Horner Syndrome

- Cause: *Sympathetic dysfunction*
- Triad:
  - Ptosis
  - Miosis
  - Anhidrosis
Horner Syndrome

- Cause: Sympathetic dysfunction
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Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

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*What does the term ‘ptosis’ mean in this context?*

- The upper lid is too... low
- The lower lid is too... high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.
Horner Syndrome

● Cause: Sympathetic dysfunction

● Triad:
  ● Ptosis

What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What does the term ‘ptosis’ mean in this context?**
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?**
Both

*In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?*
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - **Ptosis**

**What does the term ‘ptosis’ mean in this context?**

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?**

Both

**With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?**

The upper lid is too...

The lower lid is too...
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horners?
The upper lid is too...low
The lower lid is too...high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term ‘ptosis’ mean in this context? It describes an abnormal and unintended narrowing of the interpupillary fissure.

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both? Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
- The upper lid is too... low
- **The lower lid is too... high**

Note: Some authors refer to this malpositioning of the LL as ‘reverse ptosis;’ however, to the best of my ability to ascertain, this term does not appear in any BCSC book.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

Regarding each lid, how is it (mal)positioned in ptosis secondary to Horners?

- **The upper lid is too...low**
- **The lower lid is too...high**

What muscle is most influential in terms of positioning the upper lid?

The levator palpebrae superioris

What nerve innervates the levator?

CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?

No
Cause: Sympathetic dysfunction

Triad:

- Ptosis

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?

- The upper lid is too...low
- The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?

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What nerve innervates the levator?

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Is levator dysfunction implicated in the ptosis associated with Horner's?

No
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**
  - **Miosis**
  - **Anhidrosis**

**What does the term 'ptosis' mean in this context?**
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?**
Both.

**With regard to each lid, how is it (mal)positioned in ptosis secondary to Horners?**
- **The upper lid is too...low**
- **The lower lid is too...high**

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner's?**
No
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horner’s?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris.

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What does the term 'ptosis' mean in this context?**

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?**

Both

**With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?**

- The upper lid is too...low
- The lower lid is too...high

**What muscle is most influential in terms of positioning the upper lid?**

The levator palpebrae superioris

**What nerve innervates the levator?**

CN3

**Is levator dysfunction implicated in the ptosis associated with Horner’s?**

No
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
- The upper lid is too... low
- The lower lid is too... high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

### What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

### In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

### With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low
The lower lid is too...high

### What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

### What nerve innervates the levator?
CN3

### Is levator dysfunction implicated in the ptosis associated with Horner's?
No

### If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

### Are the fibers in Müller's muscle striated, or smooth?
Smooth

### Where is Müller's muscle located?
It forms a narrow strip between the distal tendon of the levator and the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid? The levator palpebrae superioris.

What nerve innervates the levator? CN3.

Is levator dysfunction implicated in the ptosis associated with Horner's? No.

In regard to each lid, the upper lid is too...low.

The lower lid is too...high.

If not the levator, what named muscle is implicated in the ptosis associated with Horner's? Müller's muscle.

What does the term 'ptosis' mean in this context? It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both? Both.

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's? The upper lid is too...low.

The lower lid is too...high.

What muscle is most influential in terms of positioning the upper lid? The levator palpebrae superioris.

What nerve innervates the levator? CN3.

Is levator dysfunction implicated in the ptosis associated with Horner's? No.

If not the levator, what named muscle is implicated in the ptosis associated with Horner's? Müller's muscle.

Are the fibers in Müller's muscle striated, or smooth? Smooth.

Where is Müller's muscle located? It forms a narrow strip between the distal tendon of the levator and the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
- The upper lid is too...low
- The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?
Smooth

Müller's muscle forms a narrow strip between the distal tendon of the levator and the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

*What muscle is most influential in terms of positioning the upper lid?*
- The levator palpebrae superioris

*What nerve innervates the levator?*
- CN3

*Is levator dysfunction implicated in the ptosis associated with Horner's?*
- No

- **The upper lid is too...low**
- **The lower lid is too...high**

*If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?*
- Müller’s muscle

*Are the fibers in Müller’s muscle striated, or smooth?*
- Smooth
Horner Syndrome

- **Cause**: Sympathetic dysfunction
- **Triad**:
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator? CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

In regard to each lid, the upper lid is too... low
The lower lid is too... high

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Smooth muscle fibers... What does this imply about the innervation of Müller’s muscle?
Horner Syndrome

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What muscle is most influential in terms of positioning the upper lid?
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What muscle is most influential in terms of positioning the upper lid?
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What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Smooth muscle fibers...What does this imply about the innervation of Müller’s muscle?
It implies its innervation is via the ANS (in this case, the sympathetic branch of the ANS)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

**The upper lid is too...low**

The lower lid is too...high

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
Horner Syndrome

- Cause: Sympathetic dysfunction
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**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner's?**
No

In regard to each lid, consider:
The upper lid is too... low
The lower lid is too... high

**If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?**
Müller’s muscle

**Are the fibers in Müller’s muscle striated, or smooth?**
Smooth

**Where is Müller’s muscle located?**
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid
Horner Syndrome

Müller’s muscle
Horner Syndrome

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The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?

**levator palpebrae superioris**

What nerve innervates the levator?

CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?

Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?

Smooth

Where is Müller's muscle located?

Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.

If innervation to the levator is lost, how much ptosis results?

Total/complete— the lid is closed

If innervation to Müller's muscle is lost, how much ptosis results?

Not nearly so much—about 2 mm or so
Horner Syndrome

● Cause: **Sympathetic dysfunction**

● Triad:

  ● **Ptosis**

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The upper lid is too... low

The lower lid is too... high

What muscle is most influential in terms of positioning the upper lid?

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What nerve innervates the levator?

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If not the levator, what named muscle is implicated in the ptosis associated with Horner's?

Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?

Smooth

Where is Müller's muscle located?

Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**
  - **Miosis**
  - **Anhidrosis**

**What does the term 'ptosis' mean in this context?**

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?

The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?

**levator palpebrae superioris**

What nerve innervates the levator?

CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?

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Are the fibers in Müller’s muscle striated, or smooth?

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Where is Müller’s muscle located?

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Total/complete—the lid is closed.

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Not nearly so much—about 2 mm or so.
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  - Miosis
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**Horner Syndrome**

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Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?

- The upper lid is too... low
- The lower lid is too... high

What muscle is most influential in terms of positioning the upper lid?

*levator palpebrae superioris*

Is levator dysfunction implicated in the ptosis associated with Horner's?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?

Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?

Smooth

Where is Müller's muscle located?

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It describes an abnormal and unintended narrowing of the interpalpebral fissure.

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Both.

**With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?**
- The upper lid is too... low
- The lower lid is too... high

What muscle is most influential in terms of positioning the upper lid?
- **levator palpebrae superioris**

If innervation to the levator is lost, how much ptosis results?
Total/complete—the lid is closed.

If innervation to Müller's muscle is lost, how much ptosis results?
Not nearly so much—about 2 mm or so.

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No.

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle.

Are the fibers in Müller’s muscle striated, or smooth?
Smooth.

Where is Müller’s muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

Horner’s ptosis in adult

Horner’s ptosis in infant

Horner syndrome: Ptosis
Horner Syndrome

Horner’s ptosis in adult

Not Horner’s ptosis in child (ptoo pttotic)

Horner’s ptosis in infant

Not Horner’s ptosis in adult (ptoo pttotic)

Horner syndrome: Ptosis
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?
Smooth

Where is Müller's muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.

If Müller's muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?
The lower lid contains a set of smooth-muscle fibers that function in a manner analogous to Müller's muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller's muscle.)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner’s?**
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
The upper lid is too... low

**The lower lid is too... high**

**If Müller’s muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?**
The lower lid contains a set of smooth-muscle fibers that function in a manner analogous to Müller’s muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller’s muscle.)

**Where is Müller’s muscle located?**
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner syndrome?

The upper lid is too... low

The lower lid is too... high

What muscle is most influential in terms of positioning the upper lid?

The levator palpebrae superioris

What nerve innervates the levator?

CN3

Is levator dysfunction implicated in the ptosis associated with Horner syndrome?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner syndrome?

Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?

Smooth

Where is Müller’s muscle located?

Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.

If Müller’s muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?

A set of smooth-muscle fibers function in a manner analogous to Müller’s muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller’s muscle.)

Does this collection of LL smooth muscle fibers have a name?

Not really (although it is sometimes referred to as the capsulopalpebral muscle because of its location.)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

*What muscle is most influential in terms of positioning the upper lid?*
The levator palpebrae superioris

*What nerve innervates the levator?*
CN3

*Is levator dysfunction implicated in the ptosis associated with Horner's?*
No

With regard to each lid, how is it (mal)positioned in Ptosis secondary to Horner's?
- The upper lid is too... low
- The lower lid is too... high

Does this collection of LL smooth muscle fibers have a name?
Not really (although it is sometimes referred to as the muscle because of its location)

*If Müller's muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?*
- The lower lid contains a set of smooth-muscle fibers that function in a manner analogous to Müller's muscle, and are innervated in identical fashion. (These LL fibers are less organized and far weaker than those comprising Müller's muscle.)

*If not the levator, what named muscle is implicated in the ptosis associated with Horner's?*
Müller's muscle

*Are the fibers in Müller's muscle striated, or smooth?*
Smooth

*Where is Müller's muscle located?*
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner's?**
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low

The lower lid is too...high

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner's?**
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

**Where is Müller's muscle located?**
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid

**Does this collection of LL smooth muscle fibers have a name?**
Not really (although it is sometimes referred to as the capsulopalpebral muscle because of its location)

**If Müller's muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?**
The lower lid contains a set of smooth-muscle fibers that function in a manner analogous to Müller's muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller's muscle.)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - **Miosis**

*How does sympathetic dysfunction result in a relatively miotic pupil?*
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - **Miosis**

*How does sympathetic dysfunction result in a relatively miosis pupil?*
At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

Horner's miosis in adult

Horner's miosis in infant

Horner syndrome: Miosis
Horner Syndrome

- **Cause**: *Sympathetic dysfunction*
- **Triad**:
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes? **Anisocoria**

How does sympathetic dysfunction result in a *relatively miotic* pupil?
At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes? Anisocoria

How does sympathetic dysfunction result in a relatively miotic pupil? At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

*Horner Syndrome*

- **Ptosis**
- **Miosis**

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?

Horner Syndrome

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.

When faced with anisocoria, what do you want to know first and foremost?

- Which pupil (if either) is 'the culprit'; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

- How can you tell which pupil is the culprit?
  - By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in **dim** light, this indicates the smaller pupil isn't dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.
  - Likewise, if the anisocoria is more pronounced in **bright** light, the larger pupil isn't constricting properly, and is therefore abnormal. A pupil that doesn't constrict as it should is suggestive of a parasympathetic problem.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes? 
Anisocoria

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and its pupil will be relatively miosis in comparison to that of the fellow eye.

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

If the anisocoria is more pronounced in dim light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.

Likewise, if the anisocoria is more pronounced in bright light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a parasympathetic problem.
Horner Syndrome

● Cause: Sympathetic dysfunction
● Triad:
  ● Ptosis
  ● Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis

'Relatively miotic' implies the pupils are not the same size. What term describes a state of unequal pupil sizes? *Anisocoria*

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?
By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in **dim** light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a *sympathetic* problem.

How does sympathetic dysfunction result in a relatively miotic pupil?
At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis
  - Miosis
  - Anhidrosis

‘Relatively miotic’ implies the pupils are not the same size.
What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?
By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in dim light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.
Horner Syndrome

Horner syndrome: Anisocoria greater in dim light
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - **Miosis**
  - Anhidrosis

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?
By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in *dim* light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem. Likewise, if the anisocoria is more pronounced in *bright* light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a sympathetic problem.
Horner Syndrome

● Cause: Sympathetic dysfunction

● Triad:
  ● Ptosis
  ● Miosis

*Relatively miosis* implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

Anisocoria

---

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?
By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in dim light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem. Likewise, if the anisocoria is more pronounced in bright light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a parasympathetic problem.
Horner Syndrome

- **Cause:** Sympathetic dysfunction

- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes? **Anisocoria**

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; i.e., is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?
By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in dim light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem. Likewise, if the anisocoria is more pronounced in bright light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a parasympathetic problem.

What if the anisocoria is the same under all lighting conditions?
Then it is nonpathologic or physiological anisocoria (a common finding).
Horner Syndrome

- **Cause**: Sympathetic dysfunction

- **Triad**:
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is “the culprit”; i.e., is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

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What if the anisocoria is the same under all lighting conditions?
Then it is nonpathologic or physiological anisocoria (a common finding)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

**Anisocoria**

When faced with anisocoria, what do you want to know first and foremost?

What if the anisocoria is the same under all lighting conditions?

Then it is nonpathologic or **physiological anisocoria** (a common finding)

What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?

Which pupil (if either) is ‘the culprit’: is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?

By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in **dim** light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.

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How does sympathetic dysfunction result in a relatively miotic pupil?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and its pupil will be relatively miotic in comparison to that of the fellow eye.

What if the anisocoria is the same under all lighting conditions?

Then it is nonpathologic or physiological anisocoria (a common finding)

Next we will embark on an extensive review of the sympathetic pathway (and less extensively, the parasympathetic) as it relates to the eye and orbit. Buckle up!
Horner Syndrome

*Neural pathway in Horner syndrome:*

First of three components

Second of three components

Third of three components
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons

Second-order neurons

Third-order neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travels in spinal cord
--Synapses in ciliospinal center of Budge

**Second-order neurons**
--Originates at Budge center
--Exits spinal cord
--Travels in sympathetic chain
--Synapses in superior cervical ganglion

**Third-order neurons**
--Originates in superior cervical ganglion
--Travels with internal carotid artery into cavernous sinus
--Hops onto VI, then V1 to enter orbit
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in two words

Second-order neurons

Third-order neurons
**Horner Syndrome**

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord

Second-order neurons

Third-order neurons
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons

Third-order neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

At what level of the spinal cord is the center of Budge found?

Second-order neurons

Third-order neurons
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons

Third-order neurons

At what level of the spinal cord is the center of Budge found?
C8-T2
Horner Syndrome

Müller’s muscle
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in two words

**Third-order neurons**
**Horner Syndrome**

_Neural pathway in Horner syndrome:_

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

*What major structure do these fibers pass over?*
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

What major structure do these fibers pass over?
The lung apex
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

What major structure do these fibers pass over?
The lung apex

Foreshadowing alert!
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

**Second-order neurons**
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in [three words]

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

**Third-order neurons**
Horner Syndrome

Sympathetic pathway: 2nd order neuron
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...?

Third-order neurons

By what other name is the superior cervical ganglion known?
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in **superior cervical ganglion** aka...the **stellate ganglion**

Third-order neurons

*By what other name is the superior cervical ganglion known?*
The **stellate ganglion**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka*...?
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka*...the stellate ganglion

Third-order neurons

*By what other name is the superior cervical ganglion known?*
*The stellate ganglion*

*Speaking of other names…The second-order neurons are often referred to by another name, one owing to the relationship between these neurons and the ganglion to which they are headed. What is that name?*
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons

*By what other name is the superior cervical ganglion known?*
The *stellate ganglion*

*Speaking of other names...The second-order neurons are often referred to by another name, one owing to the relationship between these neurons and the ganglion to which they are headed. What is that name?*
**Pre-ganglionic** neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons**
--Originate in superior cervical ganglion

*(No question—proceed when ready)*
Horner Syndrome

Sympathetic pathway: 3\textsuperscript{rd} order neuron
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...?*
--Originate in superior cervical ganglion

Likewise, the third-order neurons are also referred to by a term owing to their relationship with the stellate ganglion. What is that term?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion

Likewise, the third-order neurons are also referred to by a term owing to their relationship with the stellate ganglion. What is that term? Post-ganglionic neurons
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the orbit

Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Horner Syndrome

_Neural pathway in Horner syndrome:_

**First-order neurons**
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons** *aka...post-ganglionic neurons*
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  ---- Fibers bound for the pupil join _cranial nerve_, then _different cranial nerve_
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons** aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

**Third-order neurons** aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Sympathetic pathway: 3\textsuperscript{rd} order neuron
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

*For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?*

--In the sphenoid sinus.

----Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka*...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

For how long do these pupil-bound postganglionic sympathetic fibers run with CN6? Not long--just a few millimeters

--In the sinus:

----Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?
Not long--just a few millimeters

If it’s so trivial, why bother mentioning the relationship at all?

---In the sinus:

----Fibers bound for the pupil join CN6, then V1
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka*... pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

*For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?*
Not long--just a few millimeters

*If it’s so trivial, why bother mentioning the relationship at all?*
Because of its importance in lesion localization. If a pt presents with a LR palsy +
ipsilateral miotic pupil, the lesion *must* be located in the cavernous sinus!

--In the sinus.

----*Fibers bound for the pupil join CN6*, then *V1*
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

**Third-order neurons**
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve)

Horner Syndrome aka…pre-ganglionic neurons
aka…the stellate ganglion
aka…post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
-- -- --
With which branch do the postganglionic sympathetics run?
The nasociliary nerve
The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion
Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?
The long ciliary nerves
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve)

Horner Syndrome

Horner Syndrome

aka...pre-ganglionic neurons
aka...the stellate ganglion
aka...post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?

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The long ciliary nerves
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
Neural pathway in Horner syndrome:

First-order neurons
--Origin in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Origin at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Origin in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

Horner Syndrome
aka...pre-ganglionic neurons
aka...the stellate ganglion
aka...post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?

Mnemonic forthcoming…
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
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--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
---Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--N
--F
--L

Mnemonic forthcoming…
Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
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Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

Mnemonic forthcoming…
Horner Syndrome

Ophthalmic nerve (V₁)

Frontal
Nasociliary
Lacrimal
Horner Syndrome

**Neural pathway in Horner syndrome:**

**First-order neurons**
-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

**Second-order neurons**
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

**Third-order neurons**
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
   ---- Fibers bound for the pupil join CN6, then V1

**V1 (aka the ophthalmic nerve) breaks into three branches. What are they?**
-- Nasociliary
-- Frontal
-- Lacrimal

**With which branch do the postganglionic sympathetics run?**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
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V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

With which branch do the postganglionic sympathetics run?
The nasociliary
Neural pathway in Horner syndrome:

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Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
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*V1 (aka the ophthalmic nerve) breaks into three branches. What are they?*
--Nasociliary
--Frontal
--Lacrimal

*With which branch do the postganglionic sympathetics run?*
The nasociliary

*The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?*
Neural pathway in Horner syndrome:

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-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

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-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
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Third-order neurons
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-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
   ---- Fibers bound for the pupil join CN6, then V1

Horner Syndrome

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
-- Nasociliary
-- Frontal
-- Lacrimal

With which branch do the postganglionic sympathetics run?
The nasociliary

The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion
Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

Horner Syndrome
aka pre-ganglionic neurons
aka the stellate ganglion
aka post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

With which branch do the postganglionic sympathetics run?
The nasociliary

The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion

Will the sympathetics synapse in the ciliary ganglion as well?
No. Remember, these are postganglionic sympathetics. They will pass through the ganglion without synapsing.
Neural pathway in Horner syndrome:

First-order neurons
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

Second-order neurons
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion

Third-order neurons
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  - Fibers bound for the pupil join CN6, then V1

Horner Syndrome

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- Nasociliary
- Frontal
- Lacrimal

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The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
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--- Fibers bound for the pupil join CN6, then V1
Neural pathway in Horner syndrome:

First-order neurons:
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

Second-order neurons:
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion

Third-order neurons:
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  - Fibers bound for the pupil join CN6, then V1

Horner Syndrome

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
- Nasociliary
- Frontal
- Lacrimal

With which branch do the postganglionic sympathetics run?
The nasociliary

The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion

Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?

The long ciliary nerves
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

Horner Syndrome
aka…pre-ganglionic neurons
aka…the stellate ganglion
aka…post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

With which branch do the postganglionic sympathetics run?
The nasociliary

The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion

Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?
The long ciliary nerves
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle, as well as...

(No question—proceed when ready)
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle, as well as...
----Fibers bound for sweat glands of the forehead hop onto the artery, and then onto its and branches
Neural pathway in Horner syndrome:

**First-order neurons**
-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

**Second-order neurons** aka...*pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion aka...*the stellate ganglion*

**Third-order neurons** aka...*post-ganglionic neurons*
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
---- Fibers bound for the pupil join CN6, then V1
---- Fibers bound for Mueller’s muscle, as well as…
---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons

What about sweat glands of the lower face--how do sympathetics get to them?

---Fibers bound for Mueller’s muscle, as well as rest of the face
---Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
**Horner Syndrome**

*Neural pathway in Horner syndrome:*

**First-order neurons**
- Originate in hypothalamus
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

**Second-order neurons** aka **pre-ganglionic neurons**
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion aka **the stellate ganglion**

**Third-order neurons** aka **post-ganglionic neurons**
- What about sweat glands of the **lower face**--how do sympathetics get to them?
- Postganglionic fibers destined to innervate lower-face sweat glands don’t run with the internal carotid; rather, at the carotid bulb they hop onto the **external carotid,** then onto its branches to reach their destinations on the non-forehead face

----Fibers bound for Mueller’s muscle, as well as the rest of the face
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons *aka... pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion *aka... the stellate ganglion*

Third-order neurons *aka... post-ganglionic neurons*
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?*

Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
-- Fibers bound for the lacrimal gland?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
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--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.
**Horner Syndrome**

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka*...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka*...the stellate ganglion

Third-order neurons *aka*...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?*

No--these hop off the internal carotid *before* it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

*Fibers bound for the lacrimal gland?*

These preganglionic parasympathetic fibers ‘belong’ to which cranial nerve?

CN7
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

Fibers bound for the lacrimal gland 'belong' to which cranial nerve? CN7
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

These preganglionic parasympathetic fibers form a named nerve--what is its name? Cranial nerve?
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?*
No--these hop off the internal carotid **before** it enters the sinus, and join the **preganglionic parasympathetic fibers on their way to innervate the gland.**

*These preganglionic parasympathetic fibers form a named nerve--what is its name? Cranial nerve?*
The greater petrosal nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland—do they pass through the
These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
preganglionic parasympathetic fibers on their way to innervate the gland
These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

preganglionic parasympathetic fibers on their way to innervate the gland

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve--what is its name?
The deep petrosal nerve + The greater petrosal nerve = The vidian nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in cilio-spinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve—what is its name?
The deep petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The greater petrosal nerve

The deep petrosal nerve

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

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The deep petrosal nerve

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Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The deep petrosal nerve

The deep petrosal nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in cilio-spinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller's muscle
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve--what is its name?
The deep petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve--what is its name?
The vidian nerve aka...

By what passage does the vidian nerve exit the skull?
The vidian canal
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons \textit{aka...pre-ganglionic neurons}
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion \textit{aka...the stellate ganglion}

Third-order neurons \textit{aka...post-ganglionic neurons}
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  ---- Fibers bound for the pupil join CN6, then V1
  ---- Fibers bound for Mueller's muscle
  ---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland
These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The vidian nerve \textit{aka...the nerve of the vidian canal}
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  ----Fibers bound for the pupil join CN6, then V1
  ----Fibers bound for Mueller's muscle
  ----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Horner Syndrome

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve of their own—what is its name?
The deep petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal aka...the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

The vidian nerve aka...the nerve of the vidian canal

What is the name of the new named nerve formed by the deep petrosal and greater petrosal nerves joining up?
The vidian nerve

By what passage does the vidian nerve exit the skull?
The vidian canal aka...the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.
Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  ----Fibers bound for the pupil join CN6, then V1
  ----Fibers bound for Mueller's muscle
  ----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Horner Syndrome

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve

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Horner Syndrome
aka...pre-ganglionic neurons
aka...the stellate ganglion
aka...post-ganglionic neurons

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These preganglionic parasympathetic fibers form a named nerve of their own—what is its name?
The greater petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The vidian nerve aka...the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

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The greater petrosal nerve

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?

They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.
Horner Syndrome

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*By what passage does the vidian nerve exit the skull?*

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*Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?*

They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.

*What is the name of the named nerve formed by the deep petrosal and greater petrosal nerves?*

The vidian nerve

*By what passage does the vidian nerve exit the skull?*

The vidian canal
Horner Syndrome

Sympathetic pathway overview
Horner Syndrome

Sympathetic pathway overview
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome:** Central

  What is the noneponymous name for Wallenberg syndrome?
What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome
Horner Syndrome

Wallenberg (aka *lateral medullary*) syndrome
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: **Central**

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion? Ipsilateral
Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
Ipsilateral

Wallenberg’s hallmark symptom is sensory--what is it?
Wallenberg syndrome: Central

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Wallenberg’s hallmark symptom is sensory--what is it?
Loss of pain and temperature sensation to the ipsilateral face and contralateral body
Q

Wallenberg syndrome: **Central**

- **What is the noneponymous name for Wallenberg syndrome?**
  - Lateral medullary syndrome

- **Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?**
  - Ipsilateral

- **Wallenberg’s hallmark symptom is sensory--what is it?**
  - Loss of pain and temperature sensation to the ipsilateral face and contralateral body

- **Besides the Horner and sensory findings, what are the main signs/symptoms?**
  - --
  - --
Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
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Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
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Wallenberg’s hallmark symptom is sensory—what is it?
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Besides the Horner and sensory findings, what are the main signs/symptoms?
--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: **Central**

- **What is the noneponymous name for Wallenberg syndrome?**
  - Lateral medullary syndrome

- **Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation?**
  - Disequilibrium

- **What is the hallmark symptom of Wallenberg syndrome?**
  - Loss of pain and temperature sensation to **the ipsilateral face** and **the contralateral body**

- **Besides the Horner and sensory findings, what are the main signs/symptoms?**
  - **Cerebellar signs:** Disequilibrium, ataxia, nystagmus, skew deviation
  - **Speech and swallowing difficulties**

- **Occlusion of what vessel is implicated in Wallenberg syndrome?**
  - The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

- **In Wallenberg, do pts feel like their being pulled toward the lesion, or away from it?**
  - Toward it
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome

Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation? Lateropulsion

Disequilibrium

What is the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated? Central

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Besides the Horner and sensory findings, what are the main signs/symptoms?

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Toward it

A
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**Wallenberg syndrome: Central**

*What is the noneponymous name for Wallenberg syndrome?*
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Lateropulsion

*In Wallenberg, do pts feel like their being pulled toward the lesion side, or away from it?*
Toward it

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In Wallenberg, do pts feel like their being pulled toward the lesion side, or away from it? Toward it

Disequilibrium

--Cerebellar signs: Dizziness, disequilibrium, ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties

Besides the Horner and sensory findings, what are the main signs/symptoms? Cerebellar signs:

--Ataxia
--Nystagmus
--Skew deviation

Occlusion of what vessel is implicated in Wallenberg syndrome? The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

In Wallenberg, do pts feel like their being pulled toward the lesion side, or away from it? Toward it
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome**: Central

What is the non-eponymous name for Wallenberg syndrome?
- Lateral medullary syndrome

Speaking of lateropulsion: Wallenberg pts often manifest something called [ocular lateropulsion](#). What are the findings in this condition?

- Lateral-gaze movements toward the lesion side are notably faster than lateral movements toward the contralateral side
- During vertical saccades, the eyes will move toward the lesion side
- When the pt is not fixating a visual target (eg, during eye closure), the eyes will move into lateral gaze toward the lesion side

Speaking of disequilibrium: Wallenberg pts often manifest [disequilibrium](#). What are the findings in this condition?

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In Wallenberg, do pts feel like their body is being ‘pulled’ to one side or away from it?
- Toward it
Wallenberg syndrome: **Central**

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- Disequilibrium: ataxia, nystagmus, skew deviation
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Toward it

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A Wallenberg syndrome: **Central**

- **What is the noneponymous name for Wallenberg syndrome?** Lateral medullary syndrome

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Wallenberg syndrome is a form of CVA. In that regard: What very common sign/symptom of a CVA is **not** listed here, ie, is not a component of Wallenberg's?
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Paralysis

As in real estate, the three most important factors in CVA are location, location, and location. And with respect to CVA location, the general rule is, events that affect the lateral brainstem cause sensory loss, not paralysis (aka “stroke without paralysis”).

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Why no paralysis in Wallenberg’s?
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Wallenberg's hallmark symptom is sensory—what is it? Loss of pain and temperature sensation to the ipsilateral face and contralateral body

Besides the Horner and sensory findings, what are the main signs/symptoms?
-- Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
-- Speech and swallowing difficulties

Occlusion of what vessel is implicated in Wallenberg syndrome? The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

Wallenberg syndrome is a form of CVA. In that regard:
What very common sign/symptom of a CVA is not listed here, ie, is not a component of Wallenberg's? Paralysis

Why no paralysis in Wallenberg's?
As in real estate, the three most important factors in CVA are: location, location, and location. And with respect to CVA location, the general rule is, events that affect the lateral brainstem cause sensory loss, not paralysis (aka "stroke without paralysis").
Wallenberg syndrome: Central

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No question—proceed when ready
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- **What mechanism is typically responsible for occluding the vessel in:**
  - An older vasculopath?
  - A young adult?
  - A pt with valvular dz, or arrythmia?

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--A young adult? A pt with valvular dz, or arrythmia?

Besides:
--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
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What mechanism is typically responsible for occluding the vessel in:
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--A young adult? Dissection
--A pt with valvular dz, or arrythmia?

Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

**Wallenberg syndrome**: Central

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Wallenberg’s hallmark symptom is sensory--what is it?
Loss of pain and temperature sensation to the ipsilateral face and contralateral body

What mechanism is typically responsible for occluding the vessel in:
--An older vasculopath? Atherosclerosis
--A young adult? Dissection
--A pt with valvular dz, or arrhythmia? Embolism

Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

Wallenberg syndrome: Central

Does Wallenberg carry a good, or poor prognosis?
Lateral medullary syndrome

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Wallenberg’s hallmark symptom is sensory--what is it?
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Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery
Wallenberg syndrome: **Central**

**Does Wallenberg carry a good, or poor prognosis?**
Good--most pts recover with minimal sequelae

**Lateral medullary syndrome**

**Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?**
Ipsilateral

**Wallenberg’s hallmark symptom is sensory--what is it?**
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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic

In an adult with a pre-ganglionic Horner’s and no history of trauma or surgery, what process should be suspected?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic

*In an adult with a pre-ganglionic Horner’s and no history of trauma or surgery, what process should be suspected?*

An intrathoracic malignancy
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: **Central**
- Neck trauma: **Pre- or post-ganglionic**
- Neuroblastoma: **Pre-ganglionic**
• Wallenberg syndrome: Central
• Neck trauma: Pre- or post-ganglionic
• Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood? It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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- Neck trauma: Pre- or post-ganglionic
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Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

How about in infants (ie, prior to age 12 months)?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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How about in infants (ie, prior to age 12 months)?
It is #1.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
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Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

How about in infants (ie, prior to age 12 months)?
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What proportion of pediatrics cancer deaths are due to Nb?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- **Neuroblastoma**: Pre-ganglionic

*Where does Nb rank as a cause of cancer in childhood?*
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

*How about in infants (ie, prior to age 12 months)?*
It is #1

*What proportion of peds cancer deaths are due to Nb?*
20%
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood? It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

The cancerous cell in NB—the neuroblast—what is it?

What proportion of peds cancer deaths are due to Nb? 20%
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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Where does Nb rank as a cause of cancer in childhood?
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**The cancerous cell in NB—the neuroblast—what is it?**
It is the progenitor cell that gives rise to neuron and related cells

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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Which ‘neurons’ and ‘related cells’ are involved in Nb, ie, where are the primaries?
Wallenberg syndrome: Central

Neck trauma: Pre- or post-ganglionic

**Neuroblastoma:** Pre-ganglionic

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*For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated*

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*Which ‘neurons’ and ‘related cells’ are involved in Nb, ie, where are the primaries?*
The sympathetic chain, and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Of the two sites, which can produce a Horner syndrome? The sympathetic chain, and the adrenal medulla.
Q/A

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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*Of the two sites, which can produce a Horner syndrome?*
The sympathetic chain (provided the tumor is in the cervical portion)

Sympathetic chain neurons! Adrenal-medulla cells
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
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*Where does Nb rank as a cause of cancer in childhood?*
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The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Primary tumor in sympathetic chain

Horner syndrome secondary to Nb
Q

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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The cancerous cell in NB—the neuroblast—what is it?
It is the progenitor cell that gives rise to neuron and related cells.

Neuroblast is notorious for three other ophthalmic manifestations—what are they?

- chain neurons
- medulla cells

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
**Neuroblastoma: Pre-ganglionic**

*For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated*

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Sympathetic chain neurons
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Nb is notorious for three other ophthalmic manifestations—what are they?
--Periorbital ecchymosis (aka raccoon eyes)
--Proptosis
--Opsoclonus

Of the two sites, which can produce a Horner syndrome?
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How about in infants (ie, prior to age 12 months)?
It is #1

What proportion of peds cancer deaths are due to Nb?
20%

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Which 'neurons' and 'related cells' are involved in Nb, ie, where are the primaries?
The sympathetic chain, and the adrenal medulla

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla

What process leads to ecchymosis and/or proptosis?
Orbital metastasis

Periorbital ecchymosis (aka racoon eyes)
Proptosis
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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Nb: ‘Raccoon eyes’
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.
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Nb is notorious for three other ophthalmic manifestations—what are they?
--Periorbital ecchymosis (aka racoon eyes)
--Proptosis
--Opsoclonus

What is opsoclonus?
A saccadic intrusion characterized by multivectorial, large-amplitude movements

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis? No—it is a phenomenon.
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Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion)

Nb is notorious for three other ophthalmic manifestations—what are they?

--Periorbital ecchymosis (aka racoon eyes)
--Proptosis

Opsoclonus

What is opsoclonus? A saccadic intrusion characterized by multivectorial, large-amplitude movements.

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis? No—it is a paraneoplastic phenomenon.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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- Internal carotid dissection:
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What percent of carotid-artery dissection pts will present with a Horner? About 60

What systemic conditions predispose to carotid-artery dissection?
Connective-tissue disorders; eg, Marfan’s and Ehler-Danlos

Is carotid-artery dissection always associated with trauma?
No, it can occur spontaneously

Name a classic cause of ‘iatrogenic’ (I’m using the term loosely here) carotid-artery dissection: Cervical-spine manipulation by a chiropractor
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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If carotid dissection is suspected, what is the first step in management? Emergent neuroimaging

What imaging study should be ordered? Angiography--either CTA or MRA

What about carotid doppler study--wouldn’t that suffice? No, it is not adequate
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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Imaging must extend from where to where; ie, what anatomic structures delimit the region that needs to be imaged?

It must extend from the apex of the lung up to the Circle of Willis.
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*What is a Pancoast tumor?*
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- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic

What is a Pancoast tumor?
A mass at or near the superior sulcus (=apex) of the lung
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- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: HA = ‘Headache’ (but we’ll also use it to mean something else a few slides hence)
Wallenberg syndrome: Central
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Internal carotid dissection: Post-ganglionic
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- Pancoast tumor: Pre-ganglionic
- **Cluster HA**: Post-ganglionic

Is Horner syndrome a common finding in cluster HA? Yes--estimates run as high as 50%

So, Horner’s + HA cinches a diagnosis of cluster HA, then? No! Dissection of the internal carotid artery is also associated with HA, face and/or eye pain
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Acute-onset Horner’s + facial/neck pain is an internal carotid dissection until proven otherwise, and must be worked up emergently!
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- Forceps delivery:
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- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

**Shoulder dystocia** is another cause of congenital Horner’s. Look for a hx of complicated birth, along with signs and symptoms of brachial-plexus injury/dysfunction.

Forceps delivery/shoulder dystocia
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- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
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- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.
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How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

Why is this? That is, what is it about cocaine drops that allows this assertion to be made?
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How does one ‘prove’ a patient has a Horners?
Cocaine drop testing. **Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.**

Why is this? That is, what is it about cocaine drops that allows this assertion to be made?
Cocaine’s mechanism of action is to block the re-uptake of norepinephrine.
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- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

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*Why is this? That is, what is it about cocaine drops that allows this assertion to be made?*
Cocaine’s mechanism of action is to block the re-uptake of norepinephrine. Thus, it can dilate the pupil only if norepinephrine is already present in the neuromuscular junctions of the pupillary dilator muscle. And norepinephrine will be present in the junctions only if the post-ganglionic fibers are being prompted to release it by an intact sympathetic chain.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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Cocaine’s mechanism of action is to block the re-uptake of norepinephrine. Thus, it can dilate the pupil only if norepinephrine is already present in the neuromuscular junctions of the pupillary dilator muscle. And norepinephrine will be present in the junctions only if the post-ganglionic fibers are being prompted to release it by an intact sympathetic chain. Dysfunction anywhere in the chain will result in the absence of norepinephrine in the neuromuscular junction, and therefore a positive (i.e., a failure to dilate) cocaine test.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Positive cocaine test (failure of anisocoria to resolve)
Q

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
Wallenberg syndrome: Central
Neck trauma: **Pre- or post-ganglionic**
Neuroblastoma: Pre-ganglionic
Internal carotid dissection: Post-ganglionic
Pancoast tumor: Pre-ganglionic
Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?

How does one differentiate between a pre- and post-ganglionic Horner's?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
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- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?

HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction.

How does one differentiate between a pre- and post-ganglionic Horner's?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

How does one differentiate between a pre- and post-ganglionic Horner's?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.

And why is this? That is, what is it about HA drops that allows this assertion to be made?

HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction.
Wallenberg syndrome: Central

Neck trauma: Pre- or post-ganglionic

Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made? HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs. And norepinephrine will be present in these bulbs only if the post-ganglionic fibers are healthy. If these neurons are damaged--ie, if the pt has a post-ganglionic Horner syndrome--the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horners, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

How does one differentiate between a pre- and post-ganglionic Horners? Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected right Horner syndrome).
B. After drops administered. Note the dilation of both pupils. This indicates an intact 3rd-order, postganglionic neuron and localizes the lesion to the 1st-order (central) or 2nd-order (preganglionic) neuron.

HA test
Wallenberg syndrome: Central

Neck trauma: Pre- or post-ganglionic

Neuroblastoma: Pre-ganglionic

**And why is this?** That is, what is it about HA drops that allows this assertion to be made? HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs. And norepinephrine will be present in these bulbs only if the post-ganglionic fibers are healthy. If these neurons are damaged--ie, if the pt has a post-ganglionic Horner syndrome--the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horners, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

**Why must cocaine drop testing precede HA drop testing?**

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?

HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs. And norepinephrine will be present in these bulbs only if the post-ganglionic fibers are healthy. If these neurons are damaged—ie, if the pt has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horner’s, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

Why must cocaine drop testing precede HA drop testing?

HA drops cannot distinguish between a preganglionic/central Horner syndrome and a non-Horner eye—the postganglionic fibers are intact for both, so both will dilate in response to HA. Thus, before HA testing is performed, the cocaine test is needed to establish that a Horner syndrome is present.

How does one differentiate between a pre- and post-ganglionic Horner’s?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s (assuming cocaine testing has established that a Horner syndrome is present).
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner's?

Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.

What is the brand name for HA drops?

Paradrine
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic
Internal carotid dissection: Post-ganglionic
Pancoast tumor: Pre-ganglionic
Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.

What is the brand name for HA drops?
Paredrine
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?

**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

**Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?**

**Transynaptic degeneration.** Pre-ganglionic fiber loss prior to age 10 years leads to transynaptic degeneration of the post-ganglionic fibers. Because of this, the HA response would be negative for a pre- or post-ganglionic lesion originating with a forceps injury. After age 10 years, loss of the pre-ganglionic fibers does not result in transynaptic loss, thus preserving the HA response.

**Forceps delivery: Pre- or post-ganglionic**

**How does one ‘prove’ a patient has a Horner’s?**

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

**How does one differentiate between a pre- and post-ganglionic Horner’s?**

**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
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- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

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It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner's in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
In addition to a thorough H&P by a pediatrician, urine catecholamine (VMA, etc) testing should be undertaken. Careful consideration should be given to imaging the entire sympathetic chain as well.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
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What about a congenital Horner’s--how should that be worked up?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
In addition to a thorough H&P by a pediatrician, urine catecholamine (VMA, etc) testing should be undertaken. Careful consideration should be given to imaging the entire sympathetic chain as well.

What about a congenital Horner’s--how should that be worked up?
There is less consensus on this score. If other stigmata of birth trauma are present (eg, brachial plexus injury), a workup is unnecessary. Absent such a history, relatively low-cost and low-risk maneuvers such as a thorough H&P and urine catecholamine testing are reasonable to undertake. It is less certain that imaging of the entire sympathetic chain is warranted.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why?

How does one ‘prove’ a patient has a Horner’s?

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?

**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why?
These drugs are highly controlled substances—difficult to acquire and maintain.

How does one ‘prove’ a patient has a Horner’s?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?

How does one ‘prove’ a patient has a Horner's?

**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner's?

**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing.

How does one ‘prove’ a patient has a Horner's?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner's?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why?
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What drop test can be performed in their stead?
Apraclonidine (Iopidine) testing.

What is apraclonidine commonly used for?

How does one ‘prove’ a patient has a Horner's?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner's?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes

How does one ‘prove’ a patient has a Horner’s?

Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing.

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes.

What is its mechanism of action?

How does one 'prove' a patient has a Horners? Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horners? Hydroxyamphetamines (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

**What drop test can be performed in their stead?**
Apraclonidine (Iopidine) testing.

**What is apraclonidine commonly used for?**
An ocular hypotensive, it is used to blunt perioperative pressure spikes.

**What is its mechanism of action?**
It is a selective alpha-adrenergic agonist.

How does one ‘prove’ a patient has a Horners?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horners?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

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What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes.

What is its mechanism of action? It is a selective alpha-adrenergic agonist.

Which alpha receptors are involved in pupil dilation?

How does one ‘prove’ a patient has a Horner’s?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?
Apraclonidine (Iopidine) testing.

What is apraclonidine commonly used for?
An ocular hypotensive, it is used to blunt perioperative pressure spikes.

What is its mechanism of action?
It is a selective alpha-adrenergic agonist.

Which alpha receptors are involved in pupil dilation?
Alpha₁.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes.

What is its mechanism of action? It is a nonselective alpha-adrenergic agonist.

Which alpha receptors are involved in pupil dilation? Alpha_1.

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horner’s is confirmed.

How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner’s? It can’t.

How does one ‘prove’ a patient has a Horner’s? **Cocaine drop testing**. Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s? **Hydroxyamphetamine (HA) drop testing**. HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (lupidine) testing.

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes.

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

Which alpha receptors are involved in pupil dilation? Alpha_1.

How does one 'prove' a patient has a Horner's? Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner's? Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected left Horner syndrome).
B. After drops administered. Note the slight “reversal of anisocoria” in the left eye.

Apraclonidene testing
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (lopidine) testing

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes.

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horners is confirmed.

Which alpha receptors are involved in pupil dilation? Alpha1

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for? An ocular hypotensive, it is used to blunt perioperative pressure spikes. What is its mechanism of action? It is a nonselective alpha-adrenergic agonist.

Which alpha receptors are involved in pupil dilation? Alpha$_1$

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. **If the anisocoria reverses, the Horners is confirmed.**

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? **Denervation supersensitivity.** Horner syndrome results in upregulation of alpha$_1$ receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?
**Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. **If the anisocoria reverses, the Horner's is confirmed.**

Which alpha receptors are involved in pupillary dilation?

How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner's?

It can't

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?

**Denervation supersensitivity.** Horner syndrome results in upregulation of alpha₁ receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation compared to the fellow contralateral eye.

How long after the Horner-inciting injury to the sympathetic pathway does it take for denervation supersensitivity to develop?

In general, a few days (case reports exist of it occurring in as little as a few hours).
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?

**Apraclonidine (lopidine) testing**

What is apraclonidine commonly used for?

**How is apraclonidine used in diagnosing Horner syndrome?**
It is instilled in both eyes. If the anisocoria reverses, the Horners is confirmed.

Which alpha receptors are involved in pupil dilation?

**Alpha**

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?

**Denervation supersensitivity.** Horner syndrome results in upregulation of alpha_1 receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation compared to the normal fellow eye.

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- Cluster HA: Post-ganglionic
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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?
- An ocular hypotensive, it is used to blunt perioperative pressure spikes
- Its mechanism of action is a nonselective alpha-adrenergic agonist

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

Which alpha receptors are involved in pupil dilatation? **Alpha**

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? **Denervation supersensitivity.** Horner syndrome results in upregulation of alpha_1_ receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome? **Resolution of ptosis**

What is the pathophysiology of ptosis in Horner syndrome? The absence of sympathetic stimulation to Müller's muscle of the lid produces a mild ptosis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why?
These drugs are highly controlled substances—difficult to acquire and maintain

What drop test can be performed in their stead?
**Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?
An ocular hypotensive, it is used to blunt perioperative pressure spikes

How is apraclonidine used in diagnosing Horner syndrome?
It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

Which alpha receptors are involved in pupil dilation?
**Alpha\(_1\)**

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?
**Denervation supersensitivity.** Horner syndrome results in upregulation of alpha\(_1\) receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome?
Resolution of ptosis

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How does one 'prove' a patient has a Horner's?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner's?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome?
Resolution of ptosis
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected left Horner syndrome).
B. After drops administered. Note the slight “reversal of anisocoria” in the left eye and the resolution of ptosis.

Apraclonidine testing
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

1. Wallenberg syndrome: Central
2. Neck trauma: Pre- or post-ganglionic
3. Neuroblastoma: Pre-ganglionic
4. Internal carotid dissection: Post-ganglionic
5. Pancoast tumor: Pre-ganglionic
6. Cluster HA: Post-ganglionic
7. Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why?
These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?
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Alpha₁

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Resolution of ptosis

What is the pathophysiology of ptosis in Horner syndrome?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: Central
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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (lopidine) testing**

What is apraclonidine commonly used for?

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Which alpha receptors are involved in pupil dilation? **Alpha_1**

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? **Denervation supersensitivity**. Horner syndrome results in upregulation of alpha_1 receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome? Resolution of ptosis

What is the pathophysiology of ptosis in Horner syndrome? The absence of sympathetic stimulation to Müller’s muscle of the lid produces a mild ptosis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner's? With alpha receptors involved in pupillary light reflex? Alpha₁.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner's?
It can't

Which alpha receptors are involved in pupillary dilation?
Alpha_1
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

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I’m out of apraclonidine. Can I use brimonidine instead?
A

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing.

I’m out of apraclonidine. Can I use brimonidine instead? I’m afraid not.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? 
**Apraclonidine (Iopidine) testing**

I’m out of apraclonidine. Can I use brimonidine instead? 
I’m afraid not.

Why not? Aren’t they very similar meds?
<table>
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In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

**What drop test can be performed in their stead?**

**Apraclonidine (Iopidine) testing**

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I’m out of apraclonidine. Can I use brimonidine instead? I’m afraid not.

Why not? Aren’t they very similar meds? For purposes of Horner drop-testing, not similar enough. While apraclonidine preferentially stimulates the $\alpha_2$ receptor, it still provides some stimulation of the $\alpha_1$ receptors of the dilator muscles. In contrast, bromonidine is a **highly-selective** $\alpha_2$ agonist, and as such provides little to no $\alpha_1$ stimulation, and therefore will **not** induce pupil dilation.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: **Central**
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- Pancoast tumor: Pre-ganglionic
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Which drop test differentiates between a pre-ganglionic and central Horners?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: **Central**
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- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horners? **None.** A central Horners is usually apparent by the company it keeps, or by history.
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Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's? None. A central Horner's is usually apparent by the company it keeps, or by history.

What sorts of findings would be associated with a central Horner's?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
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- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's? **None.** A central Horner's is usually apparent by **the company it keeps**, or by history.

What sorts of findings would be associated with a central Horner's? Significant neurological impairment including difficulties with speaking, swallowing and/or balance, as well as disordered movements (ie, a Wallenberg-type scenario).
Which drop test differentiates between a pre-ganglionic and central Horner's? None. A central Horner's is usually apparent by the company it keeps, or by history.

What history would be associated with a central Horner's?

Q

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: **Central**
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- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's Syndrome? **None**. A central Horner's is usually apparent by the company it keeps, or by **history**.

**What history would be associated with a central Horner's?**
Associated history could include significant intracranial events (CVA, tumor, meningitis, a bleed) or a history of significant high C-spine trauma (fracture, dislocation).
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest
- Skull base
- Internal carotid artery (esp. at the skull base)
- Paraspinal area
- Mediastinum
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head

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- Upper chest

- Skull base

- Internal carotid artery (esp. at the skull base)

- Paraspinal area

- Mediastinum
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head

...with attention to the:

- specific aspect of head
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head

...with attention to the:

- Skull base
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base
- Specific structure in neck
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- ...with attention to the:
  - Skull base
  - Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- General body area 3

...with attention to the:

- Skull base
- Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery

- specific aspect of chest 1
- specific aspect of chest 2
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery
- Paraspinal area
- Mediastinum