Imaging of the Lumbosacral Plexus

Hailey Allen, MD
Assistant Professor of Radiology
MSK Fellowship Director

Nothing to Disclose
Outline

- Lumbosacral plexus anatomy
- Sample MRI protocol + search pattern
- Important pathology to recognize:
  - Compression Neuropathy
  - (Trauma)
  - Infectious and Inflammatory Pathology
  - Tumor and Tumor-Like Conditions
The Lumbosacral Plexus
Lumbosacral Plexus

Lumbosacral plexus (Patton and Thibodeau, 2010)
Lumbosacral Plexus
Lumbar Plexus

- Derived from the ventral rami of T12-L4
- Courses within or posterior to the psoas major muscle

**Anterior:**
- Genitofemoral nerve (L1, L2)

**Medial:**
- Obturator nerve (L2-L4)

**Lateral:**
- Iliohypogastric (L1)
- Ilio-inguinal (L1)
- Femoral (L2-L4)
- Lateral cutaneous nerve of the thigh (L2, L3)
Sacral Plexus

- Derived from the lumbosacral trunk (L4, L5) and the ventral rami of S1-S4
- Courses along the ventral piriformis muscle
- Each ventral ramus has anterior and posterior divisions which combine with other levels

Terminal Nerves
- Superior/inferior gluteal nerves
- Sciatic nerve
- Pudendal nerve
- Nerve to piriformis
- Posterior cutaneous nerve of the thigh
## Femoral Nerve

<table>
<thead>
<tr>
<th>Roots</th>
<th>L2-L4 posterior divisions; lumbar plexus</th>
</tr>
</thead>
</table>
| Motor          | ❖ Anterior compartment of the thigh (quadiceps, sartorius)  
                  ❖ Pectineus  
                  ❖ Iliacus |
| Sensory        | Anterior thigh and knee, anterior and medial knee and leg (saphenous nerve) |

[Image of MRI scan and diagram showing the femoral nerve and its branches.]

Ax T1
### Obturator Nerve

<table>
<thead>
<tr>
<th>Roots</th>
<th>L2-L4 anterior divisions, lumbar plexus</th>
</tr>
</thead>
</table>
| **Motor**              |  ❖ Medial compartment of the thigh (adductors, gracilis)*  
                          |  ❖ Obturator externus                   |
| **Sensory**            |  *Medial upper thigh, hip joint, knee joint* |

*Hamstring portion of adductor magnus is supplied by the sciatic and femoral nerves*
<table>
<thead>
<tr>
<th>Roots</th>
<th>L4-S3 from lumbosacral trunk and sacral plexus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>- Posterior compartment of the thigh</td>
</tr>
<tr>
<td></td>
<td>- Branch to adductor magnus</td>
</tr>
<tr>
<td></td>
<td>- Anterior, posterior, and lateral compartments of the leg (tibial, deep fibular, superficial fibular)</td>
</tr>
<tr>
<td>Sensory</td>
<td>Lateral calf (common fibular), posterolateral calf (sural), calcaneus and plantar foot (plantar nerves, medial calcaneal branches)</td>
</tr>
<tr>
<td>Roots</td>
<td>S2-S4 anterior divisions, sacral plexus</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------</td>
</tr>
</tbody>
</table>
| Motor | ❖ Pelvic Floor (bulbospongiosus, ischiocavernosus)  
       | ❖ Levator ani (iliococcygeus, pubococcygeus, puborectalis)  
       | ❖ External anal sphincter  
       | ❖ External urethral sphincter |
| Sensory | Perineum  
          | Sensory and sympathetic innervation of the sex organs |
Sample Protocol
+
Search Pattern
MRI Protocol Overview

Coronal T1
Coronal STIR
Axial T1
Axial T2 FS
Sagittal PD FS

Oblique
Coronal T1
Oblique Coronal T2 FS
Coronal T1 FS + Contrast
Axial T1 FS + Contrast
3D Coronal STIR SPACE
MRI Protocol Considerations

- 3T preferred unless pelvic/lumbosacral hardware

- Field of View:
  - Hip to hip (ML)
  - L4 to ischial tuberosities (SI)
  - Skin to skin (AP)

- 5 mm slices
MRI Protocol Considerations

- Oblique coronal obtained parallel to sacrum
MRI Protocol and Search Pattern

T1 Sequence: Key Facts

- Perineural fat
- Muscle atrophy
- Muscle fatty infiltration
- Bone marrow
- Met-Hg blood products
MRI Protocol and Search Pattern

Fluid Sensitive Sequences (T2 FS / STIR): Key Facts

- Nerve caliber
  - Similar in size to adjacent arteries
  - Smooth tapering distally
- Preserved fascicular pattern
- Nerve signal intensity

- Perineural edema
- Muscle edema
  - (STIR most sensitive)
High signal-to-noise ratio

Isotropic; permits multiplanar reconstruction (MPRs) and MIPs

Excellent fine detail assessment of nerves
Assess for:
- Infection
- Acute Inflammation
- Tumor
- Postoperative

- Normal nerves show minimal to no enhancement
- Intact blood-nerve barrier

Sciatic mononeuropathy
*Case courtesy of Dr. Avneesh Chaabra*
Case Based Review

- Compressive Neuropathy
- *(Trauma)*
- Infectious and Inflammatory Pathology
- Tumor and Tumor-Like Conditions
Acute, Compressive Neuropathy

Acute onset left lower extremity pain, weakness, and numbness after prolonged lithotomy position for a partial colectomy

- Enlarged, hyperintense and enhancing left sciatic nerve with perineural edema and enhancement
- Lack of muscle edema corresponds with acuity
Chronic Compressive Neuropathy

Progressive medial thigh numbness, weakness in adduction following complex rectocele/cystocele resection and reconstruction

- Adductor edema and atrophy
- Enlarged, hyperintense obturator nerve
Piriformis Syndrome

Right sided deep gluteal pain

Accessory piriformis muscle, compressing the right S2 nerve root at the level of the sacral foramina

Cor Oblique T1
Axial T1

* American Journal of Roentgenology. 2004;183: 63-64. 10.2214/ajr.183.1.1830063
Compression

Piriformis Syndrome

DOI 10.1007/s00256-015-2124-6
Enlarged, hyperintense left pudendal nerve in Alcock’s canal distal to the ischial spine.
Compression

Pudendal Neuropathy

In Neurosurgical Focus Volume 26; Issue 2 (Feb 2009): Peripheral Nerve Surgery; Biology, Entrapment, and Injuries
Infection
Inflammation

Pain, swelling and fevers; two weeks after hamstring tendon repair

- Abscess adjacent to the ischial tuberosity
- Enlarged, hyperintense sciatic and pudendal nerves
- Extensive perineural and muscular edema
Chronic Inflammatory Neuropathy

Myasthenia gravis; presenting with worsening right buttock pain and weakness

- Enlarged, hyperintense right sciatic and superior gluteal nerves
- Loss of normal nerve fascicular pattern (sciatic)
- Gluteus medius/minimus edema and atrophy (not shown)
Infection
Inflammation

Radiation Plexopathy

Prostate cancer and right pelvic nodal metastases treated with radiation presenting with right leg pain and weakness

- Diffuse enlargement of the nerves of the lumbosacral plexus
- Edema and enhancement of the right piriformis muscle
- No focal nodularity or perineural masses
History of prostate cancer and radiation presenting with sx of pudendal neuropathy

- Multiple ill-defined enhancing masses in the pelvis, tethering the rectum, causing right hydronephrosis
- Enlarged, enhancing right pudendal nerve
Peripheral Nerve Sheath Tumor: Benign

History of rectal cancer and a presacral mass on multiple CTs

- Well-circumscribed mass
- Homogeneous T2 hyperintensity and enhancement
- Tail going into the S2 neural foramen
- Low level FDG uptake
History of NF1 and a growing posterior thigh mass

- Mass arising from the sciatic nerve
- Peripheral, irregular enhancement
- Central necrosis
- Perilesional edema
- Growth

Imaging does not consistently differentiate between benign and malignant nerve sheath tumors.
Plexiform Neurofibroma

History of NF1, presenting with worsening bilateral leg weakness

- Extensive nodular/beaded nerve enlargement
- Pathognomonic for NF1
- 5-10% incidence of malignant transformation
- Look for long bone bowing, vertebral body scalloping/dural ectasia, cutaneous neurofibromas
**Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)**

Two months of progressive back pain and weakness

- Rare autoimmune demyelinating disorder of peripheral nerves
- Presents with progressive pain, weakness, sensory deficits, and areflexia lasting > 2 months
- Considered a chronic form of Guillain-Barre syndrome
- Symmetric enlargement of the nerves, “onion bulb” pattern
- DDx: Charcot-Marie-Tooth
Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)

Two months of progressive back pain and weakness

High-resolution 3T Magnetic Resonance Neurography of The Lumbosacral Plexus in Several Clinical Scenarios.
Conclusion

- The diagnostic work-up of patients with symptoms of plexopathy symptoms is complex and multi-modal.
- Knowledge of plexus anatomy is key to accurately identifying and characterizing abnormalities of the plexus on MRI.
- EMG findings and a solid clinical history are invaluable and can help focus your search pattern.
Thank you for your attention

hailey.allen@hsc.utah.edu