight pressure (axial loading) applied to the top of the head or passive rotation of the shoulders & pelvis in the same direction produces c/o LBP.
Distraction tests—SLR	A (+) clinical test (SLR) is confirmed by testing the structures in another position. By appearing to test the plantar reflex in sitting, the examiner may actually lift the leg higher than that of the supine SLR.
Regional disturbances—weakness or sensory	The dysfunction spans a widespread region of the body (sensory or motor) that cannot be explained via anatomical relationships. This may be demonstrated by the client "giving way" or cogwheel resistance during strength testing of many major muscle groups or reporting diminished sensation in a nondermatomal pattern (stocking effect).
Overreaction	Overreaction includes disproportionate responses via verbalization, facial expressions, muscle tremors, sweating, collapsing, rubbing affected area, or emotional reactions.

Note: Any positive test in ≥3 categories results in an overall Waddell score.

Differential Diagnosis[73, 74, 119, 120, 142, 151, 160, 162, 180, 189, 228, 234, 255, 377, 524]

Pathology/Mechanism	Signs/Symptoms
Torticollis[468] Seven forms of congenital torticollis & other causes include hemivertebra, cervical pharyngitis (major cause in 5–10 yo), JRA, trauma	• Symptoms appear @ 6–8 weeks of age • Contralateral rotation & ipsilateral SB • Firm, nontender swelling about the size of an adult thumb nail • (–) x-ray • Complications: visual issues &/or reflux
Cervical Sprain[42] Trauma or prolonged static positioning	• Localized pain; TTP; muscle guarding • MTrP in cervical, shoulder, & scapular regions • ↓ Cervical ROM & stiffness with activity • Headache & postural changes—forward head, kyphosis • Screen for alar & transverse ligament Px • Clear vertebral arteries • Normal DTRs & (–) x-ray
Cervical Strain[42] Single traumatic event or cumulative trauma; most often occurs in 20–40 yo who have faulty posture, overweight, deconditioning	• Pain with contraction & with stretching • Pain with prolonged sitting, walking, standing • TTP & protective muscle guarding • Pain appears several hours after injury; headache • ↓ Contralateral SB & rotation (AROM < PROM) • Clear vertebral arteries • Normal DTRs • (–) special tests & (–) x-rays
Cervical Facet Syndrome[18] Occurs as a result of isolated or cumulative trauma, DDD, aging, or postural imbalances	• Pain with hyperextension & rotation of C-spine • Muscle guarding & stiffness • Poor movement patterns but no weakness • Paresthesia but no changes in DTRs • Possible (+) NTPT; (+) quadrant test • (–) X-ray

Continued

Pathology/Mechanism	Signs/Symptoms
Cervical Stenosis Most common 30–60 yo; ♂ > ♀; can be congenital or developmental, onset is gradual	• Unilateral or bilateral symptoms usually span several dermatomes • ↑ Pain with cervical BB & ↓ with cervical FB • Pain relieved with rest • ↓ Hand dexterity, LOB, & unsteady gait • (+) Quadrant test • LMN signs at level of stenosis & UMN signs below level of stenosis • X-rays reveal spondylitic bars & osteophytes & ossification of PLL & ligamentum flavum
Cervical Spondylosis ↑ onset with aging but may be accelerated by cumulative trauma, poor body mechanics, postural changes, or previous disk injury; most common @ C5–7	• ↑ Pain with activity & stiffness @ rest • Limited AROM & PROM; crepitus • (+) Compression/distraction test • ↓ Disk height on x-ray • R/o osteophytes
Cervical Disk Pathology[503, 510] Most common level is C5–6; usually the result of repetitive stresses on the neck as a result of poor posture or muscle imbalances; most common in 30–50 yo	• (+) NTPT—median nerve with contralateral cervical SB, cervical rotation <60° & cervical FB <50° • (+) Tests: compression, distraction, shoulder depression, & Spurling maneuver • Sensory changes in respective dermatome • X-rays are of little value • CT & MRI used to differentiate nucleus pulposus from annulus fibrosis
Brachial Plexus Lesion (Plexopathy, Burner, Stinger) Occurs from stretching or compression of C-spine or forceful depression of shoulder	• Sharp & burning pain in UE • Numbness/pins & needles present in UE • Transient muscle weakness & ↓ DTR • Provocation test = ipsilateral cervical SB with compression OR contralateral SB (stretch) • (+) NTPT • Confirmed with myelogram

Continued

Pathology/Mechanism	Signs/Symptoms
Rib Fracture[104] Mechanism is a direct blow; cough in a frail person	• (+) Tests: AP & lateral rib compression • TTP & pain with deep inspiration • (+) X-ray is difficult to assess immediately after injury
Costochondritis May be due to trauma, arthritis, infection, or surgery	• Localized pain in anterior chest wall • TTP; pain ↑ with cough that may radiate into UE
Compression Fracture[104] Most common in T11-L2, may be related to trauma or osteoporosis	• Acute pain with adjacent muscle guarding • Limited BB & rotation • (+) X-ray
Spondylosis/Arthrosis[50] Degenerative changes that usually affect C5-6, C6-7, L4–5 of clients >60 yo	• Onset is slow; pain is unilateral & ↑ with prolonged postures • Pain ↑ with BB & ↓ with FB but usually does not radiate • Confirmed with x-ray; osteophytes, ↓ joint space, & narrow IVF

Ankylosing Spondylitis (Strümpell-Marie Disease)[303]
Involves anterior longitudinal ligament & ossification of disk & thoracic zygapophyseal joints; most common in 15–40 yo; ♂ > ♀
	• Postural changes:
	  • Cervical hyperextension
	  • Thoracic kyphosis & lumbar lordosis
	  • Hip & knee flexion contractures
	  • Night pain & ↓ rib expansion
	• ↑ SED rate
	• **5 screening questions:**
	  • Morning stiffness >30 minutes?
	  • Improvement with exercise?
	  • Onset of back pain before 40 yo?
	  • Slow onset?
	  • Symptoms >3 months?
	  • ≥4 (+) questions = ↑ correlation with AS

Spondylolysis[50] Traumatic pars or stress fractures due to repeated or sustained extension, seen in repetitive trauma (ski jumping, gymnastics); may have a structural predisposition	• Pain primarily with extension • Intermittent neurological signs & symptoms • Oblique x-ray reveals fracture of pars interarticularis without slippage ("Scottie dog with a collar")

Continued

Pathology/Mechanism	Signs/Symptoms
Spondylolisthesis[50] Vertebral subluxation or slippage 2° a long history of LB trauma Retrolisthesis = not common but presents with flexion symptoms	• L5 nerve entrapment sciatica • Morning stiffness; difficulty getting OOB • Pain with trunk extension • Poor neuromuscular control—"hitching sign" = 2-step process of moving from FB & BB via 1st extending lumbar spine into lordosis & then extending hip • Palpable step deformity in WB, gone in NWB • (+) Tests: PIVM & compression test • A/P & lateral x-ray confirms dx

Lumbar Disk Pathology[81, 128, 434, 437, 496]
Usually the result of repetitive stresses on LB using improper body mechanics or excessive force posterior/lateral > lateral; most common in 30–50 yo
Note: See "Lumbar Disk Posturing & Pain" on page 188.
	• *Posterior-lateral HNP:*
	  • 1st sign is LBP that slowly diminishes to leg pain
	  • LB flexion 2° ↑ disk pressure
	  • (+) Thecal signs (pain with sneezing & coughing)
	  • (+) SLR; ↓ lumbar lordosis
	  • Lateral shift in standing that ↓ in supine
	• *Lateral HNP:*
	  • No LBP; LE symptoms consistent with level of injury
	  • Pain in standing & walking; ↓ in sitting
	  • (–) SLR
	• Standard x-rays are of little value (may detect only pre-existing degenerative changes); MRI, CT scan, myelogram, & discogram are used for diagnosis

Lumbar Facet Syndrome[437, 531] Occurs as a result of isolated or cumulative trauma, DDD, aging, or postural imbalances	• Pain referred to gluteals or thigh • Muscle guarding • Pain primarily with compression; morning stiffness • Pain ↓ with FB • Pain ↑ with BB & ipsilateral SB; difficulty standing straight • X-ray may show osteophytes (spondylosis)

Continued

Pathology/Mechanism	Signs/Symptoms
Lumbar Stenosis[303, 437] Progressive, irreversible, & insidious onset of narrowing of spinal canal; history of LBP × several years; occurs mostly >50 yo; ♂ > ♀	• Dull ache across LS region when standing & walking • Pain when leaning forward, walking uphill, with pillow under knees, knees to chest, or sitting in flexion • Usually (B) pain into buttocks & proximal thigh • Nocturnal pain & cramping • Paresthesia that ↑ with BB & WB • (–) Tests: SLR & femoral nerve test • Postural changes: ↓ Lumbar lordosis • No change in B&B or pulses • LMN signs at level of lesion • UMN signs below level of lesion (ataxia, reflex hyperactivity (3+), (+) stoop test, & proprioceptive deficits) • X-ray may show osteophytes or ossification of PLL & ligamentum flavum; CT scan may show bony encroachment of spinal canal; MRI confirms clinical findings; myelogram shows amount of constriction of thecal sac
Lumbar Sprain[437] Usually results from combination of forward bending with rotation or SB; common <30 yo	• Unilateral LBP • Pain with SB away & rotation toward affected side • Referred pain limited to gluteals & thigh regions
Trochanteric Bursitis May result from contralateral gluteus medius weakness or a change/↑ in activity level; direct trauma	• Pain into buttock & lateral thigh • Pain worse at night & with activity • TTP over greater trochanter • Possible "clicking" with AROM & pain with resisted hip abduction • Check for leg length discrepancy • (–) X-ray

Continued

Pathology/Mechanism	Signs/Symptoms
Piriformis Syndrome Most commonly due to repeated compressive forces or may result from a change/↑ in activity level; ♀ > ♂	• Piriformis TTP • Ipsilateral LB, buttock, & LE pain • Pain & weakness with resisted abduction/ER of thigh • Pain with stretch into hip flexion, adduction, & IR • (–) X-ray; r/o sprain/strain or HNP
Ischiogluteal Bursitis May result from a change/↑ in activity level	• Pain into buttock & posterior thigh that is worse in sitting • TTP over ischial tuberosity • (+) Tests: SLR & Patrick test • (–) X-ray
Osteoporosis[303] Results from insufficient formation or excessive resorption of bone; occurs with ↑ age, low body fat, low Ca^{++} intake, high caffeine intake, bed rest, alcoholism, steroid use	• Dowager's hump (dorsal kyphosis) • Loss of height (2–4 cm/fracture) • Acute regional back pain (low thoracic/high lumbar) • Pain radiating anterior along costal margins • Fragile skin • X-ray shows fracture not bone loss • Bone scan needed for confirmation
Cauda equina syndrome[126, 312] Sudden loss of function of lumbar plexus; cause tumor, trauma, stenosis, inflammation	• Loss of bowel & bladder control • Saddle anesthesia = anus, perineum, genitals • Motor weakness of >1 nerve root in LE • Bilateral sensory loss • Loss of ankle DTRs • Sexual dysfunction

Lumbar Disk Posturing & Pain[128]

Posturing	*Herniation medial to nerve root*	*Herniation lateral to nerve root*
Ipsilateral list (medial pain behavior)	↓ Pain	↑ Pain
Contralateral list (lateral pain behavior)	↑ Pain	↓ Pain

Vascular vs. Neurological Claudication[9, 258, 330]

Vascular Signs & Symptoms		Neurological Signs & Symptoms
Primarily >40 yo	**Population**	
Bilateral—hip, thigh, & buttock to calf	**Pain location**	Unilateral or bilateral—LB & buttocks
Cramping, aching, squeezing	**Pain description**	Numbness, tingling, burning, weakness
Pain is present regardless of spinal position	**Positional response**	Pain ↓ with spinal flexion & ↑ with spinal extension
Pain with physical exertion (walking uphill) & relieved within minutes of rest	**Response to activity**	Pain ↑ with walking & ↓ with recumbency
↓ LE pulses; color & skin changes	**Pulses & skin**	Normal pulses & skin
No burning or sensation changes	**Sensation**	Burning & numbness in LE

Prognosis of Lumbar Disk Herniation[189, 262]

Factors That Can Influence (+) Outcome		Factors That Can Influence (–) Outcome
• (–) Crossed SLR test • No leg pain with BB • Large extrusion, sequestration • (+) Response to corticosteroids • No spinal stenosis • Progressive recovery of neurological deficits in first 12 weeks	Clinical	• (+) Crossed SLR test • Leg pain with BB • Contained herniation • (–) Response to corticosteroids • Presence of spinal stenosis • Progressive neurological deficit • Cauda equina syndrome
• Limited psychosocial issues • Self-employed • Motivated • >12 years of education • Good fitness level • No Waddell signs	Psychosocial	• Overbearing psychosocial issues • Worker's compensation • Unmotivated • <12 years of education • Illiterate • >3 Waddell signs

Differential Diagnosis of Sacroiliac Dysfunctions[122, 158, 259, 271, 272, 283, 284, 420, 483, 497, 498]

Diagnosis	Sacral Base	ILA	Lumbar Spine	Seated Flexion Test	Sit-Slump Test	Sacral Spring Test
Ⓡ Sacral flexion	Deep Ⓡ	Shallow Ⓡ Caudal Ⓡ	Convex Ⓡ	(+) Ⓡ	Deep Ⓡ base with slump	↓ Ⓡ ILA spring on MTA
Ⓛ Sacral flexion	Deep Ⓛ	Shallow Ⓛ Caudal Ⓛ	Convex Ⓛ	(+) Ⓛ	Deep Ⓛ base with slump	↓ Ⓛ ILA spring on MTA
Ⓑ sacral flexion	Deep Ⓑ	Deep Ⓑ	↓ Lordosis			
Ⓡ Sacral extension	Shallow Ⓡ	Deep Ⓡ Cranial Ⓡ	Convex Ⓛ	(+) Ⓡ	Shallow Ⓡ base with ext	↓ Ⓡ sacral base on MTA
Ⓛ Sacral extension	Shallow Ⓛ	Deep Ⓛ Cranial Ⓛ	Convex Ⓡ	(+) Ⓛ	Shallow Ⓛ base with ext	↓ Ⓛ sacral base on MTA
Ⓑ sacral extension	Shallow Ⓑ	Deep Ⓑ	↑ Lordosis			
Ⓛ/Ⓛ FW sacral torsion	Deep Ⓡ	Shallow Ⓛ Caudal Ⓡ	Convex Ⓡ	(+) Ⓡ	Deep Ⓡ base with slump	↓ Ⓛ ILA spring on LOA
Ⓡ/Ⓡ FW sacral torsion	Deep Ⓛ	Shallow Ⓡ Caudal Ⓛ	Convex Ⓛ	(+) Ⓛ	Deep Ⓛ base with slump	↓ Ⓡ ILA spring on ROA
Ⓛ/Ⓡ BW sacral torsion	Shallow Ⓛ	Deep Ⓡ Caudal Ⓡ	Convex Ⓡ	(+) Ⓛ	Shallow Ⓛ base with ext	↓ Ⓛ sacral base on ROA
Ⓡ/Ⓛ BW sacral torsion	Shallow Ⓡ	Deep Ⓛ Caudal Ⓛ	Convex Ⓛ	(+) Ⓡ	Shallow Ⓡ base with ext	↓ Ⓡ sacral base on LOA

ILA = inferior lateral angle; ROA = right oblique axis
LOA = left oblique axis; MTA = middle transverse axis

Differential Diagnosis of Iliosacral Dysfunctions[122, 158, 259, 271, 272, 283, 284, 420, 483, 497, 498]

Diagnosis	Etiology	SFT	ASIS	PSIS	Sacral Sulcus	Soft Tissue TTP	Leg Length
Ⓡ Anterior innominate	Weak glut med/max or abdominals, golf	(+) Ⓡ	Ⓡ Low	Ⓡ High	Ⓡ Shallow	Left TFL	Ⓡ Shortens with long sitting
Ⓡ Posterior innominate	Prolonged Ⓡ LE WB, fall on Ⓡ ischium, weak Ⓡ glut med, tight hamstrings, short Ⓡ leg	(+) Ⓡ	Ⓡ Up & forward	Ⓡ Down & back	Ⓛ Deep	Ⓡ Piriformis & TFL	Ⓡ Leg lengthens with long sitting
Ⓡ Inflare	Muscle imbalances, weak Ⓡ glut med	(+) Ⓡ	Ⓡ Medial	Ⓡ Lateral	Ⓡ Wider	Ⓡ Piriformis	
Ⓡ Outflare	Muscle imbalances	(+) Ⓡ	Ⓡ Lateral	Ⓡ Medial	Ⓡ Narrow		

Continued

Differential Diagnosis of Iliosacral Dysfunctions[122, 158, 259, 271, 272, 283, 284, 420, 483, 497, 498]

Diagnosis	Etiology	SFT	ASIS	PSIS	Sacral Sulcus	Soft Tissue TTP	Leg Length
Ⓡ Upslip innominate			Ⓡ High	Ⓡ High			
Ⓡ Downslip innominate			Ⓡ Low	Ⓡ Low			
Ⓡ Superior pubic shear	Fall on ischium or landing on 1 leg	(+) Ⓡ	Poss. Ⓡ high	Poss. Ⓡ high	Ⓡ Shallow	Tight ITB, adductors & Ⓡ quadratus TTP	Supine to sit = short to long
Ⓡ Inferior pubic shear	Short leg, weak glut medius &/or tight ITB	(+) Ⓡ	Poss. Ⓡ low	Poss. Ⓡ low		SIJ TTP	

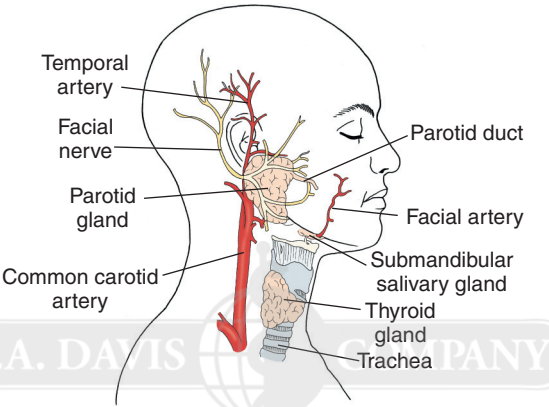
SFT = standing flexion test; PSIS = posterior superior iliac spine
ASIS = anterior superior iliac spine; TTP = tender to palpation

Clinical Prediction Rules[196, 324, 350, 455, 491]

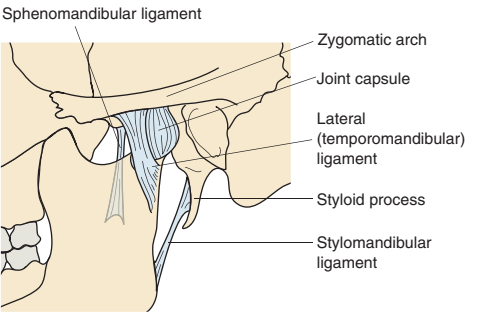
Condition	Intervention	Rule Features	Predictability
Neck pain	T-spine manipulation	• FABQPA score <12 • C-spine extension <30° • Symptoms not aggravated by looking up • ↓ Upper T-spine kyphosis • Symptoms <30 days • No symptoms beyond shoulder	≥5: (+) LR = infinite ≥4: (+) LR = 12 ≥3: (+) LR = 5.5 ≥2: (+) LR = 2.1 ≥1: (+) LR = 1.2
Neck pain	Cervical manipulation	• Neck Disability Index score <11.50 • Doesn't feel worse with neck extension • Bilateral symptoms • Does not perform sedentary work >5°/day • Feels better with neck motion • Spondylosis without radiculopathy	≥5: (+) LR = infinite ≥4: (+) LR = 5.33 ≥3: (+) LR = 1.93 ≥2: (+) LR = 0.20 ≥1: (+) LR = 0.07
Neck pain	C-spine traction & exercise	• ≥55 yo • (+) NTPT for median nerve • (+) Neck distraction test • (+) Shoulder abduction test • Peripheralization with lower C4-7 mobility testing	≥4: (+) LR = 23.1 ≥3: (+) LR = 4.8 ≥2: (+) LR = 1.4 ≥1: (+) LR = 1.2
LBP	Mechanical traction	• FABQW score <21 • No neurological deficits • >30 yo • No manual labor	=4: (+) LR = 9.4 ≥3: (+) LR = 3.0 ≥2: (+) LR = 1.8 ≥1: (+) LR = 1.0

Continued

Condition	Intervention	Rule Features	Predictability
LBP	L-spine manipulation	• Symptoms <16 days • 1 hip with >35° IR • No symptoms beyond the knee • FABQ Work subscale score <19 • (+) Spring test for hypomobility at ≥1 lumbar segment	≥5: (+) LR = infinite ≥4: (+) LR = 24.4 ≥3: (+) LR = 2.6 ≥2: (+) LR = 1.2 ≥1: (+) LR = 1.0
LBP	L-spine manipulation	• Symptoms <16 days • No symptoms beyond knee	≥2: (+) LR = 7.2
LBP	Stabilization exercises	• <40 yo • SLR >91° • (+) Prone instability test • Presence of aberrant movements	≥3: (+) LR = 4.0 ≥2: (+) LR = 1.9 ≥1: (+) LR = 1.3
LBP	SI joint dysfunction	• (+) Distraction test • (+) Compression test • (+) Thigh thrust test • (+) Gaenslen test (right) • (+) Gaenslen test (left) • (+) Sacral thrust test	≥3: (+) LR = 4.29 ≥3: (–) LR = 0.80
LBP	SI joint dysfunction	• (+) Distraction test • (+) Compression test • (+) Thigh thrust test • (+) Patrick test • (+) Gaenslen test	≥3: (+) LR = 4.02 ≥3: (–) LR = 0.19
Acute LBP	Vertebral fracture	• Female • >70 yo • Significant trauma • Prolonged use of corticosteroids	≥3: (+) LR = 218.3 ≥2: (+) LR = 15.5



Ligaments of the jaw



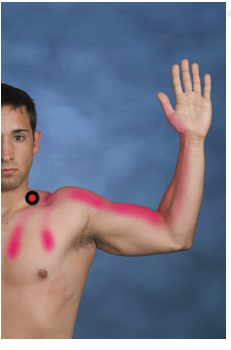
Referral Patterns

Muscle Pain Referral Patterns[488]

Masseter

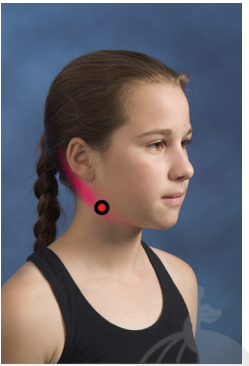
Sternocleidomastoid

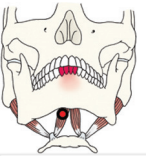
Anterior scalene



Posterior scalene

197
Digastric





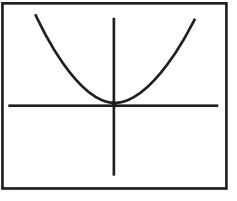
Temporalis

Medial & lateral pterygoid

Palpation Pearls[45]

- **SCM**—in supine, find mastoid process & move toward the clavicular notch, have client raise head & slightly rotate to opposite side
- **Scalenes**—stringy muscle above the clavicle between the SCM & traps; to confirm identification, palpate in the general area & have client inhale deeply & scalenes should be in the middle of the triangle
- **Masseter**—palpate the side of the mandible between the zygomatic arch & the angle of the mandible, have client clench the jaw
- **Suprahyoids**—palpate under the tip of the chin & resist mandibular depression or have the client swallow to confirm identification
- **Anterior digastric**—palpate extraorally inferior to body of the mandible
- **Posterior digastric**—palpate extraorally posterior to the angle of the mandible
- **Medial pterygoid**—palpate intraorally along medial rim of the mandible
- **Lateral pterygoid**—palpate intraorally along superior & posterior aspect behind 3rd maxillary molar

ROM



- **Mandibular depression** (opening)—35–50 mm (2–3 knuckles) is functional
  - C-deviation = hypomobility toward side of deviation (lateral pterygoid tension or disk pathology)
  - S-deviation = muscle imbalance or displacement of condyle around disk
- **Mandibular elevation** (closing)—palpate quality of movement to resting position
- **Mandibular protrusion** = 6–9 mm; must take into account starting position if there is an overbite or underbite present
- **Mandibular retrusion** = 3–4 mm
- **Mandibular lateral excursion** = 10–15 mm

TMJ Osteokinematics[125, 199, 282, 362]

Motion	Normal End-feel(s)	Abnormal End-feel(s)
Opening/closing	Open = tissue stretch/elastic Closed = bone-to-bone	Hard = osseous abnormality
Protrusion/retrusion	Tissue stretch/elastic	Springy = disk displacement
Lateral excursion	Tissue stretch/elastic	Capsular = shortening of periarticular tissues

TMJ Arthrokinematics[282]

Opening & closing	Concave surface: Mandibular fossa Convex surface: Mandibular condyle & disk	*To facilitate opening:* Condyles rotate anterior for first 25°, then anterior & inferior gliding of condyle & disk completes last 15° of movement	*To facilitate closing:* Condyles & disk roll posterior & glide medially & superior
Protrusion & retrusion	Concave surface: Mandibular fossa Convex surface: Mandibular condyle & disk	*To facilitate protrusion:* Disk & condyle move down & FW	*To facilitate retrusion:* Disk & condyle move up & BW
Lateral excursion	Concave surface: Mandibular fossa Convex surface: Mandibular condyle & disk	*To facilitate lateral excursion:* Ⓡ excursion = Ⓛ condyle & disk glide anterior, while Ⓡ condyle spins around vertical axis Ⓛ excursion = Ⓡ condyle & disk glide anterior. while Ⓛ condyle spins around vertical axis	

TMJ Tests

- **CLEAR CRANIAL NERVES**—see "Alerts/Alarms" page 12
- **AUSCULTATION**—used to identify poor joint kinematics or joint/disk damage; very sensitive to finding a problem but not specific in identification of the structure. Place stethoscope over TMJ, just anterior to tragus of ear, & listen for presence of joint sounds

Interpretation:

- Opening click = click as condyle moves over posterior aspect of disk in an effort to restore normal relationship; disk is anterior to condyle; the later the click, the more anterior the disk
- Reciprocal click = in opening, the disk reduces as the condyle moves under the disk, & in closing, a second click is heard as the condyle slips posteriorly & the disk becomes displaced anteriorly

Lateral Pole

Purpose: Assess soft tissues of TMJ
Position: Face client with clinician's index fingers palpating lateral pole of TMJ
Technique: Open & close mouth several times
Interpretation: (+) test = ↑ or reproduction of symptoms incriminating LCL or TMJ ligament

External Auditory Meatus

Purpose: Assess posterior disk
Position: Facing client, clinician inserts little fingers into client's ears
Technique: While applying forward pressure with fingers, client opens & closes mouth repeatedly
Interpretation: (+) test = ↑ or reproduction of symptoms
Statistics: Sensitivity = 43% & specificity = 75%

Dynamic Loading

Purpose: Assess response to TMJ loading to differentiate between TMJ & muscle pain
Position: Sitting with roll of gauze between molars on 1 side
Technique: Client bites down on gauze roll
Interpretation: Compression occurs on contralateral side & distraction on ipsilateral side of gauze; (+) test = ↑ or reproduction of symptoms @ TMJ

Differential Diagnosis

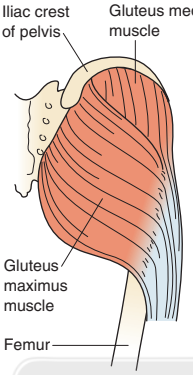
Pathology/Mechanism	Signs/Symptoms
Inflammation—may be the result of acute or repetitive trauma, prolonged immobilization, or surgery	Capsular tightness with ↓ opening Pain with or without movement R/o disk displacement
Disk displacement*—may be related to poor posture, trauma, excessive opening, muscle imbalance (anterior displacement is most common)	Muscle guarding & localized TTP Headache Confirmed with MRI
TMJ arthritis—gradual onset, poor kinematics or repeated trauma of the TMJ that leads to joint erosion	Pain, stiffness, crepitus, clicking, grinding ↓ ROM (deviation toward involved side) Headache, hearing loss, & dizziness Confirmed with x-ray or MRI; r/o disk problem

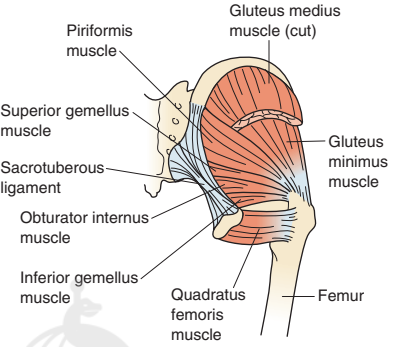
*Disk can result in clicking or locking. Locked open = disk is anterior & with opening there is a click with the disk being displaced posterior, then joint is locked in the open position; locked closed = disk is anterior to the condyle so anterior translation is limited & opening is reduced.

Clinical Prediction Rules[133]

Condition	Intervention	Rule Features	Predictability
TMJ arthralgia[133]	Successful treatment	• Onset of pain ≤42 wk • Baseline VAS ≥40 mm • VAS change ≥15 mm at 2-mo follow-up • Disk displacement w/o reduction	=4: (+) LR = 10.8 ≥3: (+) LR = 2.5 ≥2: (+) LR = 3.3

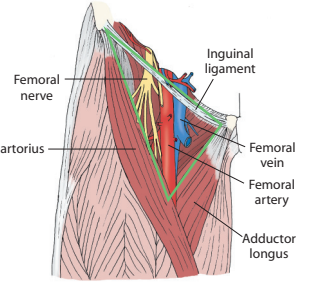
Anatomy[474]





Femoral Triangle[45]

- **Superior border** = inguinal ligament
- **Lateral to medial** = sartorius, femoral nerve, femoral artery, femoral vein, great saphenous vein, pectineus muscle, & adductor longus muscle
- **Piriformis**—find midpoint between PSIS & coccyx, piriformis runs from this point lateral to greater trochanter



Medical Red Flags[177, 178, 493]

- Pain @ McBurney's point = ⅓–½ the distance from Ⓡ ASIS to umbilicus; tenderness = appendicitis
- Blumberg sign = rebound tenderness for visceral pathology—in supine select a site away from the painful area, place your hand perpendicular to the abdomen, & push down deep & slow; lift up quickly; (–) = no pain; (+) = pain on release
- Psoas test for pelvic pathology = supine, SLR to 30° & resist hip flexion; abdominal pain is (+) test for pelvic inflammation or infection in lower quadrant; hip or back pain is (–) test
- Constitutional symptoms
- Enlarged inguinal lymph nodes
- Hip pain in men 18–24 years old of unknown etiology should be screened for testicular CA
- Systemic causes of hip pain
  - Bone tumors
  - Crohn's disease
  - Inflammatory bowel or pelvic inflammatory disease
  - Ankylosing spondylitis
  - Sickle cell anemia
  - Hemophilia
  - Urogenital problems
- Neuromusculoskeletal causes of hip pain
  - LB &/or SI
  - OA or stress fx
  - Hernia
  - Muscle weakness
  - Sprain/strain
  - Labral tear
- Screen for sports hernia
  - Palpation of marble-sized lump along the path of the inguinal ligament
  - Pain with exertion, cough, menstruation
  - Radiating pain into groin, ipsilateral thigh, flank, or lower abdomen
  - Pain with cutting, turning, striding out

Toolbox Tests[286, 287]

Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC)[33, 34]

Instructions: Please rate the activities in each category according to the following scale of difficulty:
0 = none; 1 = slight; 2 = moderate; 3 = very; 4 = extremely

Pain	Walking	
	Stair climbing	
	Rest	
	Weight bearing	
	Nocturnal	
Stiffness	Morning stiffness	
	Stiffness occurring later in the day	
Physical function	Descending stairs	
	Ascending stairs	
	Standing	
	Bending to floor	
	Walking on flat surface	
	Getting in/out of car	
	Going shopping	
	Putting on socks	
	Lying in bed	
	Taking off socks	
	Rising from bed	
	Getting in/out of bath	
	Sitting	
	Getting on/off toilet	
	Heavy domestic duties	
	Light domestic duties	
Total Score:		

Scoring: Summate the scores of each item for the total score. The higher the score, the more severe the disability.

Harris Hip Score[194]

Select the descriptor for each section that best describes your current condition		
Pain—44 possible points		
None or ignores it		44
Slight, occasional, no compromise in activities		40
Mild pain, no effect on average activities, moderate pain with unusual activities, may take aspirin		30
Moderate pain, tolerable but makes concessions, some limitation of ordinary activity, occasional pain medicine stronger than aspirin		20
Marked pain, serious limitation of activity		10
Totally disabled, crippled, pain in bed, bedridden		0
Function/Gait—33 possible points		
Distance walked	Unlimited	11
	4–6 blocks	8
	2–3 blocks	5
	Indoors only	2
	Unable to walk	0
Limp	None	11
	Slight	8
	Moderate	5
	Severe	0
Support	None	11
	Cane for long walks	7
	Cane most of the time	5
	One crutch	3
	Two canes	2
	Two crutches	0
	Unable to walk	0

Continued

Function/Activities—14 possible points		
Stairs	Normally without rail	4
	Normally with rail	2
	In any manner	1
	Unable to do stairs	0
Shoes & socks	With ease	4
	With difficulty	2
	Unable	0
Sitting	Comfortable in ordinary chair 1 hr	5
	On a high chair for 1/2 hr	3
	Unable to sit comfortably	0
Enter public transportation		1

Deformity—4 points for each of the following present	
<30° flexion contracture	
<10° adduction contracture	
<10° abduction contracture	
<3.2 cm leg-length discrepancy	

ROM		
Flexion	0°–45° (1.0 point/degree)	
	+ 0.6 points/degree from 45°–90°	
	+ 0.3 points/degree from 90°–110°	
Abduction	0°–15° (0.8 points/degree)	
	+ 0.3 points/degree from 15°–20°	
ER (in ext)	0°–15° (0.4 points/degree)	
Adduction	0°–15° (0.2 points/degree)	
Total Score:		

Scoring: The higher the total score, the lower the level of disability.

Referral Patterns

Muscle Pain Referral Patterns[488]

Gluteus maximus

Piriformis

Tensor fascia latae

Iliopsoas

Hip Osteokinematics[125, 199, 282, 362]

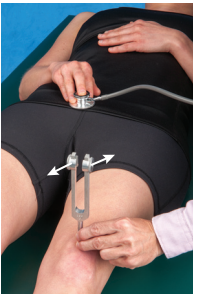
Normal ROM	OPP	CPP	Normal End-feel(s)	Abnormal End-feel(s)
Flexion = 100°–120° Ext = 10°–15° Abduction = 30°–45° IR = 30°–40° ER = 40°–60° SLR = 80°–90°	30° flexion 30° abd & slight ER	max ext, IR, abd	Flexion & Add = elastic or tissue approx SLR = elastic Ext & Abd = elastic/firm IR & ER = elastic/firm	Capsular = IR & Abd; Flex > Ext

Hip Arthrokinematics[282]

Concave surface: acetabulum	To facilitate hip flexion: Femur spins posterior	To facilitate hip extension: Femur spins anterior
Convex surface: femoral head	To facilitate hip abduction: Femur spins lateral & glides medial	To facilitate hip adduction: Femur spins medial & glides lateral
	To facilitate hip IR: Femur rolls medial & glides lateral on pelvis	To facilitate hip ER: Femur rolls lateral & glides medial on pelvis

Hip Tests[524]

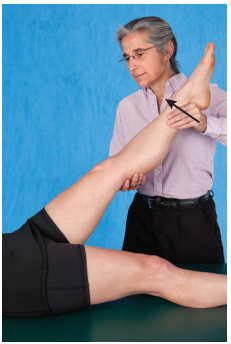
Patella-Pubic Percussion Test[2, 478]



Purpose: Assess for osseous pathology
Position: Supine with stethoscope on pubic symphysis
Technique: Percuss patella or vibrate tuning fork on patella; compare with other leg
Interpretation: (+) test = difference in sound transmission between legs
Statistics: Sensitivity = 94%–96% & specificity = 86%–96%; (+) LR = 6–21 & (–) LR = 0.14–0.70

Sign of the Buttock[66, 180]

Purpose: Assess for hip pathology, neoplasm, abscess
Position: Supine
Technique: Perform passive SLR, note angle of hip flexion that symptoms occur (image left), flex hip/knee & compare angle of hip flexion that symptoms occur with SLR angle (image right)
Interpretation: (+) test = hip flexion angle is not greater than SLR angle
Statistics: Sensitivity = NT & specificity = NT



Thomas Test[59, 85, 90, 393]

Purpose: Assess for tight hip flexors
Position: Supine with lumbar spine stabilized & involved LE extended
Technique: Flex contralateral hip to the abdomen
Interpretation: (+) test = flexion of involved hip or lumbar lordosis indicates tight hip flexors
Statistics: Sensitivity = NT & specificity = NT; Reliability = 0.89–0.92

Ely Test[377, 392]

Purpose: Assess for tight rectus femoris
Position: Side-lying or prone, hip in extension
Technique: Flex knee
Interpretation: (+) test = limited knee flexion with hip extension or inability to maintain hip extension when knee is flexed
Statistics: Sensitivity = NT & specificity = NT; reliability = 0.69

Ober Test[86, 339, 372, 401, 416]

Purpose: Assess for tight ITB
Position: Side-lying with involved hip up
Technique: Extend involved hip & allow LE to drop into adduction
Interpretation: (+) test = LE fails to adduct
Statistics: Sensitivity = NT & specificity = NT; reliability = 0.80–0.97

Piriformis Test[149]

Purpose: Assess for tight piriformis
Position: Supine or contralateral side-lying
Technique: Flex hip to 70°–80° with knee flexed & maximally adduct LE (apply downward force to knee)
Interpretation: (+) test = pain in buttock & sciatica; IR stresses superior fibers; ER stresses inferior fibers
Statistics: Sensitivity = NT & specificity = NT

Trendelenburg Test[47, 429, 489]

Purpose: Assess for weakness of gluteus medius
Position: Standing on involved LE
Technique: Flex contralateral LE; iliac crest on WB side should be lower than NWB side
Interpretation: (+) test = dropping of NWB limb is 2° to abductor weakness (common in epiphyseal problem, Legg-Calvé-Perthes, MD)
Statistics: Sensitivity = 73% & specificity = 77%; (+) LR = 3.15 & (–) LR = 0.335

Log Roll Test[68, 95, 320]

Purpose: Assess for iliofemoral ligament laxity, Legg-Calvé-Perthes, toxic synovitis
Position: Supine with LEs extended
Technique: Roll LE into maximal ER via a medial to lateral force through the thigh
Interpretation: (+) test = excessive ER compared with contralateral LE
Statistics: Kappa = 0.61

Craig Test[1, 106, 314, 433, 453]

Purpose: Assess femoral ante/retroversion
Position: Prone with knee flexed to 90°
Technique: Perform passive IR/ER of hip to find most lateral position of greater trochanter, stabilize lower leg, & measure angle of hip rotation
Interpretation: 15°–25° = normal tibial angle; >25° = femoral anteversion; <15° = femoral retroversion
Statistics: Sensitivity = NT & specificity = NT; reliability = 0.85–0.94

FADIR Test[149, 319, 338]

Purpose: Assess for piriformis problem
Position: Supine
Technique: Passively perform hip flexion, adduction, & IR
Interpretation: (+) test = reproduction of local or referred pain hip
Statistics: Sensitivity = 78%–88% & specificity = 10%–83%; (+) LR = 0.86–5.2 & (–) LR = 0.14–2.3

Dynamic External Rotatory Impingement Test[401]

Purpose: Assess for labral tears & femoroacetabular impingement
Position: Supine
Technique: Passively flex hip to 90° & then take hip through arc of abduction & ER
Interpretation: (+) test = reproduction of pain
Statistics: Sensitivity = NT & specificity = NT

Dynamic Internal Rotatory Impingement Test[401]

Purpose: Assess for labral tears & femoroacetabular impingement
Position: Supine
Technique: Passively flex hip to 90° & then take hip through arc of adduction & IR
Interpretation: (+) test = reproduction of pain
Statistics: Sensitivity = NT & specificity = NT; kappa = 0.58

Anterior Labral Test[150, 360]

Purpose: Assess for labral tear
Position: Supine in hip flexion, abduction, & ER (PNF D2 flexion)
Technique: Resist movement into ext, IR, & add (D2 extension)
Interpretation: (+) test = reproduction of pain or click
Statistics: Sensitivity = 75% & specificity = 43%; (+) LR = 1.32 & (–) LR = 0.58

Posterior Labral Test[150, 360]

Purpose: Assess for labral tear
Position: Supine in hip flexion, adduction, & IR (PNF D1 with IR)
Technique: Resist movement into ext, abduction, & ER (D1 extension with ER)
Interpretation: (+) test = reproduction of pain or click
Statistics: Sensitivity = 75% & specificity = 43%; (+) LR = 1.32 & (–) LR = 0.58

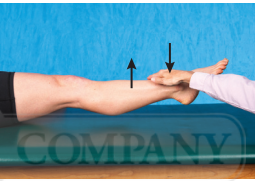
FABER (Patrick) Test[15, 57, 94, 122, 151, 259, 318, 322, 350, 384, 424]

Purpose: Assess hip/SI & labral pathology
Position: Supine, passively flex, abduct, & ER hip (figure-4 position) so that the lateral malleolus of involved LE is on the knee of uninvolved LE
Technique: Apply overpressure to medial aspect of flexed knee
Interpretation: (+) test = hip pain 2° to OA, osteophytes, intracapsular fx, or LBP 2° SI Px; tightness without pain is (–) test; pain experienced assuming this position may indicate a problem with sartorius muscle; labral pathology may be suspected if lateral aspect of knee is >4 cm from the surface & asymmetrical
Statistics: Sensitivity = 41%–77% & specificity = 16%–100%; (+) LR = 0.82 & (–) LR = 0.23–1.94

Scour Test[281, 312, 314, 322, 360]

Purpose: Assess for labral tear
Position: Supine, flex hip to 90°
Technique: IR/ER hip with abd/adduction while applying compressive force down femur
Interpretation: (+) test = clicking, grinding, or pain due to arthritis, acetabular labrum tear, avascular necrosis, or osteochondral defect
Statistics: Sensitivity = 50%–91% & specificity = 29%–75%; (+) LR = 1.32–2.4 & (–) LR = 0.51–0.58; (+) PV = 36% & (–) PV = 42%

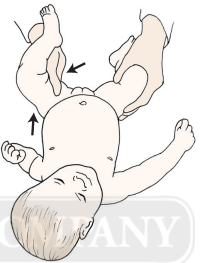
Stinchfield Maneuver[322]



Purpose: Assess for labral tear, SI pathology, or OA
Position: Supine
Technique: Perform active SLR to 30° & clinician resists hip flexion
Interpretation: (+) test = reproduction of pain
Statistics: Sensitivity = 58%–59% & specificity = 29%–32%

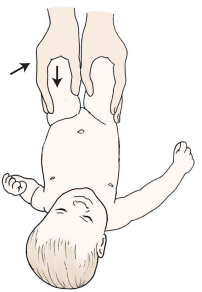
Hip Tests[322]	Sensitivity	Specificity
FABER	41%–77%	16%–100%
Stinchfield	58%–59%	29%–32%
Scour	50%–91%	29%–75%
FABER + Stinchfield	96%	11%–13%
FABER + Stinchfield + Scour	100%	11%–13%

Ortolani Test[31, 382, 470]



(Opposite of Barlow test)
Purpose: Assess for congenital hip dislocation
Position: Supine, fix hips & knees @ 90° of flexion; thumbs are on infant's medial thigh & fingers on lateral thigh
Technique: Firmly apply traction to thigh while gently abducting leg so that femoral head is translated anterior into acetabulum
Interpretation: (+) test = reduction of hip; audible "clunk" may be heard

Barlow Test[31, 470]



(Opposite of Ortolani test)
Purpose: Assess for hip dysplasia
Position: Supine 90/90; thumbs are on infant's medial thigh & fingers are on lateral thigh
Technique: Apply a posterior force through femur as thigh is gently adducted
Interpretation: (+) test = finger that is on greater trochanter detects palpable dislocation

Differential Diagnosis[7, 125, 130, 135, 165, 180, 312, 350, 401, 456, 524]

Pathology/Mechanism	Signs/Symptoms
Osteoid Osteoma[468] Benign tumor found in long bones; etiology unknown	• Vague hip pain @ night • ↑ Pain with activity & ↓ with aspirin • ↓ ROM & quad atrophy • May be apparent on x-ray but confirmed by MRI or CT • R/o trochanteric bursitis, femoral neck stress fx

Hip Dislocation[31, 468]
May result from breech birth, trauma, or when hip is in a weakened state after THR
	• (+) Tests: Ortolani, Barlow, & x-ray
	• *Congenital*
	  • Shortened limb, positioned in flexion & abduction
	• *Posterior traumatic (MVA)*
	  • Groin & lateral hip pain
	  • Shortened limb
	  • Positioned in flexion, adduction & IR
	• *Anterior traumatic (forced abduction)*
	  • Groin pain & tenderness
	  • Anterior/superior = hip in extension & ER
	  • Anterior/inferior = hip in flexion, abduction & ER

Slipped Capital Femoral Epiphysis (Skiffy)[31, 104] Imbalance of growth & hormones that weakens epiphyseal plate; may be 2° ↑ wt gain; occurs in 10–16 yo ♂ 2× > ♀	• Gradual onset of unilateral hip, thigh, & knee pain • ↓ Hip IR; hip positioned in ER • Quadriceps atrophy • Antalgic gait & ↓ limb length • AP x-ray needed to identify widening of physis & ↓ ht of epiphysis; lateral view = epiphyseal displacement • R/o muscle strain, avulsion, & endocrine disorder

Continued

Pathology/Mechanism	Signs/Symptoms
Legg-Calvé-Perthes Syndrome[31, 104, 381, 468] Idiopathic osteonecrosis of capital femoral epiphysis; associated with (+) family history & breech birth Onset occurs over 1–3 months in 4–13 yo; occurs unilaterally; ♂ > ♀	• Hip or groin pain (antalgic gait) • (+) Tests: Trendelenburg & log roll • ↓ ROM (IR & abd); >15° hip flexion contracture • Leg length inequality; thigh atrophy • Bone scan or MRI needed for early detection, x-rays may appear normal for several weeks, 1st sign (~4 wk) is radiolucent crescent image parallel to superior rim of femoral head • R/o JRA & hip inflammation
Avulsion Fracture[104] Injury results from violent muscle contraction	• May hear "pop" • TTP @ apophysis • (+) Tests: Thomas & Ely • CT or MRI if x-ray is inconclusive • R/o slipped capital femoral epiphysis
Apophysitis[104] Pelvic fx 2° strenuous muscle contraction in skeletally immature child	• TTP & weakness with resisted muscle contraction @ ASIS, AIIS, PSIS, PIIS—depending on muscle involved • (+) X-ray for avulsion
Femoral Neck Stress Fracture[104, 478] Gradual onset with history of endurance tasks Beware of eating disorders, amenorrhea, & osteoporosis	• Groin pain with activity • TTP @ greater trochanter • (+) FABER test • May need CT or MRI if x-ray is inconclusive • R/o trochanteric bursitis & osteoid osteoma
Transient Synovitis (Toxic Synovitis, Phantom Hip Disease)[135, 312] Etiology unknown; recent virus, URI, ear infection, or bronchitis; ♂ 2–4× > ♀; 3–10 yo	• Medial thigh/groin pain with movement (infant = pain with diaper change) • Child splints in hip flexion, slight abduction & ER • Awakes with a limp • Hip abduction restricted by pain • Possible low-grade fever • R/o septic hip, slipped capital femoral epiphysis, & Legg-Calvé-Perthes

Continued

Pathology/Mechanism	Signs/Symptoms
Degenerative Joint Disease[86, 94] Usually occurs >55 yo in ♀ > ♂ (3:2)	• Aching pain during WB ≥ groin, medial thigh, & knee • Loss of movement & function • (+) Tests: FABER & Trendelenberg • X-ray reveals narrow joint space, spurring & osteophytes; can r/o fx & necrosis
RA[135, 313] Systemic disorder with bilateral WB symptoms	• Aching pain during WB ≥ groin, medial thigh, & distal knee; loss of movement & function 2° pain • Trendelenburg • (+) Tests: Thomas, Ely, & FABER • X-ray = bilateral demineralization of femoral head; joint space narrowing; migration of femoral head into acetabulum
Myositis Ossificans Calcium deposits ~2–4 wk after thigh contusion	• Localized pain • Limited knee flexion • Palpation of calcific mass
Hip Pointer[135, 313] Can result from direct trauma to iliac crest or ASIS resulting in a contusion	• TTP @ iliac crest/ASIS • Pain with resisted hip flexion & stretching into hip extension • Pain with ambulation & hip abduction • Screen for McBurney's point & rebound tenderness • (–) X-ray; r/o fx & avulsion

Continued

Pathology/Mechanism	Signs/Symptoms
Labral Tear[150] Damage to fibrocartilage via repetitive hip ER or external rotatory force to hip while hyperextended & hyperabducted; highly associated with hip dysplasia; anterior hip pain correlated to weak gluteals & abdominals 2° excessive anterior femoral translation	• Pain with prolonged sitting, getting in/out of a car, putting on shoes/socks, & twisting activities • ↑ Anterior hip pain with hyperext & ER • Pain with resisted SLR (anterior lesion) • Often associated with weak gluteals • ↓ Hip ROM; clicking/catching from flexion to extension • (+) Tests: FABER, impingement, scour, & labral tests • Screen for osteoid osteoma & testicular CA • MRI with contrast is best dx test
Impingement[95, 121] Onset is slow & can be over years; deformity can be of head of femur (cam impingement) or acetabulum (pincer impingement)	• "C sign" = location of pain is identified by gripping lateral hip just proximal to greater trochanter between abducted thumb & index finger • Dull & aching anterior groin pain • Pain may increase with prolonged sitting • Occasional reports of "catching" or sharp pain with activity • Antalgic gait • Decreased hip IR with hip at 90° • (+) tests: DEXRI & DIRI • X-ray, CT, & MRA are helpful

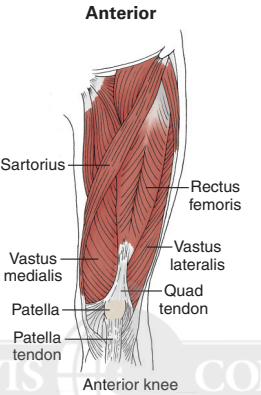
Continued

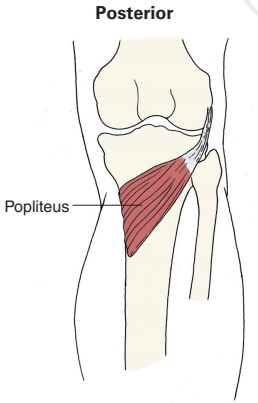
Pathology/Mechanism	Signs/Symptoms
ITB Friction Syndrome[168, 339] Repetitive stress & excessive friction 2° tight ITB, pronation with IR of tibia, genu varum, cycling with cleat in IR Proximal problem = hip syndrome Distal problem = runner's knee	• Pain with downhill running; sense of knee instability • (+) Tests: Ober, Noble, & Renne • Pain @ 30° of knee flexion in WB results in stiff leg ambulation to avoid flexion • TTP over lateral femoral epicondyle • Visible & palpable snapping • (–) X-ray; MRI & US may confirm diagnosis • R/o trochanteric bursitis & osteochondritis
Piriformis Syndrome May result from muscle contracture, trauma, prolonged sitting	• Dull ache in buttocks • Pain ↑ sitting & walking & ↓ in supine • Pain with resisted hip ER & passive IR with adduction • (–) X-ray needed to r/o stress fx; MRI to r/o spine pathology (LS root lesion, spinal stenosis, SI problem)

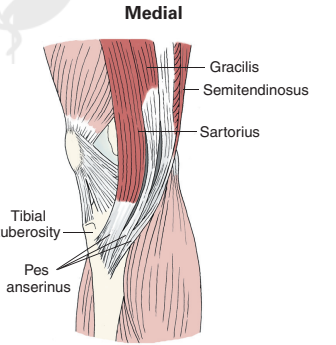
Continued

Pathology/Mechanism	Signs/Symptoms
Iliopsoas Bursitis/Tendonitis Irritation & inflammation 2° overuse or unaccustomed activity	• Pain in medial groin/thigh with hip flexion & extension • Audible snapping when moving from hip flex to ext • Screen for McBurney's point & rebound tenderness • (–) X-ray; r/o avulsion fx • Confirmed by MRI or US
Greater Trochanteric Bursitis[47] Biomechanical or overuse problem; repetitive inside kicks in soccer result in forceful adduction and compression of bursa; contusions	• Deep, aching, diffuse pain from greater trochanter to distal lateral thigh & groin • TTP on ITB & pain when rolling on hip when sleeping • ROM = WNL except abduction may be limited by pain • No snapping but palpable crepitus may be present • (+) Tests: Ober & Patrick/FABER • (–) X-ray (r/o femoral neck stress fx) • MRI & US may confirm diagnosis

Anatomy[474]







Medical Red Flags[9, 107, 177, 178, 258]

- **Night pain** = tumor or infection
- **Cellulitis**
  - Recent hx of skin trauma
  - Pain, swelling, warmth
  - Advancing erythema with reddish streaks
  - Chills, fever, weakness
- DVT risk
  - Immobilization
  - Surgery
  - Fracture or trauma
  - Oral contraceptives
  - CHF, CA, DM
  - Pregnancy
- DVT clinical presentation
  - Leg pain & tenderness
  - ↑ Circumference >1.2 cm
  - Tissue warm & firm to palpation
  - ↑ Pain with BP cuff inflated to 160 mm Hg
  - (+) Homans' sign

Imaging

Ottawa Knee Rule[19, 25, 64, 132, 419, 463, 464, 504]

X-ray series is required only if client presents with any of the following criteria:

- >55 years old
- Isolated tenderness of the patella
- Tenderness of the head of the fibula
- Inability to flex >90°
- Inability to bear weight (4 steps) *both* immediately after injury & in emergency department (regardless of limping)

Statistics: Adults: sensitivity = 98%–100% & specificity = 19%–54%
Children: sensitivity = 92% & specificity = 49%

Toolbox Tests[286, 287]

Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC)[36, 37]

Instructions: Please rate the activities in each category according to the following scale of difficulty:
0 = none; 1 = slight; 2 = moderate; 3 = very; 4 = extremely

Pain	Walking	
	Stair climbing	
	Nocturnal	
	Rest	
	Weight bearing	
Stiffness	Morning stiffness	
	Stiffness occurring later in the day	
Physical function	Descending stairs	
	Ascending stairs	
	Rising from sitting	
	Standing	
	Bending to floor	
	Walking on flat surface	
	Getting in/out of car	
	Going shopping	
	Putting on socks	
	Lying in bed	
	Taking off socks	
	Rising from bed	
	Getting in/out of bath	
	Sitting	
	Getting on/off toilet	
	Heavy domestic duties	
	Light domestic duties	

Total Score:

Scoring: Add the scores of each item for the total score. The higher the score, the more severe the disability.

Lysholm Knee Rating System[306, 471]

Which items best describe your knee function today?		
Limp	None	5
	Slight or periodic	3
	Severe & constant	0
Support	None	5
	Cane or crutch needed	2
	Weight bearing impossible	0
Locking	None	15
	Catching sensation but no locking	10
	Locking occasionally	6
	Locking frequently	2
	Locked joint at examination	0
Instability	Never gives way	25
	Rarely during physical activity	20
	Frequently during physical activity	15
	Occasionally during daily activity	10
	Often during daily activity	5
	Every step	0
Pain	None	25
	Intermittent during strenuous activity	20
	Marked during strenuous activity	15
	Marked with walking >2 km (1.2 miles)	10
	Marked with walking <2 km (1.2 miles)	5
	Constant	0
Swelling	None	10
	After strenuous activities	6
	After ordinary activities	2
	Constant	0

Continued

Stairs	No problem	10
	Slight problem	6
	One step at a time	2
	Impossible	0
Squatting	No problem	5
	Slight problem	4
	Not >90° knee flexion (halfway)	2
	Impossible	0
Total Score:		

Scoring: Add the scores of each category. The higher the score, the greater the functional abilities.

Referral Patterns

Muscle Pain Referral Patterns[488]

Rectus femoris

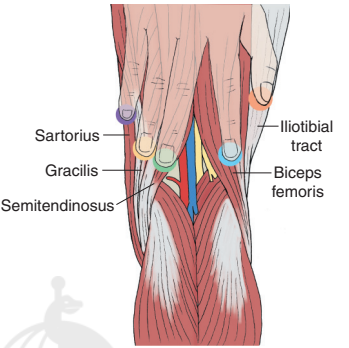
Vasti muscles

Hamstring muscles

Tensor fascia latae

Palpation Pearls[45]

- **Adductor tubercle** = attachment of adductor magnus; start on medial femoral condyle & move proximal between the vastus medialis & hamstring tendons, as the femur dips in, a small point is palpable & often tender
- **Lateral collateral ligament** = cross leg so ankle is on contralateral knee (figure-4 position); LCL is palpable at the joint line just proximal to fibular head (firm, pencil-thickness structure)
- **Common peroneal nerve** = posterior lateral knee between biceps femoris tendon & lateral gastroc muscle belly
- **Popliteus** = "unlocker" of the knee; deep muscle, only the tendon is palpable; follow tibial tuberosity medially around the knee to the posterior aspect & the popliteus tendon is deep to gastroc/soleus
- **Q-angle** = angle created by the intersection of a line from the ASIS to the midpatella & a line from the midpatella to the tibial tuberosity. In supine, normal Q-angle = 13°–18° for ♀ & 10°–15° for ♂; in sitting with knee flexed to 90°, Q-angle = 0°



Knee Osteokinematics[125, 199, 282, 362]

Normal ROM	OPP	CPP	Normal End-feel(s)	Abnormal End-feel(s)
Flexion >130° Rotation = 10°	25° flexion	Maximal extension & tibial ER	Flexion = tissue approximation Extension = elastic/firm SLR = elastic	Springy block = displaced meniscus Boggy = ligamentous pathology

- Femoral condyles begin to contact the patella inferior @ 15°–20° of knee flexion; progresses to middle pole @ 45°, to superior pole @ 90°, & to medial/lateral @ 135° of knee flexion
- Structures attached to medial meniscus = MCL & semimembranosus
- Structures attached to lateral meniscus = PCL & popliteus

Knee Arthrokinematics[282]

Concave surface: Tibial plateau	*To facilitate knee extension:* **OKC** = Tibia rolls & glides anterior on femur	*To facilitate knee flexion:* **OKC** = Tibia rolls & glides posterior on femur
Convex surface: Femoral condyles	**CKC** = Femur rolls anterior & glides posterior on tibia	**CKC** = Femur rolls posterior & glides anterior on tibia

Strength & Function

- Concentric quad-to-hamstring ratio = 5:3 (i.e., hamstrings should be 60%–65% of quads)
- Quad:hamstring ratio should approach 5:4 at the conclusion of ACL rehabilitation
- Quad:hamstring ratio should approach 5:2 at the conclusion of PCL rehabilitation

Knee Tests[317, 484, 526]

Lachman Test[39, 51, 98, 116, 157, 192, 231, 239, 277, 297, 301, 340, 351, 387, 429, 433, 486]

Purpose: Assess for ACL laxity (specifically anterior-medial bundle)
Position: Supine with knee in 0°–30° of flexion (hamstrings relaxed)
Technique: Stabilize distal femur & translate proximal tibia forward on femur
Interpretation: (+) test = >5 mm of displacement or a mushy, soft end-feel; beware of false (–) test due to hamstring guarding, hemarthrosis, posterior medial meniscus tear
Statistics: Sensitivity = 63%–99% & specificity = 42%–100%; (+) LR = 1.12–27.3 & (–) LR = 0.04–0.83

Prone Lachman Test[39, 317, 413]

Purpose: Assess for ACL laxity
Position: Prone with knee flexed to 30°, LE supported & hamstrings relaxed
Technique: Palpate anterior aspect of knee while imparting an anterior force to posterior-proximal aspect of tibia
Interpretation: (+) test = >5 mm of displacement or a mushy, soft end-feel
Beware of false (–) test due to hamstring guarding, hemarthrosis, posterior medial meniscus tear
Statistics: Sensitivity = 70%–82% & specificity = 88%–97%; (+) LR = 6.83–20.17 & (–) LR = 0.20–0.32; (+) PV = 94% & (–) PV = 80%

Anterior Drawer Test[39, 51, 85, 192, 231, 239, 277, 301, 317, 351, 428, 432, 484]

Purpose: Assess for ACL laxity (specifically the anterior-medial bundle)
Position: Supine with foot stabilized on table, knee flexed to 80°–90° & hamstrings relaxed
Technique: Translate proximal tibia anterior on the femur
Interpretation: (+) test = >5 mm of anterior displacement; snap or palpable jerk with anterior drawer indicates meniscus Px
Beware: Translation may appear excessive with PCL injury if tibia starts from a more posterior position
Statistics: Sensitivity = 22%–95% & specificity = 78%–97%; (+) LR = 1.2–87.9 & (–) LR = 0.09–0.62

ACL Symptoms	Sensitivity	Specificity
Anterior drawer test	22%–95%	78%–97%
Anterior drawer test combined with 2 of 3 symptoms: effusion, popping, giving way	63%	85%
Anterior drawer test combined with 3 of 3 symptoms: effusion, popping, giving way	16%	99%

Pivot Shift (MacIntosh) Test[24, 39, 51, 192, 239, 277, 299, 351, 383, 395, 484]

Purpose: Assess for ACL laxity (specifically posterior-lateral bundle)
Position: Supine with knee extended
Technique: Grasp ankle & maintain IR of tibia; *slowly* flex (reduction) & then extend (subluxation) the knee with a valgus stress
Interpretation: (+) test = anterior translation ("giving way") of subluxed tibial plateau occurs between 40° & 20° of flexion as ITB switches from a flexor to an extensor
Statistics: Sensitivity = 18%–98% & specificity = 97%–99%; (+) LR = 4–41 & (–) LR = 0.18–0.90
Note: Test is not reliable if ITB or meniscus is torn

Dynamic Valgus (Drop Jump) Test[130]

Purpose: Assess for risk of ACL injury
Position: Standing on a low stool
Technique: Client steps off stool & lands on both feet simultaneously
Interpretation: (+) test = valgus moment occurs at the knees on landing
Statistics: Sensitivity = 67%–87% & specificity = 60%–72%

Posterior Drawer Test[28, 85, 110, 145, 298, 317, 447, 449]

Purpose: Assess for PCL laxity
Position: Supine with knee flexed to 90° & foot on table
Technique: Translate proximal tibia posteriorly on distal femur
Interpretation: (+) test = >5 mm of posterior displacement
Statistics: Sensitivity = 25%–90% & specificity = 99%; (+) LR = 90 & (–) LR = 0.10

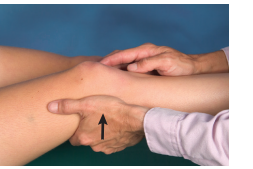
Sag (Godfrey) Test[156, 298, 317, 457]

Purpose: Assess for PCL laxity
Position: Supine 90/90, support LEs
Technique: Compare the level of the tibial tuberosities
Interpretation: (+) test = posterior displacement of tibial tuberosity is greater in the involved leg
Statistics: Sensitivity = 46%–100% & specificity = 100%

Varus Test[116, 193, 317, 526]

Purpose: Assess for LCL laxity
Position: Supine; knee in full extension & then repeat @ 30° flexion
Technique: Cup knee with heel of the hand @ medial joint line; use fingers of other hand to palpate lateral joint line; apply varus stress to knee through palm of medial hand & forearm/elbow of lateral hand
Interpretation: (+) test = pain or excessive gapping of joint compared with contralateral side
Statistics: Sensitivity = 25% & specificity = NT

Valgus Test[116, 167, 193, 226, 238, 267, 317, 526]



Purpose: Assess for MCL laxity
Position: Supine; knee in full extension & then repeat @ 30° flexion
Technique: Cup knee with heel of the hand @ lateral joint line; use fingers of other hand to palpate medial joint line; apply valgus stress to knee through palm of lateral hand & forearm/elbow of medial hand
Interpretation: (+) test = pain or excessive gapping of joint compared with contralateral side
Statistics: Pain: sensitivity = 78% & specificity = 67%; (+) LR = 2.3 & (–) LR = 0.3; laxity: sensitivity = 86%–96% & specificity = 49%; (+) LR = 1.8 & (–) LR = 0.2

Apley Test[201, 236, 344]

Purpose: Assess meniscus (nonspecific for location of meniscal tear)
Position: Prone, knee flexed to 90°; grasp foot & calcaneus
Technique: While applying a downward force through the heel, rotate the tibia internally & externally
Interpretation: (+) test = pain, popping, snapping, locking, crepitus
Statistics: Sensitivity = 16%–61% & specificity = 70%–88%; (+) LR = 1.8–2.0 & (–) LR = 0.56–0.89

McMurray Test[6, 51, 101, 133, 155, 236, 253, 332, 447, 465]

Purpose: Assess meniscus
Position: Supine, with 1 hand to the side of the patella & the other grasping the distal tibia
Technique: From a position of maximal flexion, extend knee with IR of the tibia & varus stress then return to maximal flexion & extend knee with ER of the tibia & valgus stress
Interpretation: (+) test = pain or snapping/clicking with IR incriminates lateral meniscus & ER incriminates medial meniscus; if pain, snapping, or clicking occurs with the knee in flexion, the posterior horn of the meniscus is involved, & if pain, snapping, or clicking occurs with increasing amounts of knee extension, the anterior meniscus is involved
Statistics: Sensitivity = 16%–95% & specificity = 25%–98%; (+) LR = 0.39–8.0 & (–) LR = 0.83–2.84

Thessaly Test[195, 236, 260, 349, 403]

Purpose: Assess for meniscal tears
Position: Standing on involved LE with the knee flexed @ 5°
Technique: Hold client's outstretched arms & rotate internally then externally 3×; repeat @ 20° of knee flexion
Interpretation: (+) test = Client experiences locking or catching
Statistics: At 5°: sensitivity = 66%–81% & specificity = 91%–96%; (+) LR = 6.8–16.5 & (–) LR = 0.21–0.76; at 20°: sensitivity = 89%–92% & specificity = 96%–97%; (+) LR = 23–39 & (–) LR = 0.08–0.11

KKU Test[435]

Purpose: Assess for meniscal tears
Position: Supine, palpate knee joint line
Technique: Grasp ankle & apply axial compression to knee while rotating tibia at 120°, 90°, 60°, 30°, 0° of knee flexion
Interpretation: (+) test = pain, clicking, locking
Statistics: Sensitivity = 86% & specificity = 88%

Steinmann Test[44, 403]

Purpose: Assess for meniscal tears
Position: Supine with hip/knee flexed; stabilize thigh & grasp ankle
Technique: Apply IR/ER of the tibia at various angles of knee flexion
Interpretation: (+) test = pain at knee joint line
Statistics: Sensitivity = 27%–29% & specificity = 100%

Ege Test[6]

Purpose: Assess for meniscal tears
Position: Standing with feet shoulder width apart
Technique: Squat with hip ER, repeat with hip IR
Interpretation: (+) test = pain (ER = medial meniscus; IR = lateral meniscus)
Statistics: Medial: sensitivity = 67% & specificity = 81%; (+) LR = 3.5 & (–) LR = 0.41; lateral: sensitivity = 64% & specificity = 90%; (+) LR = 6.4 & (–) LR = 0.4

Childress Duck Walking Test[367, 404]

Purpose: Assess for meniscal tears
Position: Squatting
Technique: Simulate a duck walk
Interpretation: (+) test = pain, clicking, locking
Statistics: Sensitivity = 55%–68% & specificity = 60%–67%; (+) LR = 1.7 & (–) LR = 0.53–0.67

Patella Apprehension (Fairbank) Test[138, 187, 219, 364, 365]

Purpose: Assess for subluxing patella
Position: Supine or seated, 30° knee flexion, quads relaxed
Technique: Clinician carefully pushes patella laterally
Interpretation: (+) test = Client feels patella about to dislocate & contracts quads to keep this from happening
Statistics: Sensitivity = 32%–39% & specificity = 86%

Moving Patella Apprehension Test[4, 187]

Purpose: Assess for excessive patella mobility
Position: Sitting
Technique: Place thumb on medial patella border & apply a lateral force while passively flexing & extending the knee
Interpretation: (+) test = apprehension with flexion & free motion without apprehension with extension
Statistics: Under anesthesia: sensitivity = 100% & specificity = 88%; (+) LR = 8.3 & (–) LR = 0

Patella Tilt Test

Purpose: Assess for ITB tightness/patella mobility
Position: Relaxed in supine with knee in extension
Technique: Attempt to lift lateral border of patella
Interpretation: (+) test = inability to lift the lateral border of the patella above the horizontal
Statistics: Sensitivity = NT & specificity = NT

Noble Test[168, 366]

Purpose: Assess ITB irritation
Position: Supine, start @ 90/90
Technique: Apply pressure over lateral femoral condyle while extending knee
Interpretation: (+) test = pain or clicking @ lateral femoral condyle @ 30° of knee flexion
Statistics: Sensitivity = NT & specificity = NT

Renne Test[312]

Purpose: Assess ITB irritation
Position: Standing
Technique: Apply pressure over lateral femoral condyle with AROM of the knee
Interpretation: (+) test = pain or clicking @ lateral femoral condyle @ 30° of knee flexion
Statistics: Sensitivity = NT & specificity = NT

Ober Test[339, 372, 416]

Purpose: Assess for tight ITB
Position: Side-lying with involved hip up
Technique: Extend hip & allow LE to drop into adduction
Interpretation: (+) test = LE fails to adduct past anatomical neutral
Statistics: Sensitivity = NT & specificity = NT

Stutter Test[453]

Purpose: Assess for medial plica irritation
Position: Sitting with knee flexed over the edge of the table
Technique: Slowly extend knee with a finger placed lightly in contact with the center of the patella
Interpretation: (+) test = patella stutters as knee moves into extension
Statistics: Sensitivity = NT & specificity = NT

Patellar Bowstring Test

Purpose: Assess medial plica
Position: Supine
Technique: Medially displace patella while flexing/extending knee with tibia IR
Interpretation: (+) test = palpable clunk
Statistics: Sensitivity = NT & specificity = NT

Wilson Test

Purpose: Assess for osteochondritis of medial femoral condyle
Position: Supine with knee flexed to 90°
Technique: Extend the knee with IR of tibia
Interpretation: (+) test = pain at 30° of flexion in IR that ↓ if tibia is ER; should r/o meniscal Px
Statistics: Sensitivity = NT & specificity = NT

Differential Diagnosis[72, 125, 130, 135, 138, 165, 192, 193, 312, 456]

Pathology/Mechanism	Signs/Symptoms
Patella Fracture[104] Results from direct trauma	• Pain & "dome" effusion • Palpable defect • Unable to extend knee • Confirmed with x-ray
Patella Subluxation[104, 219, 466] Predisposing factors include excessive tibial ER, pronation, patella alta, tight lateral retinaculum, weak hip ER, small medial patella facet; most common in adolescent girls with genu valgum (↑ Q-angle & femoral rotation)	• Effusion shuts down VMO • (+) Tests: Patella tilt & patella apprehension • Tenderness along medial patella border • Sitting @ 90/90, patella points lateral & superior (grasshopper eyes) • Client c/o knee giving way or clicking when cutting away from affected leg • ↑ Q-angle • X-ray may reveal osteochondral fragments or fx; multiple views are needed to evaluate all articular surfaces

Continued

Pathology/Mechanism	Signs/Symptoms
Osgood-Schlatter Disease[468] Tibial apophysitis that may occur from growth of femur resulting in avulsion of proximal tibial physis; may have genetic predisposition; 8–15 yo ♂ > ♀	• Intermittent aching pain at tibial tubercle & distal patellar tendon • Enlarged tibial tuberosity • Tight quads & hamstrings resulting in ↓ AROM • Effusion results in knee extensor lag • (+) Ely test • (+) X-ray for avulsion of tibial tuberosity (lateral view) • R/o avascular necrosis
Sinding-Larsen Johansson[468] Results from traction force on patella tendon 2° chronic extensor overload; 10–14 yo ♂	• Anterior knee pain & TTP at distal pole of patella with knee extension • Antalgic gait • ↓ Knee ROM • X-ray (lateral view) = fragmentation of inferior patella pole
Myositis Ossificans Calcification in a muscle due to trauma, painful hematomas develop rapidly & calcification occurs in 2–3 wk; may be neurogenic after SCI or TBI	• Warm & TTP over involved site • ↓ ROM • Pain with contraction of involved muscle • Confirmed with x-ray after 2–3 wk; earlier with MRI
Heterotopic Ossification Ossification between rather than within strained muscle fibers resulting from direct trauma	• ↓ ROM • Weakness of involved muscle • TTP, swelling, & hyperemia • Confirmed with x-ray after 2–3 wk; earlier with MRI
Osteochondritis Dissecans[104] Lesions of subchondral bone of insidious onset, trauma, or pre-existing abnormalities of epiphyses; most common in 10–18 yo; ♂ > ♀	• Knee effusion • Crepitus with knee flexion/extension • Poorly localized knee pain • Antalgic gait • (+) Wilson test • May have TTP over medial femoral condyle with knee flexion • X-ray may not help; need MRI or bone scan

Continued

Pathology/Mechanism	Signs/Symptoms
DJD[85, 94] Result of aging, poor biomechanics, or repetitive trauma	• Joint line crepitus • ↓ Terminal knee extension 2° to edema (quad inhibition) • ↓ Stance time during gait • "Gelling" phenomenon = ↑ viscosity of synovial fluid 2° to inflammation • Stiffness with immobility • X-ray = ↓ joint space, spurs, osteophytes
Chondromalacia (patellofemoral syndrome [PFS])[187, 364, 365, 400] Softening of patella articular cartilage 2° poor biomechanical alignment, tracking, &/or weak hip ER	• Anterior knee pain; pain with stairs; crepitus • VMO atrophy; weak hip ER • ↑ Knee valgus, ↑ Q-angle • (+) Tests: theatre sign, Clarke, & Fairbank apprehension • Confirmed via MRI
Jumper's Knee Patella tendonitis (common in skeletally immature) 2° traction overuse injury such as jumping, kicking, running, or microtrauma	• TTP at patella tendon insertion & pain with resisted knee extension • Localized crepitus & swelling • ↑ Q-angle • R/o Osgood-Schlatter, SLJ, & bursitis • Confirmed with MRI
Plica Syndrome Injury results from direct trauma or a significant ↑ in unaccustomed activity (presence of medial plica is more common than lateral plica)	• Pain over medial femoral condyle; palpable cords along medial condyle, pain at superomedial joint line • Clicking/snapping, locking, "giving way" • Full ROM, pain @ end range flexion • False (+) McMurray (pseudolocking) • (+) Tests: stutter, plica, theatre sign, & bowstring • R/o patellofemoral tracking Px • X-ray is not helpful, MRI is only non-invasive procedure that shows plica • Arthroscopy may reveal avascular fibrotic edge of the plica

Continued

Pathology/Mechanism	Signs/Symptoms
Shin Splints/Anterior Overuse syndrome of tibialis anterior, extensor hallucis longus, & extensor digitorum longus attributed to running on unconditioned legs, soft tissue imbalance, alignment abnormalities, & excessive pronation with rearfoot varus	• Pain & tenderness over anterior tibialis • Pain with resisted dorsiflexion & inversion • Pain with stretching into plantar flexion & eversion • Callus formation under 2nd metatarsal head & medial side of distal hallux • Tight gastroc/soleus • Soreness with heel walking • (–) X-ray, r/o stress fx
Shin Splints/Posterior Overuse syndrome of flexor hallucis longus & flexor digitorum longus; rapid & excessive pronation to compensate for rearfoot varus; result is stress on tibialis posterior to decelerate pronation	• Callus formation under 2nd > 3rd > 4th MT head & medial side of distal hallux • Pain & soreness over distal ⅓–⅔ of posterior/medial shin & posterior medial malleolus • Hypermobile 1st MTP • Pain with resisted inversion & plantar flexion • Pain with passive dorsiflexion & eversion • (–) X-ray, r/o stress fx
Compartment Syndrome Progression of shin splints resulting in loss of microcirculation in shin muscle; ♂ > ♀, R > L Beware: This is an emergency situation	• ↑ Tissue pressures via fluid accumulation • Ischemia of extensor hallucis longus • Skin feels warm & firm • Pain with stretch or AROM; footdrop • Most reliable sign is sensory deficit of the dorsum of foot in 1st interdigital cleft • Pulses are normal until the end & then surgery within 4–6 hr is required to prevent muscle necrosis & nerve damage • Confirmed with MRI & pressure test

Continued

Pathology/Mechanism	Signs/Symptoms
Popliteus Tendonitis Results from overuse, downhill running, activities with sudden stops	• Posterior lateral knee pain at the end of a workout or running downhill (just posterior to LCL) • Crepitus over tendon • Discomfort sitting with legs crossed & with resisted flexion from full extension • MRI may be helpful; r/o ITB, biceps tendonitis
ITB Friction Syndrome[168, 339, 366] Repetitive stress & excessive friction 2° tight ITB, pronation with IR of tibia, genu varum, cycling with cleat in IR Proximal Px = hip syndrome Distal Px = runner's knee	• Pain with downhill running • Pain @ 30° of knee flexion in WB results in ambulating stiff legged to avoid flexion • TTP over lateral femoral condyle • (+) Tests: Ober, Noble, & Renne • (–) X-ray • R/o trochanteric bursitis & osteochondritis • MRI & US may confirm diagnosis
Baker's Cyst Defect in posterior capsule that is influenced by chronic irritation or meniscus tear	• Golf ball–size swelling at semimembranosus tendon or medial gastroc muscle belly; best palpated in full knee extension • Stiff & tender with limited knee ROM • MRI may be helpful; r/o DVT & tumor
Bursitis Mechanical irritation • Prepatella = common in sport = falling on knee or maintaining quadruped position (housemaid's knee) • Infrapatella = clergyman bursitis = kneeling (mechanical irritation) • Pes anserine = prevalent in long-distance running or middle-aged women with OA of knee	• Localized radiating heat • Localized egg-shaped swelling • Radiating pain 2–4 cm below involved bursa • Crepitus • Discomfort with AROM & PROM • Diagnosis confirmed with MRI

Continued

Pathology/Mechanism	Signs/Symptoms
LCL Sprain Injury results from varus stress resulting in overstretching or tearing of LCL	• Warm & swollen lateral knee • TTP @ knee joint line (palpate in figure-4 position) • ROM may not be effected • (+) Varus stress test • Confirmed with MRI or arthrogram with contrast • (–) X-ray, r/o avulsion or epiphyseal plate injury; varus stress film may show ↑ joint gapping
MCL Sprain[167, 226, 238, 267] Injury results from valgus stress resulting in overstretching or tearing of MCL	• Flexion limited to 90° & knee extension lag present • If deep fibers are torn, knee joint rapidly fills with blood • (+) Valgus stress test • TTP @ knee joint line (possible palpable defect) • Confirmed with MRI or arthrogram with contrast • (–) X-ray, r/o avulsion or epiphyseal plate injury; valgus stress film may show ↑ joint gapping
ACL Sprain[39, 51, 276, 301] Injury results from twisting while changing directions, deceleration with valgus & ER, hyperflexion of the knee with foot in plantar flexion	• Audible pop, immediate swelling (<2 hr) • Intense pain at posterior lateral tibia • Unstable in WB • (+) Tests: anterior drawer, Lachman, & pivot shift • KT1000 anterior displacement >5 mm • (–) X-ray (except for avulsion); MRI is study of choice • Bloody arthrocentesis

Continued

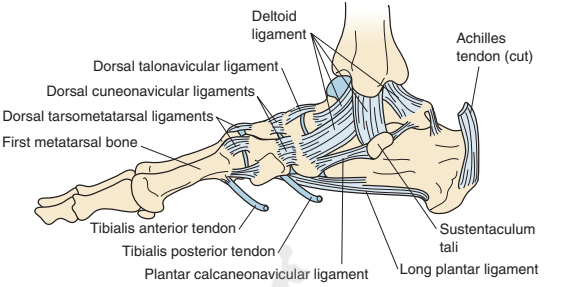
Pathology/Mechanism	Signs/Symptoms
PCL Sprain[51, 110, 298, 430] Injury results from dashboard blow to anterior shin with knee flexed @ 90° or falling on knee with foot plantar flexed	• Minimal swelling; ecchymosis may appear days later • Tenderness in popliteal fossa & pain with kneeling • Client may be able to continue to play • (+) Tests: posterior drawer, posterior Lachman, & SAG/dropback/Godfrey • (–) X-ray (except for avulsion); MRI is study of choice • Bloody arthrocentesis
Meniscus Tear[44, 51, 116, 155, 201, 260, 332, 344, 367, 403, 447] Injured via rotatory forces while WB or knee hyperextension; medial femoral/lateral tibial rotation injures medial meniscus & lateral femoral/medial tibial rotation injures lateral meniscus *Common types of tears:* Children = longitudinal & peripheral tear Teenagers = bucket handle tear	• (–) Varus/valgus stress • Pain @ end range flexion/extension & WB • Gradual swelling over 1–3 days; ecchymosis • Joint line tenderness • (+) Tests: McMurray & Apley (unreliable in children) • Anterior horn locks in extension, posterior in flexion, medial in 10°–30° of flexion, lateral >70° of flexion • X-ray may r/o fx, tumor, osseous loose bodies • MRI may reveal pseudotear; confirm with arthrogram using contrast

Clinical Prediction Rules[324, 455]

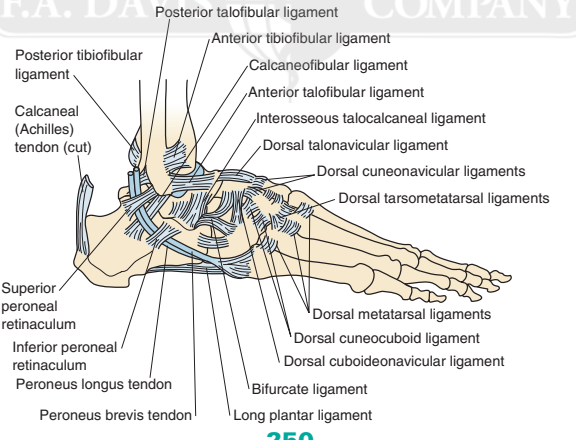
Condition	Intervention	Rule Features	Predictability
Patellofemoral pain[224]	Lumbopelvic manipulation	• Navicular drop >3 mm • Difference in hip IR of >14° • No reports of stiffness after sitting >20 min • Ankle d-flexion >16° (knee flexed) • Squatting = 1° painful task	≥4: (+) LR = infinite ≥3: (+) LR = 18.4 ≥2: (+) LR = 2.1 ≥1: (+) LR = 1.1
Patellofemoral pain[279]	Patellar taping	• Tibial varum >5° • (+) Patellar tilt test	≥1: (+) LR = 4.4
OA knee pain[109]	Hip mobilization	• Pain with hip distraction • Passive knee flexion <122° • Passive hip IR <17° • Pain/paresthesis in hip/groin • Anterior thigh pain	≥2: (+) LR = 12.9 =1: (+) LR = 5.1

Anatomy[474]

Medial view of ankle ligaments



Lateral view of ankle ligaments



Medical Red Flags[177, 178]

- **Paresthesia**—stocking distribution, associated with:
  - DM
  - Lead/mercury poison
- Gout
  - Swelling & TTP @ 1st MTP or ankle
  - Pain with AROM & PROM of foot &/or ankle
  - Hypersensitive to touch
- Lyme disease
  - "Bull's eye" rash (expanding red rings)
  - Flu-like symptoms
- **Bilateral ankle edema** with ↑ BP with hx of NSAID use may be the result of renal vasoconstriction

Complex Regional Pain Syndrome

Stage 1	• Burning, aching, tenderness, joint stiffness • Swelling, temperature changes • ↑ Nail growth & ↑ hair on foot/feet
Stage 2	• ↑ Pain, swelling, joint stiffness • Pain becomes less localized • Change in skin color & texture
Stage 3	• Pain radiates all the way up leg • ↓ Nerve conduction velocity • Muscle atrophy

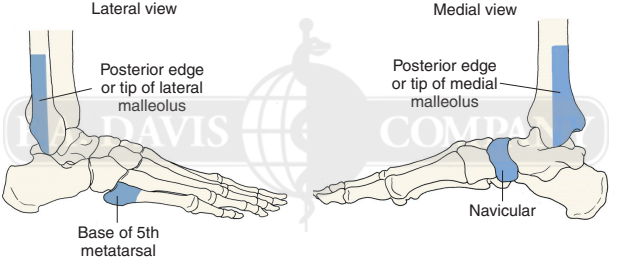
Imaging[20, 104, 461]

Ottawa Ankle Rules[19, 460, 462]

Radiographic series of the ankle is required only if one of the following are present:

- Bone tenderness at posterior edge of distal 6 cm of medial malleolus
- Bone tenderness at posterior edge of distal 6 cm of lateral malleolus
- Totally unable to bear weight *both* immediately after injury & (for 4 steps) in the emergency department

Statistics: Adults: sensitivity = 95%–100% & specificity = 16%
Children: sensitivity = 83%–100% & specificity = 21%–50%



Ottawa Foot Rules[19, 462]

Radiographic series of the foot is required only if one of the following are present:

- Bone tenderness at navicular
- Bone tenderness at the base of 5th MT
- Totally unable to bear weight *both* immediately after injury & (for 4 steps) in the emergency department

Statistics: Adults: sensitivity = 93%–100% & specificity = 12%–21%
Children: sensitivity = 100% & specificity = 36%

Toolbox Tests[286, 287]

Performance Test Protocol & Scoring Scale for Evaluation of Ankle Injuries

Subjective Assessment of Injured Ankle		Can You Walk Normally?	
No symptoms	15	Yes	15
Mild symptoms	10		
Moderate symptoms	5	No	0
Severe symptoms	0		
Can You Run Normally?		**Climb Down Stairs? (2 flights ~ 44 steps)**	
Yes	15	<18 seconds	10
No	0	18–20 seconds	5
		>20 seconds	0
Rising on Heels with Injured Leg		**Rising on Toes with Injured Leg**	
>40 seconds	10	>40 seconds	10
30–39 seconds	5	30–39 seconds	5
<30 seconds	0	<30 seconds	0
Single-limbed Stance with Injured Leg		**Laxity of Ankle Joints**	
>55 seconds	10	Stable (5 mm)	10
50–54 seconds	5	Moderate laxity (6–10 mm)	5
<50 seconds	0	Severe laxity (>10 mm)	0
Injured Leg Dorsiflexion ROM		**TOTAL SCORE:**	
>10°	10		
5°–9°	5		
<5°	0		

Scoring: Add all scores
Excellent = 85–100; Good = 70–80; Fair = 55–65; Poor ≤50

Foot Function Index[63]

Mark the horizontal lines below to address each task.

How severe is your foot pain?	No pain	Worst pain imaginable
At its worst		
In the morning		
Walking barefoot		
Standing barefoot		
Walking with shoes		
Standing with shoes		
Walking in orthotics		
Standing in orthotics		
End of the day		

How much difficulty do you have:	No difficulty	So difficult unable to
Walking in house		
Walking outside		
Walking 4 blocks		
Climbing stairs		

Continued

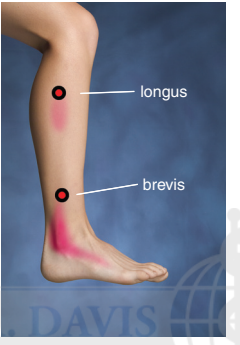
How much difficulty do you have:	No difficulty									So difficult unable to
Descending stairs										
Standing tiptoe										
Getting out of a chair										
Climbing curbs										
Walking fast										
Because of your feet, how much of the time do you:	**None**									**All**
Stay inside all day										
Stay in bed all day										
Limit activities										
Use assistive device indoors										
Use assistive device outdoors										
Total Score:										

Scoring: Add all scores, exclude items that are not applicable, & multiply by 100.
The higher the number is, the greater the impairment.

Referral Patterns[488]

Muscle Pain Referral Patterns

Peroneus longus & brevis



Peroneus (fibularis) tertius

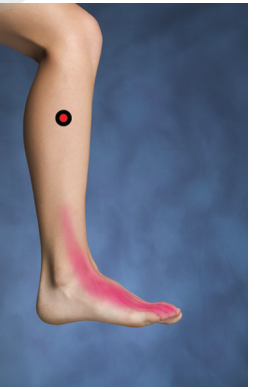
Tibialis anterior

Flexor hallucis longus

Flexor digitorum longus

Extensor digitorum longus

Extensor hallucis longus



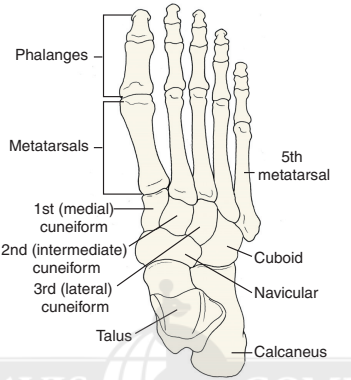
Visual Inspection

- Hammertoe = hyperextension of MTP & DIP with PIP flexion of toes 2, 3, 4, 5; associated with hallux valgus; pain is worse with shoes on; corns present
- Hallux valgus = 1st MTP >20° valgus angle; 1st & 2nd toe overlap
- Index plus foot = 1st MT > 2nd > 3rd > 4th > 5th
- Index plus-minus foot = 1st MT = 2nd > 3rd > 4th > 5th
- Index minus foot = 1st MT < 2nd > 3rd > 4th > 5th
- Subtalar neutral = in the prone position with the forefoot passively dorsiflexed & pronated, it is the position in which the head of the talus can be palpated; thought to be equally spaced from the navicular

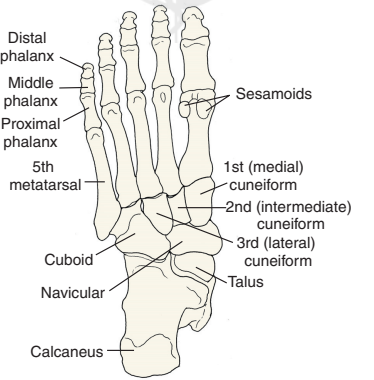
Palpation Pearls[45]

- **Dorsalis pedis artery** = on top of foot between 1st & 2nd metatarsals
- **Sustentaculum tali** = small ledge just distal to medial malleolus
- **Peroneal tubercle** = small prominence ~1 ≤ distal to lateral malleolus
- **Plantaris** = with knee flexed, palpate medial to posterior aspect of fibula head, roll over lateral gastroc head, & move slightly proximal; palpate for a 1≤-wide muscle that runs on an angle from proximal/lateral to distal/medial
- **Tibialis anterior** = follow down lateral tibial shaft to medial aspect of the medial cuneiform
- **Extensor digitorum longus** = while extending the toes, follow the 4 prominent tendons proximal to the ankle—the tendons dive under the extensor retinaculum & emerge proximally as a thicker mass—follow the muscle belly along the tibia between the tibialis anterior and the peroneals (fibularis)

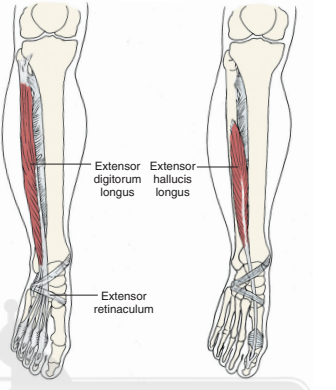
Superior view



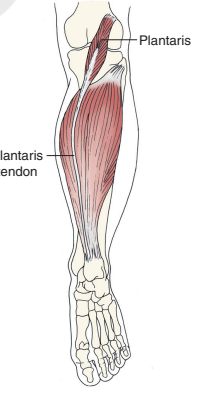
Inferior view



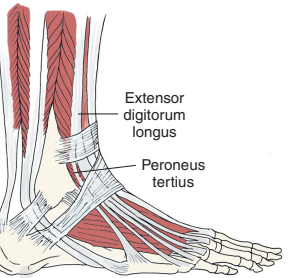
Extensor digitorum & ext hallucis



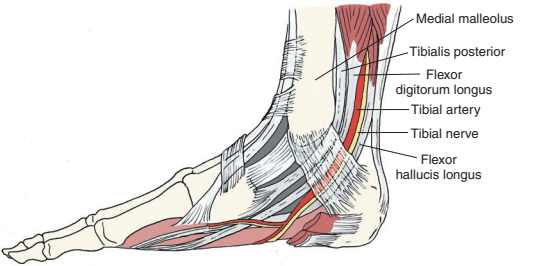
Plantaris



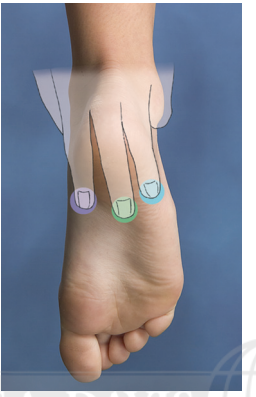
Lateral ankle structures

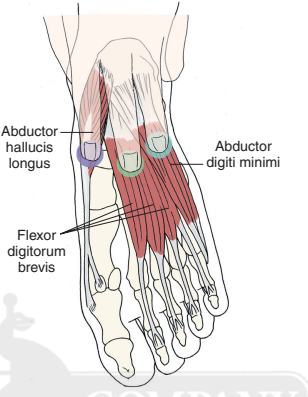


Medial ankle structures



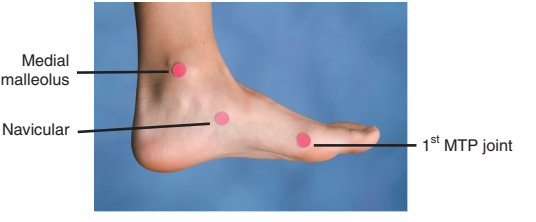
Plantar surface of the foot





Feiss Line[312]

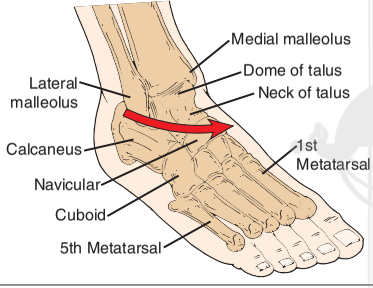
In NWB, a line is constructed to connect the apex of the medial malleolus to the head of the 1st MTP joint. The navicular bone should be in line with these 2 structures. In the standing (WB) position, the navicular should not drop more than ⅔ the distance to the floor.



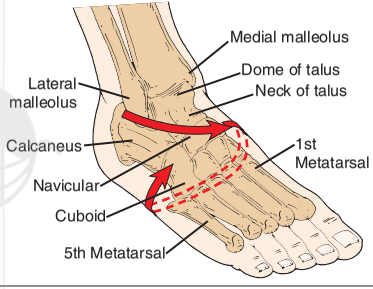
Girth Assessment

Figure-8 Method to Assess Ankle Edema

1. Start distal to lateral malleolus; go medial, just distal to navicular tuberosity



2. Under the arch to proximal aspect of the head of the 5th metatarsal

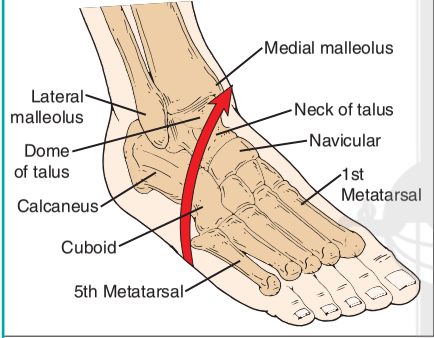


Source: From Gulick, D. Sport Notes: Field & Clinical Examination Guide. FA Davis, Philadelphia, 2008, p 169.

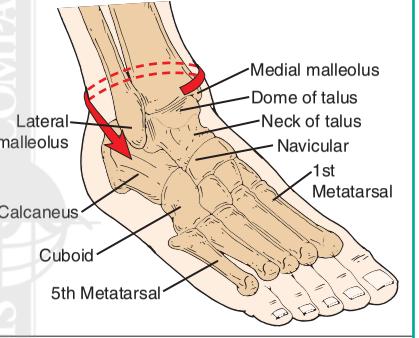
Continued

Figure-8 Method to Assess Ankle Edema—*cont'd*

3. Across anterior tibialis tendon to distal aspect of medial malleolus



4. Over Achilles tendon back to lateral malleolus



Source: From Gulick, D. 2008, p 170.

Ankle & Foot Osteokinematics[125, 199, 282, 312, 362]

Normal ROM		OPP	CPP	Normal End-feel(s)	Abnormal End-feel(s)
Plantar flexion 30°–50° Dorsiflexion 20° Inversion 10°–30° Eversion 10°–20°		10° PF & mid-way between inversion & eversion	Maximal DF	Elastic (tissue stretch) for all planes	Empty = sprain/ strain
1st MTP	Extension 70°–75°	5°–10° extension	Maximal extension	Flex/ext = capsular/ elastic Abd/add = ligamentous	Capsular Empty
	Flexion 35°–45°				
2nd–5th MTP	Extension 35°–40°	5°–10° extension	Maximal extension	Flex/ext = capsular/ elastic Abd/add = ligamentous	Capsular Empty
	Flexion 35°–40°				
1st IP	Extension 0°	10° extension	Maximal extension	Flex/ext = firm/ elastic	Empty
	Flexion 90°				
2nd–5th PIP	Extension 0°	Slight flexion	Maximal extension	Flex/ext = firm/ elastic	Empty
	Flexion 35°				
2nd–5th DIP	Extension 0°	Slight flexion	Maximal extension	Flex/ext = firm/ elastic	Empty
	Flexion 60°				

Ankle & Foot Arthrokinematics[282]

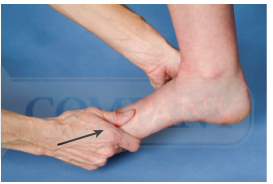
Ankle flexion & extension	**Concave surface:** Distal tibia/fibula **Convex surface:** Talus	*To facilitate ankle dorsiflexion:* **OKC**—talus rolls anterior & glides posterior on tibia **CKC**—tibia rolls & glides anterior	*To facilitate ankle plantar flexion:* **OKC**—talus rolls posterior & glides anterior on tibia **CKC**—tibia rolls & glides posterior
Ankle inversion & eversion	**Concave surface:** Anterior calcaneal facet & posterior talus **Convex surface:** Posterior calcaneal facet & anterior talus	*To facilitate inversion:* **OKC**—anterior calcaneal facet rolls & glides medial while posterior calcaneal facet rolls & glides lateral **CKC**—talus rolls medial & glides lateral on anterior calcaneal facet while talus rolls & glides medial on posterior calcaneal facet	*To facilitate eversion:* **OKC**—anterior calcaneal facet rolls & glides lateral while posterior calcaneal facet rolls & glides medial **CKC**—talus rolls lateral & glides medial on anterior calcaneal facet while talus rolls & glides lateral on posterior calcaneal facet
MTP flexion & extension	**Concave surface:** Phalanx **Convex surface:** Metatarsal	*To facilitate flexion*: Phalanx rolls & glides distal/inferior on metatarsal	*To facilitate extension:* Phalanx rolls & glides proximal/superior on metatarsal

Ankle and Foot Tests

Bump Test[104, 291]

Purpose: Test for stress fx
Position: NWB—ankle in neutral
Technique: Apply a firm force with the thenar eminence to the heel of the foot
Interpretation: (+) test = pain at site of possible fx
Statistics: Sensitivity = NT & specificity = NT

Metatarsal Load[312]



Purpose: Assess for metatarsal fracture
Position: NWB
Technique: Grasp distal aspect of metatarsal bone & apply a longitudinal force to load the metatarsal
Interpretation: (+) test = localized pain as metatarsal joints are compressed
Statistics: Sensitivity = NT & specificity = NT

Anterior Drawer[16, 34, 48, 96, 163, 206, 256, 293, 399, 479, 490]

Purpose: Assess for ATF laxity
Position: NWB position in ~ 20° of plantar flexion, stabilize distal tibia/fibula
Technique: Grasp the posterior aspect of the calcaneus/talus & translate the calcaneus/talus anterior on the tibia/fibula
Interpretation: (+) test = pain & excessive movement 2° to instability
Statistics: Sensitivity = 75%–86% & specificity = 50%–88%; (+) LR = 3.1 & (–) LR = 0.29

Talar Tilt[16, 48, 96, 206, 256, 293, 399]

Purpose: Test for laxity of lateral ankle ligaments—ATF, CF, PTF
Position: NWB—stabilize the lower leg & palpate respective ligament
Technique: Grasp calcaneus to apply a varus stress to displace the talus from the mortise. Should be performed in plantar flexion (ATF), neutral (CF), & dorsiflexion (PTF)
Interpretation: (+) test = pain or excessive gapping with respect to contralateral limb
Statistics: Sensitivity = 67%–100% & specificity = 75%–100%; (+) LR = 2.7 & (–) LR = 0.44

Peroneal Tendon Dislocation[125]

Purpose: Assess for damage to peroneal retinaculum
Position: Prone, knee flexed to 90°
Technique: Have client actively plantarflex & dorsiflex ankle against resistance
Interpretation: (+) test = tendon subluxing from behind lateral malleolus
Statistics: Sensitivity = NT & specificity = NT

Syndesmotic Squeeze Test[11, 53, 58, 213, 290, 368, 371, 394, 528]

Purpose: Assess for syndesmotic sprain
Position: Supine with knee extended
Technique: Begin @ proximal tibia/fibula & firmly compress (squeeze) tibia/fibula together, progress distally toward ankle until pain is elicited
Interpretation: (+) test = pain at the syndesmosis; the farther from the ankle the pain is elicited, the more severe the sprain
Statistics: Sensitivity = NT & specificity = NT
Note: Recovery time = 5 + (0.97 × cm from ankle joint that squeeze test is positive) ± 3 days

ER Stress Test (Rotate via Heel)[11, 43] & Kleiger Test (Rotate via Forefoot)

Purpose: Assess for deltoid or syndesmotic sprain
Position: Sitting with lower leg stabilized but syndesmosis not compressed
Technique: Grasp the heel or medial aspect of the foot & ER in plantar flexion (deltoid lig) & repeat with ER in dorsiflexion (syndesmosis)
Interpretation: (+) test = pain or gapping compared with contralateral limb
Statistics: Sensitivity = NT & specificity = 95%

Thompson (Simmonds) Test[311, 442, 450, 477, 478]

Purpose: Assess for Achilles tendon rupture
Position: Prone
Technique: Passively flex the knee to 90° & squeeze the middle 1/3 of the calf
Interpretation: Plantar flexion of foot should occur; (+) test = failure to plantar flex
Statistics: Sensitivity = 40%–96% & specificity = 93%

Matles Test[311]

Purpose: Assess for Achilles tendon rupture
Position: Prone, knee flexed to 90°
Technique: Observe position of ankle
Interpretation: (+) test = ↑ dorsiflexion (known as the angle of dangle)
Statistics: Sensitivity = 88% & specificity = 85%

Windlass Test[113]

Purpose: Assess for plantar fasciitis
Position 1: NWB with knee flexed to 90°
Technique 1: Stabilize ankle in neutral & dorsiflex great toe
Interpretation 1: (+) test = pain along medial longitudinal arch
Statistics: Sensitivity = 13.6%–31.8% & specificity = 100%

Position 2: WB
Technique 2: Have client stand on a stool with equal weight on both feet & toes hanging over the edge of the stool & dorsiflex the great toe
Interpretation 2: (+) test = pain along medial longitudinal arch
Statistics: Sensitivity = 13.6%–31.8% & specificity = 100%

Homans Sign[107, 258, 312]

Purpose: Assess for thrombophlebitis of the lower leg
Position: Supine
Technique: Passively dorsiflex the foot & squeeze the calf
Interpretation: (+) test = sudden pain in posterior leg or calf
Statistics: Sensitivity = 35%–48% & specificity = 41%; (+) LR = 0.81 & (–) LR = 1.27

Morton Test[312]

Purpose: Assess for neuroma
Position: NWB
Technique: Grasp around the transverse metatarsal arch & squeeze the heads of the metatarsals together
Interpretation: (+) test = pain between 2nd/3rd or 3rd/4th digits that refers to the toes
Statistics: Sensitivity = NT & specificity = NT

Tinel Test[312, 379]

Purpose: Assess for tibial nerve damage
Position: NWB
Technique: Tap over posterior tibial nerve (medial plantar nerve), just inferior & posterior to medial malleolus
Interpretation: (+) test = paresthesia into the foot
Statistics: Sensitivity = 58% & specificity = NT

Differential Diagnosis[34, 48, 52, 70, 437]

Pathology/Mechanism	Signs/Symptoms
Complex Regional Pain Syndrome Etiology unknown, may occur after trauma See stages on page 255.	• Hyperalgesia & hyperhidrosis • Capsular tightness & stiffness • Muscle atrophy & osteoporosis • Trophic changes & edema • Vasomotor instability
Charcot Foot Hypertrophic osteoarthropathy of midfoot in clients with IDDM	• Progressive bone & muscle weakness • ↓ Sensation but minimal pain • Profound unilateral swelling • ↑ Skin temp (local); erythema • X-ray looks like osteomyelitis (bone fragments present)
Stress Fracture[104] Repetitive stresses, occurs ~3 wk after ↑ training; 2nd MT is most common **Beware** of eating disorders with repetitive stress fx	• Point tenderness & swelling • Deep nagging & night pain • ROM WNL • (+) Tests: Metatarsal load & bump • Bone scan & MRI detect earlier than x-ray • Therapeutic US in continuous mode will ↑ pain to aid in dx • R/o DVT

Continued

Pathology/Mechanism	Signs/Symptoms
Tarsal Tunnel[370] Compression of contents of tarsal tunnel (posterior tibial nerve & artery, tibialis posterior, FDL, FHL) may be 2° trauma, weight gain, excessive pronation, or inflammation	• Sharp pain into medial/plantar aspect of foot & 1st MTP • Burning, night pain, swelling • ↑ Pain with walking & passive dorsiflexion or eversion • Motor weakness & intrinsic atrophy difficult to detect • DTRs & ROM = WNL • (+) Tinel sign just below & behind medial malleolus • Abnormal EMG; r/o diabetic neuropathy & neuroma
Morton Neuroma Thickening of interdigital nerve (25–50 yo; ♀ > ♂) 2° high heel shoes, excessive pronation, high arch, lateral compression of forefoot, ↑ wt	• Throbbing/burning into plantar aspect of 3rd & 4th MT heads; feels like a pebble is in the shoe • Callus under involved rays • ↑ Pain with WB • (+) Morton test • Weak intrinsic muscles • EMG = unreliable • R/o stress fx (contrast MRI)
Common Peroneal Nerve Palsy Sitting with legs crossed, compression during sx, presence of a fabella (20% of population), tight ski boots or hockey skates, tx of nerve during strong inversion & plantar flexion contraction	• Compromised ankle stability can ↑ risk of sprains • Local pain & ecchymosis at the site of external trauma • Footdrop, ↓ eversion & dorsiflexion • Partial sensory loss • Test = pain with walking on medial borders of foot • MRI, EMG/NCV may be helpful
Sesamoiditis Repetitive high-impact sports or direct trauma	• Impairment of push-off, antalgic gait, swollen 1st MTP • TTP, pain with passive dorsiflexion of MTP • (+) X-ray & MRI • R/o turf toe, bipartite sesamoid

Continued

Pathology/Mechanism	Signs/Symptoms
Plantar fasciitis Continuous with gastroc/soleus muscle complex; subject to inflammation 2° repetitive stress, poorly cushioned footwear, hard surfaces, ↑ pronation, obesity	• Morning pain that ↓ with activity, nodules are palpable over proximal-medial border of plantar fascia • Pain with dorsiflexion & toe extension • ↓ Dorsiflexion due to tight gastroc/soleus muscle complex • Weak foot intrinsics • Sensation & reflexes WNL • (−) EMG; x-ray may show calcaneal spur, but there is no correlation between a bone spur & pain of plantar fasciitis
Hallux Rigidus May be associated with osteochondritis (child) or DJD, gout, or RA (adult)	• ↓ Dorsiflexion of 1st MTP joint • Pain & swelling on dorsal aspect of 1st MTP • Difficulty walking up stairs & uphill • LE ER to clear foot during gait • X-ray confirms dorsal osteophyte & ↓ joint space
Hallux Valgus (Bunion) RA, poor fitting footwear, flatfeet	• Pain, swelling, great toe valgus >15° • ↓ ROM of great toe & hammertoe of 2nd toe • X-ray helpful; r/o RA
Turf Toe[379] Extreme hyperextension of great toe in CKC position resulting in sprain of plantar capsule & LCL of 1st MTP	• Pain with toe extension • Impairment of push-off, antalgic gait • Ecchymosis & swelling of 1st MTP joint • (−) X-ray • R/o sesamoid & MT head fx
Sever Syndrome (Achilles Apophysitis)[311, 475, 476] Occurs in 8–16 yo ♂ > ♀ 2° rapid growth with stress on epiphysis with jumping or athletic events; may occur (B)	• TTP with mediolateral compression of calcaneus • ↓ Dorsiflexion due to pain; pain with stairs • Radiographs may not be helpful • Responds well to heel lift (healing takes months)

Continued

Pathology/Mechanism	Signs/Symptoms
Achilles Tendonitis[311, 475, 476] Vascular watershed is 4.5 cm above tendon insertion & vulnerable to ischemia 2° running hills (up = stretch & down = eccentric stress), poor footwear, excess pronation (↑ rotational forces); occurs mostly in ♂ 30–50 yo	• Localized tenderness 2–6 cm proximal to Achilles insertion • Morning stiffness, antalgic gait; pain climbing stairs • Tendon thickening & crepitus with AROM (wet leather) • Palpable Achilles nodule (retrocalcaneal exostosis = pump bump) • ↓ Ankle dorsiflexion with knee extended • MRI to r/o tendon defect, DVT
Achilles Tendon Rupture[311, 475, 476] <30 yo, injury is 2° direct blow to gastroc or forceful contraction; >30 yo, injury is 2° degeneration (higher incidence in people with type O blood)	• Snap/pop associated with injury • Palpable gap in tendon (hatchet sign) if examined early • Cannot walk on toes, swelling (within 1–2 hr) & ecchymosis • (+) Thompson & Matles tests • MRI confirms diagnosis
Posterior Tibialis Tendonitis Inflammatory condition due to poor biomechanics or overuse	• TTP & crepitus @ medial ankle • Pain with passive pronation • Pain with resisted inversion (supination) & plantar flexion
Peroneal Tendonitis Structurally 3 anatomical sites where tendon passes through tunnel/passage with acute angulation that can result in irritation & ↓ vascularization 2° trauma, inversion sprains, or direct blow	• Subluxing tendon = snapping while everting in dorsiflexion; subluxation is more common in young athletes 2° to forceful dorsiflexion of inverted foot with peroneals contracting • Swelling & ecchymosis inferior to lateral malleolus • X-ray may show avulsion of peroneal retinaculum

Continued

Pathology/Mechanism	Signs/Symptoms
Lateral Sprain[16, 96, 206, 256] Injury to ATF, CF, PTF 2° inversion with plantar flexion See "Grades of Ankle Sprains" below	• Rich blood supply = significant swelling within 2 hr • TTP over involved ligaments, ecchymosis that drains distal • Varying levels of instability (grade 1–3) • (+) Tests: Talar tilt & anterior drawer (presence of dimple just inferior to tip of lateral malleolus) • (−) X-ray for fracture but stress film may show ↑ joint space • Arthrography is accurate only within 24 hr
Syndesmotic Sprain[11, 43, 53, 58, 213, 290, 291, 368, 371, 394, 528] Injury to anterior &/or posterior inferior tibiofibular ligament 2° hyperdorsiflexion & eversion See "Grades of Ankle Sprains" below	• (+) Tests: Squeeze & ER test • Pain & swelling over ligament/interosseous membrane • Oblique x-ray may show abnormal widening of joint space • Recovery time = 5 + (0.97 × cm from ankle joint that squeeze test is positive) ± 3 days • R/o fx & avulsion
Compartment Syndrome Progression of shin splints resulting in loss of microcirculation in shin muscle; ♂ > ♀, R > L **Beware:** Immediate referral is needed (ice but do not compress)	• 5 P's = paresthesia (toes), paresis (dropfoot), pain (anterior tibia), pallor, pulseless • Skin feels warm & firm • Cramping, pain, & tightness • Most reliable sign is sensory deficit at dorsum of foot in 1st interdigital cleft • Ischemia of EHL • Pulses are normal until the end & then surgery is needed within 4–6 hr to prevent muscle necrosis & nerve damage • ↑ Soft tissue pressures via fluid accumulation • Normal compartment pressure <10 mm Hg

Continued

Pathology/Mechanism	Signs/Symptoms
	• 20 mm Hg is compromised capillary blood flow • 30 mm Hg results in ischemic necrosis • (–) X-ray & bone scan; need to r/o tibial stress fx • Confirmed with MRI & pressure assessment
Shin Splints/Anterior Overuse syndrome of tibialis anterior, ext hallucis longus, & ext digitorum longus attributed to running on unconditioned legs, soft tissue imbalance, alignment abnormalities, & excessive pronation to accommodate rearfoot varus	• Pain & TTP @ anterior tibialis • Pain with resisted dorsiflexion & inversion • Pain with stretching into plantar flexion & eversion • Callus formation under 2nd MT head & medial distal hallux • Tight gastroc/soleus muscle • Soreness with heel walking • (–) X-ray, r/o stress fx
Shin Splints/Posterior Overuse syndrome of flexor hallucis longus & flexor digitorum longus	• Callus under 2nd > 3rd > 4th MT head & medial distal hallux • Pain & soreness over distal ⅓–⅔ of posterior/medial shin & posterior medial malleolus • Hypermobile 1st metatarsal • ↑ Pronation 2° rearfoot varus = ↑ stress on tibialis posterior to decelerate foot • Pain with resisted inversion & plantar flexion • Pain with stretching into dorsiflexion & eversion • (–) X-ray, r/o stress fx

Grades of Ankle Sprains[70]

1st Degree	2nd Degree	3rd Degree
• No hemorrhage • Minimal swelling • Point tender • No varus laxity • (–) Anterior drawer • (–) Talar tilt • No/little limp • Difficulty hopping • 2–10 day recovery	• Some hemorrhage • Localized swelling (↓ Achilles definition) • (+) Anterior drawer • (+) Talar tilt • No varus laxity • (+) Limp • Unable to heel raise, hop, run • 10–30 day recovery	• Diffuse swelling (no Achilles definition) • Tenderness medial & lateral • (+) Anterior drawer • (+) Talar tilt • (+) Varus laxity • NWB • 30–90 day recovery

Clinical Prediction Rules[455]

Condition	Intervention	Rule Features	Predictability
Ankle sprain[520]	Manual therapy	• ↑ Symptoms with standing • ↑ Symptoms in evening • Hypomobility of distal tibial-fibular joint • Navicular drop ≥5.0 mm	=4: (+) LR = 0.4 ≥3: (+) LR = 5.9 ≥2: (+) LR = 1.2 ≥1: (+) LR = 0.3

References

All references are posted on Davis*Plus*, http://davisplus.fadavis.com

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