Indication for and Results of Sympathectomy in Patients with Peripheral Vascular Disease
Overview

- History
- Anatomy
- Physiology
- Clinical Indications
- Operative Techniques
Sympathetic denervation to treat occlusive arterial disease
- Jaboulay (1889): periarterial sympathectomy on femoral artery
- Leriche (1921): results disappointing due to reinnervation and vasospasm within weeks of operation
- Royle (1924): observed after lumbar sympathectomy that skin and toes of ipsilateral foot became warm and dry

1930s-1950s: widely used for occlusive arterial disease because it was often the only alternative to amputation
- Short-lived and palliative

1960s: direct surgical revascularization replaced sympathectomy for treatment of occlusive arterial disease in most patients
Reflex arc

- Afferent fibers from blood vessels travel with somatic nerves to cell bodies in the dorsal root ganglion of the spinal nerve
- Central axon synapse with cell bodies of the efferent fibers located in the anteromediolateral column of the spinal cord
- Efferent fibers are myelinated and travel in the white rami communicantes as preganglionic fibers to the ganglia in the sympathetic chain/preaortic region
- Postganglionic fiber (unmyelinated) travel in the gray rami communicantes to join the somatic nerves
Anatomy

- Small percentage of the preganglionic efferent fibers either bypass the paravertebral ganglia and synapse more peripherally or cross over.

- Complete sympathetic denervation of an extremity requires division of preganglionic fibers along their segmental origin and resection of the relay ganglion.
Anatomy

- Sympathetic outflow to lower extremities originates from spinal cord segments T10 to L3 and are conveyed primarily through L1 to L4 ganglia.
- Usually 3 lumbar ganglia found:
  - L1 and L2 fused
  - L2 and L3 ganglionectomy usually sufficient
  - Crossover fibers occur in 15% patients (usually L4)
- Anatomic completeness of sympathectomy is essential to minimize regeneration (occurs 2-5 years post operation):
  - Most common causes of early failure of procedure due to poor patient selection and incomplete degeneration.
Physiology

- Sympathetic denervation increases blood flow to a normal limb
- Impact on an extremity affected by arterial occlusive disease less clear
  1. Increase in blood flow
  2. Effect of collateral circulation
  3. Nutritive value of blood flow increase
  4. Alteration of pain impulse transmission
Physiology

Increase in Blood Flow

- Abolishing basal and reflex constriction of arterioles and precapillary sphincters
  - Flow increases of 10-200% are observed
    - Depends on degree of occlusive disease
    - Severe, multilevel occlusions may derive no benefit since already maximally dilated at rest
  - Alters distribution of blood flow by shunting through cutaneous arteriovenous anastomoses
    - Maximized by distributing to distal cutaneous circulation
    - Leads to characteristic warm, pink foot
    - Not necessarily an increase in tissue perfusion
      - Canine model showed neither resting or exertional muscle perfusion improved by sympathectomy
      - Explains why sympathectomy not useful for claudication

Rutherford 1971, Cronenwett 1980
Physiology
Increase in Blood Flow

Maximal vasodilation noted immediately after sympathectomy
- Tapers within 5-7 days
- Resting vasomotor tone returns to normal levels 2-6 months later
  - Incomplete denervation
  - Cross-over reinnervation
  - Vascular hyperreactivity to circulating catecholamines seen in rabbit and canine models
Physiology
Effect on collateral circulation

**Temporary but significant increase in collateral blood flow**
- Studied in humans and dogs
- 10% increase in distal perfusion after sympathectomy attributable to collateral perfusion
- Most patients with ischemia, local humoral factors maximize blood flow

Dalessandri 1983, Ludbrook 1966,
Physiology
Nutritive value of blood flow increase

- Shunting through cutaneous arteriovenous anastomoses bypasses capillary perfusion
  - Presumably makes blood non-nutritive
  - Conflicting studies regarding clearance of radio-labeled isotopes

- Uncontrolled clinical series (Moore ’71) reported ischemic ulcer healing in 40-67% of patients after sympathectomy

Physiology

Alteration of pain impulse transmission

- Relief of ischemic rest pain due to loss of attenuation of painful stimulus transmission

- Relationship between lumbar sympathectomy and pain threshold
  - Sympathectomy decreases noxious stimulus by decreasing tissue norepi levels
  - Explains why in clinical series that rest pain improves without hemodynamic evidence of improved tissue perfusion
  - Petten 1983 demonstrated increased tolerance of hind limb noxious stimuli after lumbar sympathectomy in cats
Clinical Findings

- **Lumbar sympathetic block**
  - Significant increase in warmth (subjective or objective)
  - Increased filling of veins
  - Increase in arterial pulsations shown by oscillometry or plethysmography
  - Abolished secretion of sweat

- **Noninvasive Lab**
  - ABI<0.3 indicates low likelihood to improve after sympathectomy (Yao ’73)
  - Presence of sympathetic vasomotor tone assessed by noting response of digit pulse amplitude to deep breath
    - Loss of vasoconstrictive reflex in DM, surgical sympathectomy, or advanced ischemia
  - Ability of digit circulation to increase pulse amplitude by inducing temporary ischemia using pneumatic cuff
Clinical Indications

- Review of lumbar sympathectomy (Cross ’99)
  - Sympathectomy does not improve claudication
  - May improve ischemic rest pain
  - Does not improve long-term patency of peripheral vascular bypass grafts

- Subjective and objective preoperative assessment of response to sympathetic blockade greatly enhances probability of therapeutic success

- Three main indications:
  - Causalgia
  - Inoperative arterial occlusive disease with limb-threatening ischemia causing rest pain, limited ulceration, or superficial digital gangrene
  - Symptomatic vasospastic disorders
Causalgia

Stage I - Acute (warmth, erythema, burning, edema)
- 40-60% respond to intensive medical therapy including mild analgesics, physiotherapy, TCAs, anticonvulsants, adrenergic blockers
- Surgical sympathectomy considered after 3 months
- Translumbar sympathetic blocks can be used

Stage 2 - Dystrophic (coolness, mottling, cyanosis)
- Sympathectomy should be applied as soon as there is relief from blockade

Stage 3 - Atrophic
- Not indicated
Causalgia

Mockus 1987
- 34 pt
- 28 month follow up
- 97% immediate relief of symptoms, 61% complete relief of pain
- 10% complications – Horner’s, neuralgia

Others report similar success with 95-100% patients reporting excellent response

AbuRahma 1994, Je’bara 1987
Inoperable Arterial Occlusive Disease

- Lumbar sympathectomy can be considered prior to amputation
  - ABI>0.3
  - Absent neuropathy
  - Symptomatic relief obtained by trial block
- Relief of rest pain expected in 50-85% of patients meeting these criteria
- For tissue loss patients, need to limit treatment to patients who only have limited ulceration or single-digit gangrene and absence of major deep infection
  - Healing seen in 35-65% of patients
Cross 1985

- Randomized, controlled, prospective double-blind trial of phenol chemical sympathectomy against placebo bupivacaine
- LCS (lumbar chemical sympathectomy) performed on 37 pt/41 limbs with critical limb ischemia
- 83% vs. 23% had relief of rest pain at 1 wk
- 66% had relief of rest pain at 6mo while 23% of the control group had relief of rest pain at 6mo
Arterial Occlusive Disease

Norman and House 1988

- Retrospective review of 153 pts had operative lumbar sympathectomy for intermittent claudication and/or rest pain
- 67% of claudicants and 54% rest pain pt avoided surgery after 5 years
- No difference for diabetes
- Problems: included claudicants
Arterial Occlusive Disease

Baker and Lamerton 1994
- Retrospective review of patients with severe PVD
- 132 lumbar sympathectomies on 118 pt
- Severe PVD unsuitable for vascular reconstruction
- 62 had debridement or toe amputation at same time
- 45% limb loss but of those with limbs that survived:
  - 86% resolution of rest pain in 6mo
  - 64% recovered from trophic changes
Arterial Occlusive Disease

Mashiah 1995

- Retrospective review of 373 pt of which 226 DM
- End points: relieve pain, arrest gangrene, postpone amputation
- Treatment chemical sympathectomy
- Symptomatic relief in 58% patient (FU 24-120 months)
  - Relief from pain
  - Healing of ulcers
  - DM with rest pain or non-diabetic pt with ulcers had the most favorable results
Matarazzo 2002

- 385 pt with PVD tx with surgical sympathectomy
- 63% improvement in symptoms after 1 year
  - Pain, recovery of trophic lesions, rise in skin temperature
- 10% stationary
Inoperable Arterial Occlusive Disease

- Lumbar chemical sympathectomy for inoperable PVD
- Rest pain or tissue loss
- Questionnaires to Vascular Surgical Society members
- 75% stated LCS had a role in current practice,
- 78% performed less than 10/yr
- Complications neuralgia, ureteric damage, paraplegia
Extremity Vasospasm

- Primarily affects patients with Raynaud’s phenomenon or frostbite victims
  - Discomfort and typical color changes in response to environmental cold
  - Severe vasospasm can produce digital ulceration even with palpable pulses
- Maximal medical therapy
  - CA channel blockers
  - Cold avoidance
  - Cessation of smoking
- Refractory vasospasm warrants surgery
  - 90% success rates
Vasospastic Disorders complicated by Digital Ulceration

- Khan 2008
  - Non-randomized controlled trial
  - Severe cold trauma
  - 48 pt
  - 17 thoracic sympathectomy
    - 11 symptome free
    - 3 mild but improved symptoms
    - 2 initially improved but required further treatment

Figure 1. Patient with an ulcer in the middle finger.
Surgery for Vasospasm

- Maga et al 2007
  - 25 pt with Raynauds
  - Tx with VATS sympathectomy
  - Symptom severity score to zero immediately postoperative period
  - At 5 years, 28% of initial value

- Wang 2006
  - 6pt with 14 digits with tissue loss
  - Peripheral sympahtectomy
    - 12/14 healed amputation avoided
Surgery for Vasospasm

Matsumoto 2002 JVS

- 28 pt with Raynaud’s
- Severe symptoms refractory to medical management
- 54 procedures (ELS) on 28 pt
- Initially 92% resolution or improvement in symptoms
- 82% recurred, no recurrence of ulcerations
- 89% reported improvement in symptoms at mean FU of 62 mo
Peripheral Vasospasm

Janoff 1985
- 10 pt with episodic distal vasospasm refractory to medical management
- 100% response
- Toe plethysmography normalized
- At 4 yrs, all pt asymptomatic

Gifford 1958
- Sympathectomy for Raynaud’s
- 70 women with Raynaud’s and 54 with secondary Raynaud’s
Hyperhidrosis

- Excessive production of sweat may be noticed on hand, armpit, and less commonly in the lower extremities

- Malone 1986
  - 7 pt
  - 13 sympathectomies
  - Excellent outcomes
  - Simple, safe, effective

- Appleby 1992
Lumbar Sympathetic Block

Anatomy
- L1: level of junction of 12\textsuperscript{th} rib and erector spinae muscles
- L4-L5: level of line drawn between posterior iliac crests
- 19 gauge needle 12-18cm long
- Injection between transverse process anterior border of vertebral body
- 15 mL Marcaine

Chemical blockade
- 3mL of 6.5% to 7% phenol dissolved in water
- 3mL of absolute alcohol
MIS Operative Technique

- **Laparoscopic**
  - **Thorascopic**
    - Lateral decubitus
    - 2 trocar with 30 telescope
    - Midaxillary line 4th/ 6th intercostal splace
    - Single lung ventilation
    - Symathetic thoracic ganglia (2,3,4) dissected and coagulated with cautery bilaterally
  - **Retroperitoneal/ Retroperitoneoscopy**
    - left lateral decubitus position
    - Trocars positioned in the retroperitoneal space and dissection by CO2 insufflation
    - IVC reclined
    - Rt sympathetic ganglia (L3-L4) were removed by bipolar electro-coagulation.
    - Aorta isolated on a vessel loop and careful anterior traction allowed a retro-aortic pre-vertebral approach bw the lumbar vessels.
    - The left sympathetic chain was dissected. Two ganglia (L3-L4) were removed by bipolar electro-coagulation
Open Operative Technique

Thoracic Sympathectomy
- 5th intercostal space
- Resect sympathetic thoracic ganglia (2,3,4) dissected and coagulated with cautery bilaterally

Open Lumbar Sympathectomy
- Lumbar sympathetic chain located medial to psoas muscle overlying transverse processes of lumbar spine
- Tactile identification by plucking the chain causes a “snap” (genitofemoral nerve nearby is less taut)
- Clips placed proximal and distal to proposed sites of transection
  - pathology to confirm sympathetic fibers
Complications

- Major complications result from failure to appreciate normal anatomic relationships
- Most common complication is postsympathectomy neuralgia
  - 50% of patients 5-20 days post operation
  - Annoying “ache” in anterolateral thigh worse at night unaffected by activity
  - Responds to analgesics and spontaneously resolves 8-12 weeks
- Sexual problems 25-50% of patients undergoing bilateral surgery
- Failure to achieve desired objectives of pain relief or tissue healing
Summary

- Sympathectomy increases peripheral blood flow by vasodilation of arterioles in cutaneous vascular beds

- Good for:
  - Causalgia
  - Hyperhidrosis
  - Vasospastic disorders (frostbite, Raynaud’s)

- PVD:
  - Some inoperable patients may receive sufficient increases to help heal superficial ischemic ulcers and relieve rest pain
  - Short-term
  - Palliative