Complex Nerve and Vascular Conditions of the Upper Extremity

CCSU Sports Medicine Symposium

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Orthopedic Associates of Hartford

Disclosures

- None

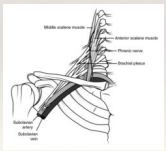
Learning Objectives

1. Identify the typical signs and symptoms of nerve and vascular disorders in the upper extremity
2. Determine early management strategies for these conditions
3. Understand when to refer for specialized care

Outline

- Thoracic Outlet Syndrome
- Exertional Compartment Syndrome
- Cubital Tunnel Syndrome
- Complex Regional Pain Syndrome
- Raynaud's Disease and Phenomenon

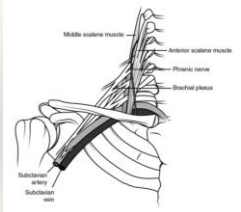
Thoracic Outlet Syndrome



J Am Acad Orthop Surg. 2015 Apr;23(4):222-32. doi: 10.5435/JAAOS-D-13-00215.
Thoracic outlet syndrome.
Kuhn JE, Lebus V GF, Bible JE.

Thoracic Outlet Syndrome

- Thoracic Outlet compression of neurovascular bundle
  - Brachial plexus and Subclavian Artery and Vein
- Neurogenic vs vascular
  - Symptoms >90% neurogenic
- No reproducible diagnostic study



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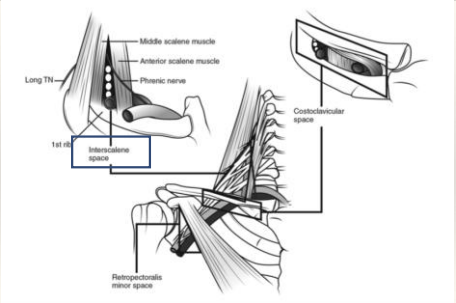
Thoracic Outlet Syndrome



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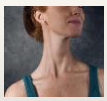
Thoracic outlet syndrome.
Kuhn JE, Lebus VG, Bible JE.

Etiology- Thoracic Outlet Syndrome



- Anatomic predisposition with addition of neck trauma from acute or chronic injury
  - Young, thin females with a long neck and drooping shoulders
- **Soft-tissue (70%)**
  - Accessory scalene muscle, trauma and scarring
- **Bony (30%)**
  - Cervical ribs, prominent C7 transverse process

Presentation- Thoracic Outlet Syndrome

- **Variable!**
- Symptoms with activity (especially overhead) and with sleep
- Neurogenic: Weakness, numbness, paresthesia, pain in a non-dermatomal distribution
  - Must differentiate from other nerve compression
    - Cubital Tunnel, Carpal Tunnel, Cervical Radiculopathy

Symptoms	*50 patients (%)*
Neck pain	88
Trapezius pain	92
Supraclavicular pain	76
Chest pain	72
Shoulder pain	88
Arm pain	88
Occipital headache	76
Paresthesia:	98
All 5 fingers	58
4th and 5th fingers	26
1st- 3rd fingers	14
No Paresthesia	2

Thoracic Outlet Syndrome: A Review
Richard J. Sanders; Sharon L. Hammond, Neal M. Rao
The Neurologist. 14(6):365-373, NOV 2008

Presentation- Thoracic Outlet Syndrome

- Vascular- Rare
  - **Swelling** of upper extremity, **pain** in arm/chest/shoulder, **cyanosis**
  - Symptoms worse after activity

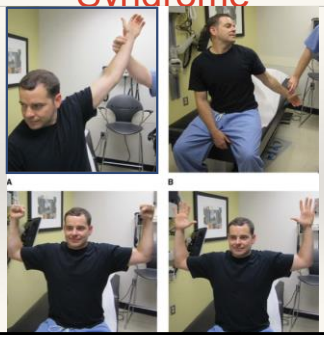
Exam- Thoracic Outlet Syndrome

- Differentiate from other disorders
- Inspect appearance of arms
  - *Gilliat-Sumner hand*: atrophy of thenar AND hypothenar muscles
  - Color, temperature, atrophy, nail changes, edema, prominent veins
- Vascular
  - 20 mmHg difference between the extremities (rare)

https://obgynkey.com/thoracic-outlet-syndrome/

Exam- Thoracic Outlet Syndrome

- Wright



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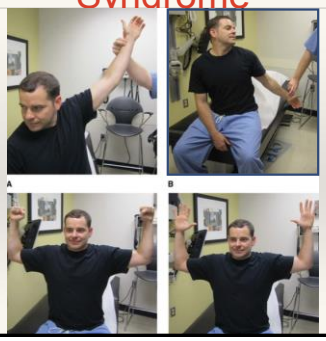

- Edson

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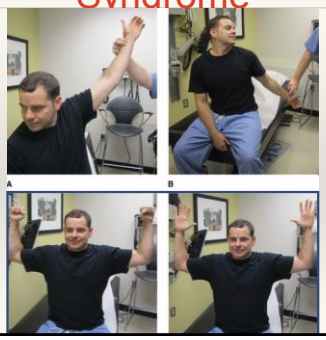
Exam- Thoracic Outlet Syndrome

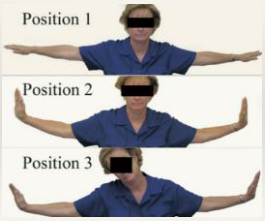


- Roos

J Am Acad Orthop Surg. 2015 Apr;23(4):222-32. doi: 10.5435/JAAOS-D-13-00215. **Thoracic outlet syndrome.** Kuhn JE, Lebus V, DF, Bible JE

Exam- Thoracic Outlet Syndrome

- Upper Limb Tension Test



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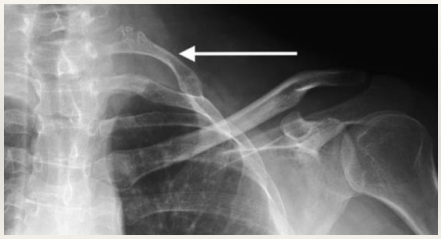
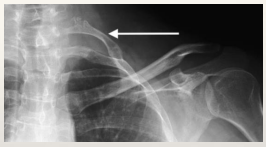
Richard J. Sanders; Sharon L. Hammond; Neal M. Rao
The Neurologist. 14(6):365-373, NOV 2008

Imaging- Thoracic Outlet Syndrome



J Am Acad Orthop Surg. 2015 Apr;23(4):222-32. doi: 10.5435/JAAOS-D-13-00215. **Thoracic outlet syndrome.** Kuhn JE, Lebus V GF, Bible JE.

Diagnosis- Thoracic Outlet Syndrome

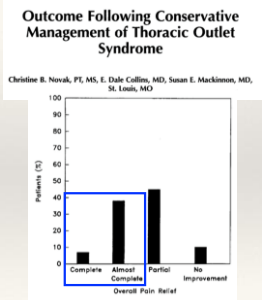


- X-rays, CT/MRI
- Nerve Conduction Studies
- Anterior scalene blocks- prognosis for surgery

J Am Acad Orthop Surg. 2015 Apr;23(4):222-32. doi: 10.5435/JAAOS-D-13-00215. **Thoracic outlet syndrome.** Kuhn JE, Lebus V GF, Bible JE.

Treatment- Thoracic Outlet Syndrome: Non-Operative

- Non-operative
  - Almost all neurogenic TOS
  - Novak et al: 42 patients
    - Education and activity modification with therapy
      - Relaxation techniques, posture modification, weight control
      - Limit repetitive overhead stress
      - Stretching, core strengthening, aerobic conditioning, ROM, nerve and tendon gliding exercises
  - Ultrasound guided Botox injections
  - NSAID's, TENS



J Hand Surg Am. 1995 Jul;20(4):542-8. **Outcome following conservative management of thoracic outlet syndrome.** Novak CB1, Collins ED, Mackinnon SE.

Treatment- Thoracic Outlet Syndrome: Operative

- For those who fail non-operative treatment for 6 months, or vascular TOS
- Multiple methods and approaches, depending on pathology
  - Can include cervical or first rib resection, or release of tight fibrous bands
  - High risk of complications

Thoracic Outlet Syndrome

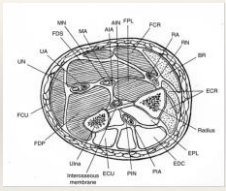
- Take Home Points
- The majority of thoracic outlet syndrome presents with pain and neurogenic symptoms in a non-dermatomal distribution
- Exam maneuvers can give false positive results
- All patients should have at least 6 months of physiotherapy prior to considering any surgical intervention

Exertional Compartment Syndrome

http://dailyburn.com/lifetimes/30-minute-strength-workouts-rowing-machine/

Exertional Compartment Syndrome

- Temporary increase in the pressure within compartments of the arm during and after exercise activity
  - Muscle expansion against tight fascial compartments
  - *Increased* pressure leads to *decreased* perfusion (ischemia)
    - Pain and neurologic symptoms from ischemia



J Am Acad Orthop Surg. 2011 Jan;19(1):49-58.
Acute compartment syndrome of the upper extremity.
Prasarn ML1, Ouellette EA.

Exertional Compartment Syndrome: Presentation

- Pain, swelling, and cramping during and immediately after exercise
  - Repetitive and vigorous gripping exercises
    - Rowers, cyclists, gymnasts
  - Predictable pattern of onset with delayed improvement after exercise cessation


http://dailyburn.com/life/fitness/30-minute-strength-workouts-rowing-machine/


http://jacpersonaltraining.com/blog/movement-blog/126/holding-grip-strength-matters/

Exertional Compartment Syndrome: Exam

- Physical exam at rest? **Normal**
  - Rule out other entities
- Examination during exercise is crucial
  - Firm, tender compartments
  - Paresthesias/dysesthesia in some cases

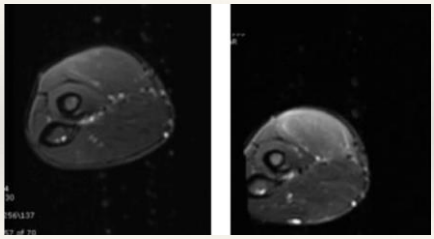
Exertional Compartment Syndrome: Diagnosis

- Intra-compartmental pressure measurements
  1. Resting pressure: >15 mm Hg
  2. 1 min post-exercise: >30 mm Hg
  3. 5 min post-exercise: >20 mm Hg

http://strykercorp.com/en-us/products/SurgicalEquipment/PressureMonitors/IntraCompartmentalPressureMonitor/index.html#

Exertional Compartment Syndrome: Diagnosis

- Dynamic MRI



J Hand Surg Am. 2017 Nov;42(11):917-923. doi: 10.1016/j.jhsa.2017.09.009.
Chronic Exertional Compartment Syndrome in Athletes.
Liu R[1], Barrazueta GJ[2], Buchelsman DE[3]

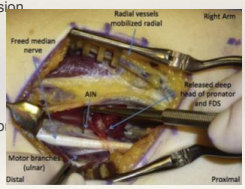
Exertional Compartment Syndrome: Treatment

- Conservative Treatment
  - Activity modification/cessation
  - Technique modification
  - Stretching
  - Ice/NSAID's with gradual return to sport

http://pacpersonaltraining.com/blog/movement/blog/126/holding-grip-strength-matters/

Exertional Compartment Syndrome: Treatment

- Surgical Fasciotomy
  - Open, mini-open, endoscopic
    - Can release specific nerve compression sites
  - 86-99% Successful resolution of symptoms
  - 3-21% complications
    - Scar widening, paresthesias, hemato
  - Return to play 4-6 weeks



J Hand Surg Am. 2017 Nov;42(11):917-923. doi: 10.1016/j.jhsa.2017.09.009.
Chronic Exertional Compartment Syndrome in Athletes.
Liu B[1], Barnaveld DP, Rutherman DE[1]

Exertional Compartment Syndrome

- Take Home Points
- Predictable pattern of symptom onset followed by relief after exercise cessation
  - Pain and neurologic symptoms
  - Physical exam needs to be performed immediately after exercise
- Compartment pressure measurements key to diagnosis
- Surgical release has good outcomes with a moderate complication rate

Cubital Tunnel Syndrome

http://newsroom.cumc.columbia.edu/blog/2014/11/06/arm-pain-young-baseball-players-common-preventable/

Cubital Tunnel Syndrome

- Second most common compressive neuropathy in the upper extremity
- Rare in pediatric and adolescent patients
  - Increased incidence in throwing athletes
  - Numerous case studies
  - Specific interest in addressing this in ulnar collateral ligament reconstruction

http://newsroom.cumc.columbia.edu/blog/2014/11/08/arm-pain-young-baseball-players-common-preventable/

Cubital Tunnel Syndrome

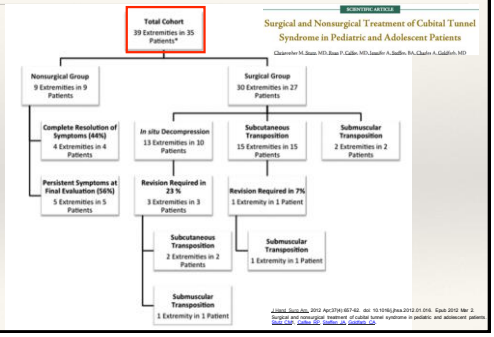
SCIENTIFIC ARTICLE

Surgical and Nonsurgical Treatment of Cubital Tunnel Syndrome in Pediatric and Adolescent Patients

Christopher M. Sturm, MD, Ryan P. Calfee, MD, Jennifer A. Steffen, BA, Charles A. Goldfarb, MD

- 35 patients from 7-18 yo with EMG confirmed cubital tunnel
  - 25% throwing athletes
  - 62% dominant arm
  - 56% post-traumatic
- Presentation: Medial Elbow pain, numbness/tingling ring and small finger, weakness of hand
  - 41% with ulnar nerve instability on exam

Cubital Tunnel Syndrome



SCIENTIFIC ARTICLE

Surgical and Nonsurgical Treatment of Cubital Tunnel Syndrome in Pediatric and Adolescent Patients

Christopher M. Sturm, MD, Ryan P. Calfee, MD, Jennifer A. Steffen, BA, Charles A. Goldfarb, MD

J Hand Surg Am. 2012 Apr;37(4):667-42. doi: 10.1016/j.jhsa.2012.01.016. Epub 2012 Mar 2.
Surgical and nonsurgical treatment of cubital tunnel syndrome in pediatric and adolescent patients
Goldfarb CA, Calfee RP, Steffen JA, Sturm CM.

Cubital Tunnel Syndrome

- Take Home Points
- When evaluating complaints of numbness and tingling in a throwing athlete, have a higher suspicion for cubital tunnel
  - Many of these patients have a history of prior elbow trauma
- Non-operative management has a low success rate in adolescents
- For surgical cases, transposition is most appropriate

Complex Regional Pain Syndrome

https://en.wikipedia.org/wiki/File:Pain.jpg

Complex Regional Pain Syndrome

- Initially known as RSD (Reflex sympathetic dystrophy)
  - Causalgia, shoulder-hand syndrome, algodystrophy
- **Disproportionate amount of pain that persists after an injury has healed or in a different location from a defined injury**
- Diagnosis of exclusion
- Classification:
  - *Type 1*: No identifiable nerve lesion
  - *Type 2*: Identifiable nerve injury or compression

Complex Regional Pain Syndrome

- Rare in children and adolescents
- True incidence and prevalence unknown
  - Estimated to affect between 4-39% of distal radius fractures
- Can have a prolonged time course
- Staging (acute, dystrophic, and atrophic) is variable and questionable prognostic ability

Complex Regional Pain Syndrome

	Hot	Cold
	The two states of microvascular perfusion associated with CRPS	
	Increased total flow Decreased nutritional flow	Decreased total flow Decreased nutritional flow
Symptoms	Hot, swollen	Cold, stiff
Signs	Edema Increased sweating	Atrophic
Pain	With hyperalgesia Without hyperalgesia With cold intolerance Without cold intolerance	Hyperalgesia Cold

Koman LA, ed. Bowman Gray Orthopaedic [Wake Forest School of Medicine] Manual. Winston-Salem, NC: Orthopaedic Press

Complex Regional Pain Syndrome

- Risk factors
  - Prior CRPS
  - Wrist fractures immobilized in extreme positions after manipulation
- Symptoms
  - Pain out of proportion with hyperalgesia and increased anxiety
- Signs
  - Allodynia, hyperalgesia
  - Joint swelling
  - Swelling, skin color changes, sweating, hair growth, fingernail growth

Calfee RP. Pain Syndromes. In Weiss APC, Goldfarb CA, Hentz VR, Raven RB, Slutsky DJ, Steinmann SP Eds. Hand Surgery. *Textbook of Hand and Upper Extremity Surgery*. American Society for Surgery of the Hand, pp. 1399-1411, 2013.

Complex Regional Pain Syndrome

TABLE 1. Proposed Diagnostic Criteria for CRPS Type 1

International Association for the Study of Pain	American Medical Association's Guides to the Evaluation of Permanent Impairment, 6th Edition	American College of Occupational and Environmental Medicine
1. The presence of an initiating noxious event or a cause of immobilization.	1. Continuing pain, which is disproportionate to any inciting event.	1. Continuing pain that is disproportionate to any inciting event.
2. Continuing pain, allodynia (perception of pain from a nonpainful stimulus), or hyperalgesia disproportionate to the inciting event.	2. Must report at least one symptom in 3 of the following categories: sensory (hyperesthesia/allodynia), vasomotor (temperature or skin color asymmetry), sudomotor/edema, motor (weakness, tremor, dystonia)/trophic (hair, nail, skin).	2. At least one symptom in 3 of these four categories: sensory vasomotor, sudomotor/edema, motor/trophic.
3. Evidence at some time of edema, changes in skin blood flow, or abnormal sudomotor activity in the region of the pain.	3. Must display at least one sign at time of evaluation in 2 or more of the following categories: sensory vasomotor, sudomotor/edema, motor/trophic.	3. At least one sign at evaluation in 2 or more of the following categories: sensory, vasomotor, sudomotor/edema, motor/trophic.
4. CRPS is excluded by the existence of conditions that would otherwise account for the degree of pain and dysfunction.	4. There is no other diagnosis that better explains the signs and symptoms.	4. CRPS is excluded by the existence of conditions that would otherwise account for the degree of pain and dysfunction.

J Hand Surg Am. 2010 Aug;35(8):1345-7. doi: 10.1016/j.jhsa.2010.06.007.
Evidence-based medicine: disproportionate pain and disability.
Rino DY, Barth R, Rankin A

Complex Regional Pain Syndrome: Treatment

- Best treatment? PREVENTION!
  - Avoid tight casts with significant wrist flexion
  - Protect sensory nerves during surgery
  - Vitamin C?
- Early identification of patients to start treatment
  - Up to 94% good outcomes when treatment started within 4 months of injury
- Identification of the type 2 patients for potential nerve decompression

https://www.naturalhealth365.com/health-basics-vitamin-C-1577.html

Complex Regional Pain Syndrome: Prevention

- Vitamin C
  - Zollinger et al (1999 and 2007)- RCT's showing decreased incidence from 10% to 2% with 500mg/day
  - Ekrol et al (2014)- RCT showing no difference in CRPS incidence
  - Meta-Analysis combining data from these trials: No statistically significant benefit of Vitamin C
- **Take-home? Vitamin C may not decrease CRPS incidence, but has minimal potential for side effects**

https://www.naturalhealth365.com/health-basics-vitamin-C-1577.html

Type II Complex Regional Pain Syndrome: Treatment

- Patients with a diagnosis of CRPS who were found to have positive exam and EMG findings for carpal or cubital tunnel
- Results (Pre-op, 8d post-op, 1 yr post-op)
  - DASH score: 71->53->30
  - VAS 7.5->3.5->1.8

Nerve Decompression for Complex Regional Pain Syndrome Type II Following Upper Extremity Surgery

Jeffrey D. Placzek, MD, *St. Louis, MO, Rochester, MI*, Martin I. Boyer, MD, Richard H. Gelberman, MD, Barbara Sopp, Charles A. Goldfarb, MD, *St Louis, MO*

- **Take Home? When there is a defined nerve injury, decompression can significantly improve pain and function for the patient**

Complex Regional Pain Syndrome: Treatment

- Potential Treatments
- Physiotherapy
- Psychological Therapy
- Nerve decompression for Type II
- Bisphosphanates
- Dimethyl sulfoxide
- N-acetylcysteine
- Glucocorticoids
- Calcitonin
- Gabapentin
- Pregabalin
- Anti-depressants
- Anti-Epileptics
- Sympathetic nerve blocks
- Neurostimluation
- Amputation

Calfee RP. Pain Syndromes. In Weiss APC, Goldfarb CA, Hentz VR, Raven RB, Slutsky DJ, Steinmann SP Eds. Hand Surgery. *Textbook of Hand and Upper Extremity Surgery*. American Society for Surgery of the Hand, pp. 1399-1411, 2013.

Complex Regional Pain Syndrome: Treatment

- Physiotherapy
  - Cochrane review (2016) on 18 RCT's
    - **Graded motor imagery**
    - Multimodal physiotherapy
    - Mirror therapy
    - No benefit seen for tactile discrimination training, manual lymphatic drainage, or pulsed electromagnetic field therapy
  - Stress loading (Watson and Carlson, 1987)
    - 85% pain relief and 95% improved ROM
  - Desensitization and edema management

https://www.anatomy-physiotherapy.com/graded-motor-imagery

Smart KM, Ward BM, O'Connell NE.
Physiotherapy for pain and disability in adults with complex regional pain syndrome (CRPS) types I and II. Cochrane Database of Systematic Reviews 2016, Issue 2. Art. No.: CD010853. DOI: 10.1002/14651858.CD010853.pub2.

Complex Regional Pain Syndrome: Treatment

- Local Anesthetic Sympathetic Blockade
  - Temporarily prevents maintenance sympathetic tone
  - Cochrane review (2016)
    - "Limited data available do not suggest that LASB is effective for reducing pain in CRPS"
    - Lack of high-quality evidence on this topic

O'Connell NE, Wand BM, Gibson W, Carr DB, Birklein F, Stanton TR.
Local anaesthetic sympathetic blockade for complex regional pain syndrome. Cochrane Database of Systematic Reviews 2016, Issue 7. Art. No.: CD004598. DOI: 10.1002/1465

Complex Regional Pain Syndrome

- Take Home Points
- Diagnosis of exclusion
  - Important to identify any contributing peripheral nerve compression
- Prevention is best treatment option
- Early institution of treatment with therapy is likely to improve long-term results
  - Graded motor imagery
  - Limited evidence on any of the other medical or invasive therapies

Raynaud's Disease

https://emedicine.medscape.com/article/331197-overview?pa=h%2BvJJZOgSy5aEakd%2Bh%2FEciPlyZrSQ4MKr8mWXBi2IxfcT27v4vfAVAePB4vLzftlR6ET6Mqn3RDv%2BG87KVdWLy8HoCpv88EfsR0xVZ6JHe4%3D

Raynaud's Disease

- Raynaud's Disease
- Cold hypersensitivity
- Temporary digital color change
- Cause: exaggerated vasoconstrictive response to cold or emotional stress
- Typically symmetric
- **Irreversible Tissue injury does NOT occur**

- Raynaud's Phenomenon
- Patients have a diagnosis of collagen vascular disease
- Abnormal vascular flow can be appreciated on Allen's test and angiography
- **Progressive and permanent changes to the digits**

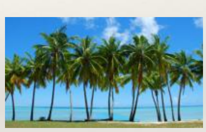
Raynaud's Disease

- Etiology
  - Healthy young women in cold climates
    - 11% of women, 8 % of men
- Evaluation
  - Full vascular exam
    - Rule out abnormalities such as injury, aneurysm, or thrombus with asymmetric exam findings
  - Signs of connective tissue diseases

https://emedicine.medscape.com/article/331197-overview?pa=h%2BvJJZOgSy5aEakd%2Bh%2FEciPlyZrSQ4MKr8mWXBi2IxfcT27v4vfAVAePB4vLzftIR6ET6Mqn3RDv%2BG87KVdWLy8HoCpv88EfsR0xVZ6JHe4%3D

Raynaud's Disease: Treatment

- **Conservative**
  - Limitation of cold exposure
  - Glove wear
  - Smoking/tobacco cessation



https://www.thetreecenter.com/how-fast-do-palm-trees-grow/

Raynaud's Disease: Treatment

- **Medications**
  - Calcium channel blockers
    - Meta-analysis (Thompson et al 2005): 33% reduction in symptom severity and 50% reduction in frequency of episodes
  - Vasodilators
  - Botulinum toxin injections
  - Temperature Biofeedback

Raynaud's Disease

- Take Home Points
- Raynaud's disease does not cause irreversible tissue damage
- Raynaud's phenomenon requires a diagnosis of a collagen vascular disease
- Management is conservative, with appreciable benefit in some patients with Ca-channel blockers

References

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2. Thoracic Outlet Syndrome: A Review. Richard J. Sanders; Sharon L. Hammond; Neal M. Rao. The Neurologist. 14(6):365-373, NOV 2008
3. J Vasc Surg. 2007 Sep;46(3):601-4. Diagnosis of thoracic outlet syndrome. Sanders RJ1, Hammond SL, Rao NM.
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Questions?