The Hitchhikers Guide to the Lumbosacral Plexus

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2016-2017 UCSD MSK Fellow
Objectives

• Review the anatomy of the lumbosacral plexus and relevant lower extremity nerves.
• Better understand the sometimes complex pelvic courses of nerves.
• Familiarize with lumbosacral MR neurography (LS MRN) protocols and approaches to interpretation.
• Explore samples of potential pathological processes in the lumbosacral plexus.
“All you really need to know for the moment is that the universe is a lot more complicated than you might think, even if you start from a position of thinking it’s pretty damn complicated in the first place.”

Some might say the same about the LS plexus, but as we will see, there is nothing to panic about.
Brief History of Nerves

• Etymology:
  – Latin nervus "sinew, tendon; cord, bowstring." (1)

• 4\textsuperscript{th} Century BC, Aristotle (Greek) believed that nerves were controlled by and originated in the heart.

• 2\textsuperscript{nd} Century AD, Galen (Roman) concluded that the brain was the most important organ of the body, with the nerves emanating from it. Came to this conclusion via dissection. Also thought soft and hard nerves for sensation and motion and that nerves must be hollow.
Nerve Plexuses

Latin for “braid”

4 major plexuses in the body:

• Cervical
• Brachial
• Lumbar
• Sacral
Anatomy

“Lumbosacral” Plexus
• Lumbar Plexus
• Sacral Plexus
  – Lumbosacral Trunk
  – Pudendal Plexus
## Anatomy

<table>
<thead>
<tr>
<th>Lumbar Plexus (T12)L1-L4</th>
<th>Sacral Plexus (L4-S4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Branches</strong></td>
<td><strong>Branches</strong></td>
</tr>
<tr>
<td>– Iliohypogastric</td>
<td>– Superior Gluteal</td>
</tr>
<tr>
<td>– Ilioinguinal</td>
<td>– Inferior Gluteal</td>
</tr>
<tr>
<td>– Genitofemoral</td>
<td>– Sciatic</td>
</tr>
<tr>
<td>– Lateral femoral cutaneous</td>
<td>• Tibial</td>
</tr>
<tr>
<td>– Femoral</td>
<td>– Common Peroneal</td>
</tr>
<tr>
<td>– Obturator</td>
<td>– Posterior Femoral Cutaneous</td>
</tr>
<tr>
<td>• Accessory obturator (8-29%)</td>
<td>– Pudendal</td>
</tr>
</tbody>
</table>
Anatomy

- The lumbar and sacral plexuses arise from the ventral rami of the spinal nerves L1-L4 and L4-S4, respectively.

[Image: http://teachmeanatomy.info/lower-limb/nerves/lumbar-plexus/]

[Image: https://upload.wikimedia.org/wikipedia/commons/d/d1/Gray802.png]
Anatomy

- Neuron
  - Axon
  - Myelin

- Connective tissues
  - Endoneurium
  - Perineurium (surrounds fascicles)
  - Epineurium (also surrounds blood vessels)

http://www.lrn.org/Popup/Nervous/figure7_10.html
Anatomy

• Neuron
  – Axon
  – Myelin

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Anatomy

Anatomy

Anatomy

Pudendal Plexus (S2-S4)
- Perforating cutaneous
- Pudendal
- Visceral
- Muscular
- Anococcygeal*
Pudendal (Alcocks) Canal

[Diagram showing anatomical structures related to the pudendal canal, including:
- Sacral spinal nerves
- Pudendal nerve
- Lesser sciatic foramen
- Inferior anal nerve
- Dorsal nerve of penis
- Deep perineal nerve
- Superficial perineal nerve
- Posterior scrotal nerves
- Greater sciatic foramen
- Ischial spine
- Pudendal canal]

https://en.wikipedia.org/wiki/Pudendal_canal
Pudendal (Alcocks) Canal
Normal

Iliohypogastric

Ilioinguinal

Lateral Femoral Cutaneous
Normal

Genitofemoral

Normal

Normal

Normal

Sciatic
REVIEW OF NERVES INDIVIDUALLY
Upper Lumbar Plexus

- Iliohypogastric (T12 and L1) and Ilioinguinal Nerves (L1)
  - Internal oblique and transversus abdominis muscles.

- Genitofemoral Nerve (L1, L2)
  - Genital branch innervates the cremasteric muscle.

- Lateral Femoral Cutaneous Nerve (L2, L3)
  - No motor contribution.
IH, II, GF, and LFC Sensory

Femoral Nerve (L2, L3, L4)

- Illiacus
- Pectineus*
- Sartorius
- All the muscles of quadriceps femoris
  - Rectus femoris
  - Vastus medialis
  - Vastus lateralis
  - Vastus intermedius


http://teachmeanatomy.info/lower-limb/nerves/lumbar-plexus/
http://accessphysiotherapy.mhmedical.com/data/Multimedia/grandRounds/lumbar/media/lumbar_print.html
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  – Vastus intermedius

https://human.biodigital.com/
Femoral Nerve (L2, L3, L4)
Psoas Exception

- **Psoas** major is **innervated** by direct branches of the anterior rami off the lumbar plexus at the levels of L1-L3
- Iliacus is **innervated** by the femoral nerve
Femoral Nerve (L2, L3, L4)

- Femoral nerve splits into anterior and posterior branches below the inguinal ligament
- **Anterior**
  - Anterior femoral cutaneous
  - Muscular (Sartorius, Pectineus)
- **Posterior**
  - Muscular (Quadriceps)
  - Saphenous nerve*
  - Articular (Knee)

[Link to Learn More](http://teachmeanatomy.info/lower-limb/nerves/femoral-nerve/)
Femoral Nerve (L2, L3, L4)

- Femoral nerve splits into anterior and posterior branches below the inguinal ligament

  - **Anterior**
    - Anterior femoral cutaneous
    - Muscular (Sartorius, Pectineus)

  - **Posterior**
    - Muscular (Quadriceps)
    - Saphenous nerve*
    - Articular (Knee)

* Saphenous nerve is a branch of the femoral nerve.
Obturator Nerve (L2, L3, L4)

- Obturator externus
- Pectineus*
- Adductor longus
- Adductor brevis
- Adductor magnus
- Gracilis

http://teachmeanatomy.info/lower-limb/nerves/lumbar-plexus/
Obturator Nerve (L2, L3, L4)

- Obturator externus
- Pectineus*
- Adductor longus
- Adductor brevis
- Adductor magnus
- Gracilis
Obturator Nerve (L2, L3, L4)
Obturator Nerve (L2, L3, L4)

- Obturator nerve courses through obturator canal and splits into anterior and posterior branches.
  - **Anterior**
    - Gracilis, adductor brevis and longus
    - Rarely pectineus
    - Sensory to medial upper thigh
  - **Posterior**
    - Obturator externus, adductor magnus, occasionally Adductor brevis
    - Sensory to medial knee
Obturator Nerve (L2, L3, L4)
Obturator Nerve (L2, L3, L4)

- Femoral nerve
- Femoral artery
- Adductor longus (cut)
- Adductor brevis
- Obturator nerve (anterior division)
- Gracilis

Cutaneous branches of the obturator nerve
Anterior cutaneous branches of the femoral nerve
Sciatic Nerve (L4-S3)

- Muscles of the posterior thigh and the hamstring portion of the adductor magnus
- Indirectly innervates (via terminal branches) the muscles of the leg and foot
Sciatic Nerve (L4-S3)

- Muscles of the posterior thigh and the hamstring portion of the adductor magnus
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https://human.biodigital.com/
Sciatic Nerve (L4-S3)

- No direct sensory supply.
- Indirectly supplies much of the lower leg via common peroneal and tibial branches.
Posterior Femoral Cutaneous (S1-3)

- No muscle contribution
Superior Gluteal (L4, L5, S1)

- Gluteus minimus
- Gluteus medius
- Tensor fascia lata
Superior and Inferior Gluteal Nerves

http://radsouce.us/piriformis-syndrome/
Inferior Gluteal Nerve (L5, S1, S2)

- Gluteus maximus

https://human.biodigital.com/
http://teachmeanatomy.info/lower-limb/nerves/sacral-plexus/
Pudendal Nerve (S2, S3, S4)

- Skeletal muscles in the perineum
  - External urethral sphincter
  - External anal sphincter
  - Levator ani.
Other Muscle Branches Not Already Discussed

In addition to the five major nerves of the sacral plexus:

• Nerve to piriformis

• Nerve to obturator internus (also innervates superior gemelllus)

• Nerve to quadratus femoris (also innervates inferior gemelllus)
Tibial vs Common Peroneal

- 4 Compartment approach, 3 nerve branches
- Posterior Compartments:
  - Deep:
    - TIBIAL NERVE
  - Superficial:
    - TIBIAL NERVE
- Lateral compartment:
  - SUPERFICIAL PERONEAL N.
- Anterior compartment:
  - DEEP PERONEAL N.

von Keudell, Arvind G et al., Diagnosis and treatment of acute extremity compartment syndrome. The Lancet, Volume 386, Issue 10000, 1299 - 1310
Tibial Nerve (L4-S3)

**Deep Compartment**
- Popliteus
- Flexor Hallucis Longus
- Flexor Digitorum Longus
- Tibialis Posterior

**Superficial Compartment**
- Plantaris
- Soleus
- Gastrocnemius


http://accessphysiotherapy.mhmedical.com/data/Multimedia/grandRounds/lumbar/media/lumbar_print.html
Tibial Nerve (L4-S3)

Deep Compartment
• Popliteus
• Flexor Hallucis Longus
• Flexor Digitorum Longus
• Tibialis Posterior

Superficial Compartment
• Plantaris
• Soleus
• Gastrocnemius

https://human.biodigital.com/
Common Peroneal Nerve (L4-S3)

**Superficial fibular nerve:**  
(Lateral compartment)  
• Peroneus longus  
• Peroneus brevis

**Deep fibular nerve:**  
(Anterior compartment)  
• Tibialis anterior  
• Extensor digitorum longus  
• Extensor hallucis longus  
• Peroneus Tertius

Figure 28-16. The common peroneal nerve (L4, 5; S1, S2). In: Waxman SG. Clinical Neuroanatomy. 26th ed. New York, NY: McGraw-Hill; 2010.  
Common Peroneal Nerve (L4-S3)

**Superficial fibular nerve:**
(Lateral compartment)
- Peroneus longus
- Peroneus brevis

**Deep fibular nerve:**
(Anterior compartment)
- Tibialis anterior
- Extensor digitorum longus
- Extensor hallucis longus
- Peroneus Tertius
Sensory Innervation

- Obturator nerve
- Femoral nerve (anterior cutaneous nerves of thigh)
- Femoral nerve (saphenous nerve)
- Common fibular nerve (lateral cutaneous of calf)
- Common fibular nerve (superficial branch)
- Common fibular nerve (deep branch)
- Tibial nerve (sural nerve)
- Tibial nerve (medial calcaneal branches)
- Medial plantar nerve
- Lateral plantar nerve

Posterior rami (L1 to L3)
Posterior rami (S1 to S3)
Lateral cutaneous nerve of thigh (from lumbar plexus)
Posterior cutaneous nerve of thigh (from sacral plexus)
Sensory Innervation

- **Lateral plantar nerve**
  - (branch of the tibial nerve)

- **Medial plantar nerve**
  - (branch of the tibial nerve)

- **Saphenous nerve**
  - (branches of the common fibular and tibial nerves)

- **Sural nerve**
  - (branches of the common femoral nerve)

- **Medial calcaneal branches**
  - (branches of the tibial nerve)

http://accessphysiotherapy.mhmedical.com/data/Multimedia/grandRounds/lumbar/media/lumbar_print.html  
http://radsource.us/baxters-nerve/
“There is an art, or rather, a knack to flying. The knack lies in learning how to throw yourself at the ground and miss.”
Performing MR LSP Neurography

At UCSD:
Strong preference for 3 Tesla magnet (allows 3D sequences)

- Obl Axial T1
- Obl Axial T2 FS
- Obl Cor T1
- Obl Cor STIR
- Cor PD Cube (reformat to sag and axial)
- Cor T2 Cube FS (reformat to sag and axial)
- Obl Ax T1 FS PRE and POST Contrast
- Ax (straight) DWI
Possible Protocols

SPAIR- Selectively suppresses fat (similar to STIR)

SPACE- isotropic 3D TSE

VIBE- isotropic 3D GRE

Phased-array body coils +/- phased-array spinal coils

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Our 3-T MR Neurographic Protocol for Evaluating the Lumbosacral Plexus</th>
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<tbody>
<tr>
<td>Sequence</td>
<td>Area</td>
</tr>
<tr>
<td>Axial/T1-weighted turbo spin-echo</td>
<td>Bilateral</td>
</tr>
<tr>
<td>Axial/T2-weighted SPAIR</td>
<td>Bilateral</td>
</tr>
<tr>
<td>Coronal proton-density SPAIR</td>
<td>Bilateral</td>
</tr>
<tr>
<td>Coronal T1-weighted turbo spin-echo</td>
<td>Bilateral</td>
</tr>
<tr>
<td>Coronal 3D STIR SPACE</td>
<td>Bilateral</td>
</tr>
<tr>
<td>Sagittal T2-weighted 3D SPACE</td>
<td>Lumbar spine</td>
</tr>
<tr>
<td>Coronal 3D VIBE*</td>
<td>Bilateral</td>
</tr>
</tbody>
</table>

Note. Reprinted, with permission, from reference 2. SPAIR = sampling perfection with application of optimized contrasts using varying flip angles, SPAIR = spectral adiabatic inversion recovery, STIR = short inversion time inversion recovery, TE = echo time, 3D = three dimensional, TR = repetition time, VIBE = volume interpolated breath-hold examination.

*This sequence is optional.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Magnetic resonance neurography protocol on 3 Tesla scanner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse sequence</td>
<td>2D/3D</td>
</tr>
<tr>
<td>Axial T1W</td>
<td>2D</td>
</tr>
<tr>
<td>Axial T2 SPAIR</td>
<td>2D</td>
</tr>
<tr>
<td>Coronal STIR SPACE</td>
<td>3D</td>
</tr>
<tr>
<td>Sagittal T2 SPACE</td>
<td>3D</td>
</tr>
<tr>
<td>Axial DTI</td>
<td>2D</td>
</tr>
</tbody>
</table>

T: Tesla; 2D/3D: 2 dimensional/3 dimensional; DTI: Diffusion tensor imaging; SPACE: Sampling perfection with application optimized contrasts using variable flip angle evolutions; SPAIR: Spectral adiabatic inversion recovery; STIR: Short tau inversion recovery; TR: Repetition time; TE: Echo time
Possible Protocols

SPAIR - Selectively suppresses fat (similar to STIR)

SPACE - isotropic 3D TSE

VIBE - isotropic 3D GRE

Phased-array body coils +/- phased-array spinal coils

3D DW-SSFP

Reading MR Neurography/Plexography

• Things to have on hand:
  – History including motor and sensory deficits and laterality
  – Any relevant prior imaging
  – EMG results
  – Reference material
Sensory Dermatomes


http://accessphysiotherapy.mhmedical.com/data/Multimedia/grandRounds/lumbar/media/lumbar_print.html
http://www.backpain-guide.com/Chapter_Fig_folders/Ch06_Path_Folder/4Radiculopathy.html
What Do You Mean by Numb?

- Anesthesia - Loss of sensitivity

- Paresthesia - abnormal sensation such as tingling, tickling, pricking, numbness or burning of a person's skin with no apparent physical cause.

- Dysesthesia – unpleasant sensation, ranging from a mild tingling to incapacitating pain, from touch to the skin by normal stimuli (e.g. clothing)

- Allodynia - perception of innocuous stimuli as being painful*
Clinical Indications of MR Neurography

1. Confirmation of lumbrosacral plexus involvement and definition of the extent of disease in patients with a tumor or tumor-like condition.


4. Exclusion of a mass lesion in patients with unilateral abnormalities at EMG.

5. Exclusion of lesions in patients with normal or indeterminate findings at EMG and persistent symptoms.

6. Confirmation of lumbar plexitis or plexopathy in patients with clinically confusing findings and underlying known systemic conditions.

7. Evaluation of peripheral branch nerve abnormalities and associated lesions, such as piriformis syndrome, pudendal neuralgia, meralgia paresthetica, and nerve entrapments after hernia repair.


Categories of Disease

• Localized
  – Trauma, stretch injuries, extrinsic compression or infiltration

• Systemic conditions
  – Metabolic, autoimmune, ischemic, and inflammatory disorders and vasculitis
Localized

- **Neoplasms**
  - Benign and malignant peripheral nerve sheath tumors; lymphoma; malignancies, such as cervical cancer, uterine cancer, colorectal cancer, mesenchymal tumors, and metastatic infiltration; fibrolipomatous hamartoma.
- **Tumor-like**
  - Perineurioma, amyloid
  - Intra- and extraneural ganglion cysts
  - Neuroma
- **Entities related to the psoas major muscle or greater sciatic notch, such as hematoma, abscess, and phlegmon**
- **Endometriosis**
- **Trauma**

Systemic and Inflammatory

- Diabetes mellitus (diabetic amyotrophy)
- Inflammatory neuritis (eg, Guillain-Barré syndrome)
- Ischemic or vasculitic conditions
- Chronic inflammatory demyelinating polyneuropathy,
- Hereditary neuropathies (eg, Charcot-Marie-Tooth disease)
- Radiation neuropathy
- Sarcoidosis
- Connective tissue disorders
- Idiopathic (primary) lumbrosacral plexopathy (analogous to idiopathic brachial plexopathy or Parsonage Turner)
Characteristics of Nerve Disease

Direct imaging Features
Changes in:
• Nerve size
• Fascicular morphologic characteristics
• Signal intensity
• Nerve course

Indirect imaging Features
Changes of:
• Effacement of perineural fat planes as a result of focal fibrosis or mass lesions
• Regional muscle denervation*

Normal
Abnormal
Muscle Edema DDx

• Trauma
  – Effects of direct injury or tear
  – Denervation injury: denervation changes in muscles
• Early myositis ossificans
• Inflammatory myopathies
  – Dermatomyositis
  – Polymyositis
  – Inclusion body myositis
  – Eosinophilic myositis
  – Proliferative myositis
  – Myositis associated with connective tissue diseases
    • Systemic lupus erythematosus (SLE)
    • Sjögren syndrome
    • Overlap syndrome
    • Scleroderma
    • Mixed connective tissue disease
• Infective myositis including pyomyositis and viral myositis
• Infiltrating neoplasm, e.g. muscle lymphoma
• Acute or subacute phase of autoimmune neuropathy, e.g. Parsonage-Turner syndrome (in the shoulder)
• Rhabdomyolysis
  – Drug-induced
  – Intravenous heparin therapy
  – Trauma
  – Burns
  – Toxins
  – Autoimmune inflammation
• Vascular causes
  – Muscle infarction
    • Microvascular disease, e.g. Diabetes
  – Behcet disease
  – Sickle cell crisis
• Overuse
  – delayed onset muscle soreness (DOMS)

https://radiopaedia.org/articles/skeletal-muscle-oedema-on-mri-differential
## Denervation Changes

<table>
<thead>
<tr>
<th>Duration</th>
<th>Imaging Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute (&lt;1 month)</td>
<td>Areas of hyperintensity on T2-weighted images <em>(indicative of edema)</em></td>
</tr>
<tr>
<td>Subacute (1–3 months)</td>
<td>Areas of hyperintensity on T2- <em>(indicative of edema)</em> and T1-weighted images <em>(indicative of fatty infiltration)</em></td>
</tr>
<tr>
<td>Chronic (&gt;3 months)</td>
<td>Areas of hyperintensity on T1-weighted images <em>(indicative of fatty infiltration)</em> and reduced muscle volume <em>(indicative of atrophy)</em></td>
</tr>
</tbody>
</table>

Nerve Signal Intensity

• Similar to the brachial plexus, the signal intensity of the lumbrosacral nerves at T2-weighted imaging is considered abnormal when it approaches that of adjacent vessels and is asymmetric to that in the contralateral side.

• Minimally increased signal intensity at T2-weighted MR imaging should be approached with caution because “magic angle” artifact is a well-recognized occurrence at MR imaging of the lumbrosacral plexus.

LOCALIZED CASES
Nerve Trauma

• Mechanisms:
  1. Nerve sectioning
  2. Stretching
  3. Compression (intrinsic or extrinsic)

• May result from fractures, dislocations, or hematoma.


http://radsource.us/hamstring-tears/
Seddon Classification of Nerve Injury

Neurapraxia
• Axonal dysfunction without interruption of axons or nervous sheath
• Increased signal intensity in the involved nerve or nerves on T2-weighted images and no associated muscle denervation changes.

Axonotmesis
• Discontinuity of axons preserving the integrity of connective tissue (perineurium, endoneurium, and epineurium)
• Wallerian degeneration distal to the site of insult.
• Muscle denervation changes and nerve enlargement as well as disruption or effacement of nerve fascicles.

Neurotmesis
• Axonal injury and disruption of the surrounding perineurium and epineurial layers are seen
• Development of a neuroma in continuity or complete transection of the nerve with formation of an end-bulb (stump) neuroma.

http://clinicalgate.com/acute-nerve-injuries/
Severity of Traumatic Nerve Injury

<table>
<thead>
<tr>
<th>Birch &amp; Bonney</th>
<th>Non-degenerative</th>
<th>Degenerative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lundborg 1988</td>
<td>Physiological conduction block</td>
<td>Myelin damage</td>
</tr>
<tr>
<td></td>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td>Sunderland 1951</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Seddon 1942</td>
<td>Neurapraxia (Transient Block)</td>
<td>Axonotmesis (Lesion in Continuity)</td>
</tr>
</tbody>
</table>

Nerve injuries occur on a continuum of severity. Increasing cross-innervation leading to poorer outcome.

http://www.nerveclinic.co.uk/nerve-injuries/classification
Terminal Neuroma

• Any nerve that is lacerated, avulsed, or traumatized may form a neuroma. Neuroma is not a neoplasm.

• *Neuroma-in-continuity*
  – Spindle neuroma
  – Lateral neuroma
  – Neuroma after nerve repair

• *Neuromas in completely severed nerves*
  – Terminal neuroma (end-bulb neuroma)

• *Amputation stump neuroma*
Terminal Neuroma

- Neuroma:
  - Develops a few months after nerve trauma
  - Fusiform enlargement of the nerve of variable length
  - T1 iso- to muscle
  - T2 iso- to hyper-
  - Typically does not enhance
Terminal Neuroma

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  - Develops a few months after nerve trauma
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Neuroma in Continuity

Spindle or Fusiform
Bulbous
Lateral
Dumbell
Amputation Stump Neuroma
Sciatic Stretch Injury

Courtesy of Brady Huang
Prolonged Lithotomy Position

Traumatic Avulsion and Pseudomeningocele

L5 and S1 root avulsions and traumatic pseudomeningocele
Traumatic Avulsion and Pseudomeningocele
Obturator Nerve Injury
Femoral and Obturator Neuropathy

Cube PD

Cube T2 FS
Femoral Nerve Injury

Arthroplasty
Femoral Nerve Injury
Obturator Nerve Compression

Meralgia Parasthetica (LFC)

- Entrapment usually occurs in patients who are middle-aged and is bilateral in 10% of patients.

- **Common causes:**
  - Seat belt injury from motor vehicle accidents
  - Compression by tight garments
  - Anomalous pelvic positioning resulting from a leg length discrepancy
  - Abdominal (eg, ovarian and uterine) masses
  - Diabetes

http://epomedicine.com/medical-students/lumbosacral-plexus-simplified/
Meralgia Parathetica with a Focal Neuroma

Hockey Goalie–Baseball Pitcher Syndrome

Intraneural Ganglion Cyst

Case courtesy of Dr Jeremy Jones, Radiopaedia.org, rID: 24071
Intraneural Ganglion Cyst

- Cyst formation arising from an articular branch, usually of the peroneal nerve and less commonly the tibial nerve.
Intraneural Perineurioma

- Not a traumatic lesion like neuroma
- Rare benign peripheral nerve neoplasm
- Most commonly affects teenagers and young adults
- Features:
  - Fascicles involved individually
  - T1 hypo- to isointense
  - T2 hyperintense
  - Avid enhancement post gadolinium.
  - Atrophy may be present within the muscles innervated by the affected nerve

Nerve Lipomatosis

- Most commonly affects median nerve
- Sciatic nerve involvement quite rare.
- Also known as:
  - Neural Fibrolipoma
  - Intraneural Lipoma
  - Perineural Lipoma
  - Fibrolipomatous Hamartoma

Malignant Psoas Syndrome

- Patients present with:
  - Proximal lumbosacral plexopathy
  - Painful fixed flexion of the ipsilateral hip
  - Imaging evidence of ipsilateral psoas major muscle malignant involvement.

Relationship of Lumbar Plexus and Psoas

In one study:

• 61 of 63 cadaveric specimens showed the lumbar plexus within the psoas major muscle.
  – completely posterior to the psoas major muscle in only 2 of 63.

• In nearly all cases the femoral nerve as well as the obturator were located within the psoas major muscle at the L4-L5 level.

Piriformis Syndrome

- Hypertrophy, spasm, contracture, or inflammation/scarring of the piriformis muscle can compress the sciatic nerve and lead to piriformis syndrome.

- Syndrome characterized by isolated sciatic pain limited to the buttock with radiation down the thigh, no sensory deficits, and for which no other discernable cause can be found.
Piriformis Syndrome

• In one study of patients who responded well to piriformis surgery, 38.5% had ipsilateral muscle hypertrophy and 15% had muscle atrophy.

• Muscle asymmetry alone had a specificity of 66% and sensitivity of 46% in identification of patients with muscle-based piriformis syndrome.

• Ipsilateral nerve edema was associated with reproducible symptoms of piriformis syndrome (during adduction or abduction of the flexed internally rotated thigh) in 88% of patients.

• Use of both asymmetry of the piriformis muscle and increased nerve signal intensity improved the diagnostic ability of MR neurography to 93% specificity and 64% sensitivity in predicting the outcome of piriformis surgery.

Piriformis Syndrome

• Overall, the syndrome is somewhat controversial.

• Treatment of piriformis syndrome
  – Initially conservative: NSAIDS, PT, and image-guided CS muscle injection.
  – Botulinum toxin has been explored with promising results.
  – Surgical release of the sciatic nerve and sectioning of the piriformis muscle may be considered in refractory cases.
Split Sciatic Nerve
Beaton and Anson

A – Normal, inferior sciatic relative to piriformis
B – Sciatic nerve divisions pass through and below piriformis
C – Nerve above and below piriformis
D – Emerges through the piriformis
*E – Above and through piriformis
*F – Above piriformis

http://clinicalgate.com/sciatic-neuropathy/
Split Sciatic Nerve
Course of the Proximal Sciatic Nerve Roots

Course of the Proximal Sciatic Nerve Roots

- The S1 nerve roots were located above the piriformis muscle in 99.5% of cases (n=199).

- The S2 nerve roots were located above the piriformis muscle in 25% of cases (n=50) and traversed the muscle in the remaining 75% (n=150); 46% were in the top quarter (n=92), 22.5% were in the second quarter (n=45), and 6.5% were in the third quarter (n=13).

- The S3 nerve roots were located above the piriformis muscle in 0.5% of cases (n=1), below the muscle in 2.5% (n=5), and traversed the muscle in the remaining 97% (n=194); 1% were in the top quarter (n=2), 7% in the second quarter (n=14), 42.5% in the third quarter (n=85), and 46.5% in the bottom quarter (n=93).

- The S4 nerve roots were located above the piriformis in 0.5% of cases (n=1) and below the muscle in 95% (n=190); 4.5% were located within the piriformis muscle (n=9), all in the bottom quarter.
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Lumbar Disc Disease

Courtesy of Brady Huang
Endometriosis
Endometrial Carcinoma

T1 FS Post

T2 FS

Courtesy of Brady Huang
Endometrial Carcinoma

[Images: MRI and CT scan of the pelvis with annotations]

Courtesy of Brady Huang
Pudendal Nerve Compression

• 60-year-old male patient with a tingling sensation and burning pain in the right buttock and perineal area.

• Symptoms improved after aspiration of the cyst.

Pudendal (Alcocks) Canal

Sites of Entrapment:

- At the levels of the SS and ST ligaments
- At the entrance to or within Alcocks canal due to the falciform process of the sacrotuberous ligament or a thickened obturator fascia.

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Pudendal Nerve Compression (Cyclist)
SYSTEMIC DISEASES
Radiation Induced Plexopathy
Radiation Induced Plexopathy
Radiation Induced Plexopathy
Radiation Induced Plexopathy

• Patients with a history of cancer and radiation therapy may have recurrent tumor or radiation-induced plexopathy.

• Features that favor postradiation plexopathy:
  – Absence of focal or eccentric enhancing mass.
  – Diffuse, uniform, symmetric swelling and T2 hyperintensity of the plexus within the radiation field and soft tissues changes.
  – Diffuse, uniform postcontrast enhancement for months to years after treatment may also result from radiation injury.

Radiation Induced Plexopathy

Charcot Marie Tooth

Hypertrophic LS Plexopathies

• Hypertrophy and diffuse hyper-intensity on T2W images of the plexus components have been described in:
  – Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)
  – Multifocal Motor Neuropathy (MMN)
  – Hereditary Hypertrophic Motor And Sensoryneuropathy (HMSN or CMT)
Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)

• Immune mediated neurological disorder causing damage to the myelin sheath of the peripheral nerves.

• Radiologic characteristics include diffuse marked enlargement of peripheral nerves.

• Gadolinium enhancement may be present in active disease.

Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)
Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)
Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)

Acute Inflammatory Demyelinating Polyneuropathy (AIDP or Guillain-Barre)

- MRI findings of the lumbosacral plexus for both AIDP and CIDP overlap and the distinction is therefore based on clinical features and time course.

Neurofibromatosis Type 1

Plexiform Neurofibroma

- Multiple expansive heterogeneous images located in the right lumbosacral plexus region with involvement of the femoral nerve, lumbosacral trunk, sciatic nerve, internal obturator, and pudendal nerve.

Cejas C, Escobar I, Serra M, Barroso F. High resolution neurography of the lumbosacral plexus on 3T magnetic resonance imaging. *Radiol (English Ed.* 2015;57(1):22-34.)
Isolated Peripheral Nerve Sheath Tumors

- Multiple peripheral nerve sheath tumors which demonstrate the target and tail signs involving the right Ilioinguinal nerve.
HIV Associated Amyotrophy vs Mononeuropathy Multiplex
Diabetic Amyotrophy

- AKA- Diabetic lumbosacral radiculoplexus neuropathy (DLRPN)
- Usual history of poorly controlled diabetes
- Perivascular inflammation and secondary nerve infarction involving L2, L3 and L4 roots
- Severe proximal leg and hip pain.
- Progressive proximal weakness of the affected extremity.
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Idiopathic Lumbrosacral Plexopathy

- AKA- non-diabetic lumbosacral radiculoplexus neuropathy (LRPN).

- Usually unilateral LSP hyperintensity on T2-weighted images, with or without contrast enhancement.

- Painful idiopathic LSP afflicts lumbar plexus predominantly, although sacral plexopathy or complete LSP might also occur.

- Monophasic disease, with relapses and continuous progression unusual.
Idiopathic Lumbrosacral Plexopathy

Summary

...There's a lot to know...
References

End of Year Lecture:
Mission Accomplished!