Vertical Deviations

? -> Vertical Deviations -> ?

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Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction?  Uncertain mechanism?

Which is the more common cause of vertical deviations?
Vertical Deviations

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Do vertical deviations tend to be comitant, or incomitant?
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It means the ‘the same in all fields of gaze’

What is spread of comitance?
The neuroadaptive process in which a longstanding palsy gradually transforms from incomitant to comitant (ie, becomes similar in all fields of gaze)
Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism

?
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism

Superior Oblique (SO)

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Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism
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2° to oblique dysfunction

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What is the surgical treatment for SO overaction?

Overaction

- Palsy
- Brown syndrome

Why are surgeons reluctant to operate on a patient with bifixation?

Surgery could result in torsional diplopia.
Vertical Deviations

2° to oblique dysfunction

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--congenital SO palsy is much more likely to be unilateral
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What is the most common cause of acquired SO palsy?
Closed head trauma

How can you confirm that a SO palsy is congenital?
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When diagnosing a unilateral SO palsy, what must you be sure to rule out?
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For pts without a history of congenital SO palsy, how much vertical prism can they accept without losing fusion?
Not much—2-3 prism diopters or so

How much vertical prism can pts with a congenital SO palsy take without losing fusion?
A lot more—in the 12-15 prism diopter range
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2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

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Overaction

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Why should you care whether a palsy is unilateral vs bilateral?

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2° to oblique dysfunction

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Why should you care whether a palsy is unilateral vs bilateral?
All bilateral SO palsies should be assumed to be acquired. Thus, absent an appropriate head-trauma hx, a bilateral SO palsy represents an ongoing intracranial dz process until proven otherwise. For this reason, it is absolutely vital that one establish with certainty the uni- vs bilaterality of SO palsy!
### Vertical Deviations

#### 2° to oblique dysfunction

- **Superior Oblique (SO)**
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**That it’s not in fact an asymmetric bilateral SO palsy**

#### If a bilateral SO palsy pt lacks an appropriate trauma hx, what should you do?

Image them...
2° to oblique dysfunction

Superior Oblique (SO)  Inferior Oblique (IO)

--- Overaction
--- Palsy
--- Brown syndrome

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When diagnosing a unilateral SO palsy, what must you be sure to rule out?
That it’s not in fact an asymmetric bilateral SO palsy

Key Findings in Uni- vs Bilateral SO Palsy

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2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

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**2° to oblique dysfunction**

**Superior Oblique (SO)**
- Overaction
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- Brown syndrome

**Inferior Oblique**

**Regarding SO palsy:**
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**What is the most common cause of acquired SO palsy?**
- Closed head trauma

**How can you confirm that a SO palsy is congenital?**
1. **Family-album biopsy** (i.e., check old photos for a longstanding head tilt)
2. **Check vertical fusional amplitudes**
   - Normal ~ 2 ∆
   - Can be as high as 12-15 ∆ in congenital SO palsy

**When diagnosing a unilateral SO palsy, what must you be sure to rule out?**
- V-pattern ET present?
- **Excyclotorsion** on Maddox-rod testing?
- **Head-tilt test?**

**Unilateral SO palsy**
- No
- Always less than 10°
- Positive to one side only

**Bilateral SO palsy**
- Yes
- May be more than 10°
- Positive to both sides

### Key Findings in Uni- vs Bilateral SO Palsy

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When diagnosing a unilateral SO palsy, what patterns are present?
V-pattern ET always less than 10°
Positive to one side only

When diagnosing a bilateral SO palsy, what patterns are present?
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What is double Maddox rod testing? I’m glad you asked…
What is a Maddox rod?

A translucent disc of red plastic constructed of a set of very small cylinders aligned parallel to one another.

What does a pt see when shown a point-source of light through a Maddox rod?
The point of light is seen as a line oriented 90° from the orientation of the cylinders.

Ok, so what is double Maddox-rod testing, and how is it used to identify and quantify excyclotorsion?

In the double Maddox rod test, a separate Maddox rod is placed before each eye, and a point-source of light is presented to both eyes simultaneously. Thus, each eye sees its own line, courtesy of its Maddox rod. In individuals for whom their eyes have identical rotational orientation, the line seen by each eye will be perceived as parallel to the other. However, because an eye with a SO palsy is excyclotorted, the line produced by its Maddox rod will be in a different orientation than that experienced by its non-torted fellow eye. (Bear in mind that it's not the orientation of the line itself that's off; rather, it's the orientation of the retina perceiving the line that's off.)

How can double-Maddox rods be used to measure the amount of cyclotorsion?
The Maddox-rod lenses can be mounted in trial frames that allow the orientation of the cylinders to be changed, and the pt is instructed to do so until s/he perceives the lines to be parallel.

The difference in degrees between the orientation of the two sets of cylinders is the size of the excyclotorsion.
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How can the size of the excyclotorsion be used to differentiate between unilateral and bilateral SO palsies?
The maximum amount of excyclotorsion that can result from *unilateral* SO palsy is 10 deg. Therefore, when the excyclotorsion measured is greater than 10 deg, bilateral palsies must be present. 

*This means that if less than 10 deg is present, the palsy must be unilateral, right?*
Slow ya roll. It’s true that if only one eye is excyclotorted, the total measured excyclotorsion is always 10 deg or less. However, if both eyes are only mildly palsied—say, 4 degree’s worth each—the total excyclotorsion (in this case 8 deg) *could* be less than 10. Thus, whereas >10 deg rules out unilateral SO palsy, <10 does not rule it in.
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**How can the size of the excyclotorsion be used to differentiate between unilateral and bilateral SO palsies?**
The maximum amount of excyclotorsion that can result from unilateral SO palsy is 10°. (This is a rule of thumb and is not universally accepted.) If the maximum amount of excyclotorsion that can result from unilateral SO palsy is indeed 10°, then the maximum amount of excyclotorsion that can result from bilateral SO palsy is twice that, or 20°. Thus, if more than this amount is present, bilateral palsies must be present. (However, it’s possible that both eyes are mildly palsied—say, 4° for each—resulting in a total 8° of excyclotorsion. This is why we say >10° rules out unilateral SO palsy, but <10 does not rule it in.)

**All that said, it is very unusual for a bilateral SO palsy to present with less than 5° of torsion.**
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The maximum amount of excyclotorsion that can result from unilateral SO palsy is 10°. Thus, anything greater than this maximum is indicative of a bilateral palsy.

**TLDR**

> 10 excyclotorsion is always bilateral

< 5 (but greater than 0, duh) is *almost* always unilateral

5-10 is indeterminate

All that said, it is very unusual for a *bilateral* SO palsy to present with less than 5° of torsion. This means that if less than 10 deg is present, the palsy must be unilateral, right?

Slow ya roll. It’s true that if only one eye is excyclotorted, the total measured excyclotorsion is always 10 deg or less. However, if both eyes are only mildly palsied—say, 4° each—then the total measured excyclotorsion (in this case 8 deg) could be less than 10 deg. Thus, <10 does not rule it in.
Vertical Deviations

Regarding SO palsy: As a general rule:
--congenital SO palsy is much more likely to be unilateral
--acquired SO palsy is much more likely to be bilateral

What is the most common cause of acquired SO palsy?
Closed head trauma

How can you confirm that a SO palsy is congenital?
1) Family-album biopsy (i.e., check old photos for a longstanding head tilt)
2) Check vertical fusional amplitudes (normal ~ 2 \(\Delta\); can be as high as 12-15 \(\Delta\) in congenital SO palsy)

When diagnosing a unilateral SO palsy, which V-pattern ET present? Always less than 10°
How much excyclotorsion on double Maddox rod testing? Positive to one side only
Head-tilt test?

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Key Findings in Uni- vs Bilateral SO Palsy
Regarding SO palsy: As a general rule:
--congenital SO palsy is much more likely to be unilateral
--acquired SO palsy is much more likely to be bilateral

What is the most common cause of acquired SO palsy?
- Closed head trauma

What is the most common cause of congenital SO palsy?
- Overaction

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### Key Findings in Uni- vs Bilateral SO Palsy

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Unilateral SO palsy

- Superior Oblique (SO)
- Inferior Oblique
- Overaction
- Brown syndrome

Bilateral SO palsy
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique

Overaction

Palsy

Brown syndrome

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What is the head-tilt test? I’m glad you asked…

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The head-tilt test is actually a single component of what double-eponymous 3-step test?

Generally speaking, what is the purpose/goal of the Parks-Bielschowsky 3-step test?

How is the head-tilt test performed?

The pt is told to tilt their head first to one side, then to the other, while you observe their eyes. A SO palsy is present if the eye on the side toward which the head is tilted responds to the tilt by drifting up (ie, by becoming hypertropic).
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Generally speaking, what is the purpose/goal of the Parks-Bielschowsky 3-step test? To identify the EOM function muscle responsible for a direction deviation
The head-tilt test is also known by what eponymous name?
The Beilschowsky head-tilt test

The head-tilt test is actually a single component of what double-eponymous 3-step test?
The Parks-Bielschowsky 3-step test

Generally speaking, what is the purpose/goal of the Parks-Bielschowsky 3-step test?
To identify the cyclovertical muscle responsible for a vertical deviation
The *head-tilt test is also known by what eponymous name?*  
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*Generally speaking, what is the purpose/goal of the Parks-Bielschowsky 3-step test?*  
To identify the cyclovertical muscle responsible for a vertical deviation*

*Note: The Parks-Bielschowsky test works if and only if weakness of a single muscle is responsible for the vertical deviation in question!*
The head-tilt test is also known by what eponymous name? The Beilschowsky head-tilt test

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How is the head-tilt test performed?
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To identify the cyclovertical muscle responsible for a vertical deviation

How is the head-tilt test performed?
The pt is told to tilt their head first to one side, then to the other, while you observe their eyes. A SO palsy is present if the eye on the side toward which the head is tilted responds to the tilt by drifting up (ie, by becoming hyper- or hypertropic).
Vertical Deviations

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Why does a head-tilt cause an SO palsy eye to become hyperopic?

A SO palsy is present if the eye on the side toward which the head is tilted responds to the tilt by drifting up (ie, by becoming hypertropic).
Vertical Deviations

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The head-tilt test is actually a single component of what double-eponymous 3-step test?
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Why does a head-tilt cause an SO palsy eye to become hyperopic?
It has to do with a ‘righting reflex’ in the ocular control system. When the head is tilted to one side, the eyes attempt to remain level (= superior poles pointing toward the ceiling) by counter-torting in the other direction. So for example, when the head is tilted to the right, to stay upright the right eye will in-cyclotort (ie, the superior pole will tort toward the midline), while the left eye will excyclotort (ie, the superior pole will tort away from the midline).

In vs excyclotort

toward vs away from

Eyes: A SO palsy is present if the eye on the side toward which the head is tilted responds to the tilt by drifting up (ie, becoming hypertropic).
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Vertical Deviations

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Recall that the intorters of the eye are the superior rectus and the superior oblique (you can remember this with the mnemonic **SIN**, which stands for **S**uperiors INtort). Thus, when an eye attempts to intort, both the SR and the SO fire. Note that the SR and the SO also have equal-but-opposite vertical components to their actions—the SR elevates the eye, while the SO depresses it. So when both muscles fire simultaneously, their vertical components cancel each other out, and the eye simply intorts.

Now consider what happens upon head tilt if the eye on that side has a SO palsy. Attempted intorsion results in contraction of the SR only (because the palsied SO cannot contract). Thus, the vertical component of the SR contraction is unopposed, and because it is unopposed, the eye elevates. This is why an eye with a SO palsy demonstrates a hypertropia upon head tilt to that side!
Vertical Deviations

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**Vertical Deviations**

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Vertical Deviations

- 2° to oblique dysfunction
  - Superior Oblique (SO)
    - Overaction
      - Palsy
      - Brown syndrome
  - Inferior Oblique (IO)
    - Uncertain mechanism

Management of unilateral SO palsy:
-- If no IO overaction is present: [surgery]
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Management of unilateral SO palsy:
--If no IO overaction is present: **Contralateral IR recession**

Inferior Oblique (IO)

Uncertain mechanism

Overaction

Palsy

Brown syndrome
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Management of unilateral SO palsy:
--If no IO overaction is present: **Contralateral IR recession**

Why perform contralateral IR recession for unilateral SO palsy?
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Management of unilateral SO palsy:
--If no IO overaction is present: **Contralateral IR recession**

Why perform contralateral IR recession for unilateral SO palsy? Patients with an SO palsy c/o diplopia in downgaze. This is because the unaffected eye can depress fully, but the eye with the SO palsy cannot. The contralateral IR is the yoke muscle for the palsied SO. By recessing the contralateral IR, you inhibit that eye’s ability to depress, thereby eliminating the source of diplopia (i.e., the asymmetry in depression). In essence, you treat a **unilateral** motility problem by giving the patient a **bilateral** motility problem.
Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism

Superior Oblique (SO)

Overaction

Palsy

Brown syndrome

Management of unilateral SO palsy:
--If no IO overaction is present: **Contralateral IR recession**
--If IO overaction is present, but deviation is <15°: [surgery]
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism

Management of unilateral SO palsy:
- If no IO overaction is present: **Contralateral IR recession**
- If IO overaction is present, but deviation is <15Δ: **IO weakening procedure**
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

- Uncertain mechanism

Management of unilateral SO palsy:
- If no IO overaction is present: **Contralateral IR recession**
- If IO overaction is present, but deviation is <15°:
  - IO weakening procedure
- If IO overaction is present and the deviation is >15°: [surgery]
Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism

Superior Oblique (SO)

Inferior Oblique (IO)

Management of unilateral SO palsy:
--- If no IO overaction is present: **Contralateral IR recession**
--- If IO overaction is present, but deviation is <15Δ: **IO weakening procedure**
--- If IO overaction is present and the deviation is >15Δ: **Perform both**
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Overaction

Palsy

Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism

Management of unilateral SO palsy:
--If no IO overaction is present: **Contralateral IR recession**
--If IO overaction is present, but deviation is <15Δ: **IO weakening procedure**
--If IO overaction is present and the deviation is >15Δ: **Perform both**

Management of bilateral SO palsy:
--If main c/o is torsional diplopia: [surgery]
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

- Palsy
- Brown syndrome

Inferior Oblique (IO)

- Overaction
- Uncertain mechanism

Management of unilateral SO palsy:
- If no IO overaction is present: **Contralateral IR recession**
- If IO overaction is present, but deviation is <15Δ:
  - IO weakening procedure
- If IO overaction is present and the deviation is >15Δ:
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Management of bilateral SO palsy:
- If main c/o is torsional diplopia: **Harada-Ito procedure**
Brown syndrome

Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Uncertain mechanism

Inferior Oblique (IO)

Management of unilateral SO palsy:
-- If no IO overaction is present: Contralateral IR recession
-- If IO overaction is present, but deviation is <15Δ:
  IO weakening procedure
-- If IO overaction is present and the deviation is >15Δ:
  Perform both

Management of bilateral SO palsy:
-- If main c/o is torsional diplopia:

Briefly, what is the Harada-Ito procedure?

Both SO tendons are split, and the anterior portion of each is repositioned anteriorly and temporally

Harada-Ito procedure
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Overaction

Palsy

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Uncertain mechanism

Management of unilateral SO palsy:
-- If no IO overaction is present: Contralateral IR recession
-- If IO overaction is present, but deviation is <15°: IO weakening procedure
-- If IO overaction is present, but deviation is >15°: Perform both

Management of bilateral SO palsy:
-- If main c/o is torsional diplopia: Harada-Ito procedure

Briefly, what is the Harada-Ito procedure?
Both SO tendons are split, and the anterior portion of each is repositioned anteriorly and temporally.
Vertical Deviations

- Superior Oblique (SO)
  - Overaction
    - Palsy
      - Brown syndrome
    - Uncertain mechanism
  - Inferior Oblique (IO)
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- If no IO overaction is present: Contralateral IR recession
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Management of bilateral SO palsy:
- If main c/o is torsional diplopia: Harada-Ito procedure

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Both SO tendons are split, and the anterior portion of each is repositioned anteriorly and temporally.
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique

Define **Brown syndrome**:

Overaction

Palsy

**Brown syndrome**

In addition to restricted elevation, what else occurs during adduction in Brown syndrome?

- The palpebral fissure widens
- The eye may involuntarily depress (called *downshoot*)

What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)?

Duane syndrome

Name three causes of trochlear restriction:

- Idiopathic
- Traumatic
- Inflammatory

Males... OD or OS?

Is Brown syndrome more common in males or females?
Vertical Deviations

Define Brown syndrome:
Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique

Brown syndrome

Overaction

Palsy

Brown syndrome
Define **Brown syndrome**: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea.

*Is Brown syndrome more common in...*  
...males or females?  
...OD or OS?

- Overaction
- Palsy
- **Brown syndrome**
Define Brown syndrome:
Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in…
…males or females? Males
…OD or OS? OD

Brown syndrome
Vertical Deviations

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Brown syndrome: Overaction Palsy
Vertical Deviations

Define **Brown syndrome**: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea.

*Is Brown syndrome more common in...* males or females? **Males**
*...OD or OS?** **OD**

*What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)?** **Duane syndrome**
Define **Brown syndrome**: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in…
…males or females? **Males**
…OD or OS? **OD**

What common strabismus syndrome has the opposite pattern (i.e., is more common in **females** and **left** eyes)? **Duane syndrome**

Name three causes of SO restriction at the trochlea:
--
--
--
Define Brown syndrome:
Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in... males or females? **Males**
...OD or OS? **OD**

What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)? **Duane syndrome**

Name three causes of SO restriction at the trochlea:
-- **Idiopathic/congenital** (ie, born with a short tendon)
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Define Brown syndrome:
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Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

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**Duane syndrome**

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Vertical Deviations

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Is Brown syndrome more common in…
…males or females? Males
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What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)? Duane syndrome

Briefly, what is Duane syndrome?

- A motility disorder with the following key findings:
  - At least some limitation of horizontal movement
  - Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

What is the cause?
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III

In addition to restricted elevation, what else occurs during adduction in Brown syndrome?

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*What is the cause?*
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III
Define **Brown syndrome**: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea.

Is Brown syndrome more common in... males or females? **Males**

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The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.
**Vertical Deviations**

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be).

*(No question—continue when ready)*
Vertical Deviations

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be). However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct.

(No question—continue when ready)

**Define Brown syndrome:** Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in... males or females? OD...

What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)?

Duane syndrome

Name three causes of SO restriction at the trochlea:

-- Idiopathic/congenital (ie, born with a short tendon)
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How does this...
Vertical Deviations

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be). However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct. And when two muscles on opposite sides of the eye contract simultaneously, the net result will be that the eye is pulled back, ie, it retracts.

(No question—continue when ready)

Briefly, what is Duane syndrome?
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Brown syndrome

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Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in males or females?
Males...

OD or OS?

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-- Traumatic
-- Inflammatory

In addition to restricted elevation, what else occurs during adduction in Brown syndrome?
-- The palpebral fissure widens
-- The eye may involuntarily depress (called downshoot)

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be). However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct. And when two muscles on opposite sides of the eye contract simultaneously, the net result will be that the eye is pulled back, ie, it retracts.

(No question—continue when ready)
Vertical Deviations

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be). However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct. And when two muscles on opposite sides of the eye contract simultaneously, the net result will be that the eye is pulled back, ie, it retracts. Further, if this co-contraction is sufficiently vigorous, one or the other rectus muscle might ‘slip’ upwards or downwards, causing the eye to up- or downshoot respectively.

Briefly, what is Duane syndrome?
A motility disorder with the following key findings:
--At least some limitation of horizontal movement
--Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

What is the cause?
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III
Vertical Deviations

When someone with an intact oculomotor system adducts their eye, innervation is increased to the medial rectus (as it should be) and decreased to the lateral rectus (also as it should be). However, in a Duane’s pt CN6 innervates the L-R, so when she attempts to adduct her eye, innervation to both the medial rectus and lateral rectus is increased, causing the eye to up- or downshoot respectively.

**Duane syndrome**

Briefly, what is Duane syndrome?
A motility disorder with the following key findings:
--At least some limitation of horizontal movement
--Attempted adduction causes the globe to retract, and may cause it to up- or downshoot.

What is the cause?
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

This finding—that increased innervation to an agonist muscles is accompanied by a simultaneous decrease in innervation to its antagonist—is ubiquitous to have been ratified into law. What is the eponymous name of the law of ‘reciprocal innervation’?
**Vertical Deviations**

When someone with an intact oculomotor system adducts their eye, **innervation is increased to the medial rectus** (as it should be) and **decreased to the lateral rectus** (also as it should be). However, in a Duane’s pt, CN3 innervates the L-R, so when she attempts to adduct her eye, innervation increases to both medial and lateral rectus, so the eye may involuntarily retract or, if this co-contraction is vigorous, may cause the eye to **up- or downshoot** respectively.

**This finding—that increased innervation to an agonist muscles is accompanied by a simultaneous decrease in innervation to its antagonist—is ubiquitous to have been ratified into law.** What is the eponymous name of the law of ‘reciprocal innervation’? **Sherrington’s law.** You should note that Duane syndrome is an exception to Sherrington’s law (this is noteworthy because it would make a good OKAP question).

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:

-- **At least some limitation of horizontal movement**
-- Attempted adduction **causes the globe to retract**, and may cause it to **up- or downshoot**

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

---

**Superior Oblique (SO)**

**Inferior Oblique (IO)**
Vertical Deviations

Define Brown syndrome:
Deficient elevation in adduction
2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in...
...males or females? Males
...OD or OS? OD

What other two entities could produce restriction of elevation in adduction?
1)
2)
Vertical Deviations

Define Brown syndrome:
- Deficient elevation in adduction
- Due to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in... males or females? Males
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What other two entities could produce restriction of elevation in adduction?
1) IR restriction
2) IO palsy
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What clinical exam finding must be present if one is to make the diagnosis of Brown syndrome?
Forced ductions testing must be positive (i.e., indicate restriction)
Vertical Deviations

Define Brown syndrome: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

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What clinical exam finding must be present if one is to make the diagnosis of Brown syndrome? Forced ductions testing must be positive (i.e., indicate restriction)

But forced ductions are positive in IR restriction as well—how can the two conditions be differentiated?
Define Brown syndrome: Deficient elevation in adduction 2° to restriction of the SO tendon at the trochlea

Is Brown syndrome more common in... males or females? Males... OD or OS? OD

What common strabismus syndrome has the opposite pattern (i.e., is more common in females and left eyes)? Duane syndrome

Name three causes of trochlear restriction: -- Idiopathic -- Traumatic -- Inflammatory

In addition to restricted elevation, what else occurs during adduction in Brown syndrome?--The palpebral fissure widens -- The eye may involuntarily depress (called downshoot)

What other two entities could produce restriction of elevation in adduction? 1) IR restriction 2) IO palsy

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But forced ductions are positive in IR restriction as well—how can the two conditions be differentiated? By retropulsing the globe while performing forced ductions.
Vertical Deviations

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Define Brown syndrome:  
**Deficient elevation in adduction**

2° to oblique dysfunction

Superior

**Is Brown syndrome more common in...**
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But forced ductions are positive in IR restriction as well—how can the two conditions be differentiated?
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Differentiating Brown syndrome from IO palsy

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<tr>
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<th>Brown Syndrome</th>
</tr>
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Brown syndrome: negative for IO palsy: positive for Brown syndrome.
Vertical Deviations

Defining Brown syndrome:
Deficient elevation in adduction
2° to restriction of the SO tendon at the trochlea

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Vertical Deviations

Define Brown syndrome:
- Deficient elevation in adduction
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2° to oblique dysfunction

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**Duane syndrome**

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1. Idiopathic
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In addition to restricted elevation, what else occurs during adduction in Brown syndrome?

-- The palpebral fissure widens
-- The eye may involuntarily depress (called *downshoot*

What other two entities could produce restriction of elevation in adduction?

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2) IO palsy

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**Differentiating Brown syndrome from IO palsy**

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Deficient elevation in adduction

2° to oblique dysfunction

Superior Oblique (SO)
Inferior Oblique (IO)

Uncertain mechanism

Overaction Palsy

Brown syndrome

Double Elevator Palsy

DVD

Define Brown syndrome: Deficient elevation in adduction

2° to restriction of the SO tendon at the trochlea

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Differentiating Brown syndrome from IO palsy

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But forced ductions are positive in IR restriction as well—how can the two conditions be differentiated?

If the globe is anteropulsed (pulled forward) prior to performing forced ductions, the pattern reversed.
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism

Brown syndrome: Management
-- In acute-onset cases, image… [2 locations]
Brown syndrome: Management

In acute-onset cases, image sinuses & orbits. Consider systemic and/or local steroids. If present, treat systemic inflammatory disease. Consider surgery only if hypotropic in primary gaze.

Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - Uncertain mechanism

*Brown syndrome: Management*

--In acute-onset cases, image...sinuses & orbits
**Vertical Deviations**

2° to oblique dysfunction

**Superior Oblique (SO)**
- Overaction
- Palsy
- Brown syndrome

**Inferior Oblique (IO)**

**Uncertain mechanism**

---

*Brown syndrome: Management*
-- In acute-onset cases, image... sinuses & orbits
-- Consider... [drug]
Brown syndrome: Management

--In acute-onset cases, image...sinuses & orbits
--Consider... steroids (systemic and/or local)

Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)

Uncertain mechanism
Brown syndrome: Management
-- In acute-onset cases, image sinuses & orbits
-- Consider steroids (systemic and/or local)
-- If present, treat systemic inflammatory disease

Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Overaction

Palsy

Brown syndrome

Brown syndrome: Management
-- In acute-onset cases, image sinuses & orbits
-- Consider steroids (systemic and/or local)
-- If present, treat...
Brown syndrome: **Management**

-- In acute-onset cases, image... sinuses & orbits
-- Consider... steroids (systemic and/or local)
-- If present, treat... systemic inflammatory disease
Brown syndrome: Management
--In acute-onset cases, image sinuses & orbits
--Consider steroids (systemic and/or local)
--If present, treat systemic inflammatory disease
--Consider surgery only if [specific strabismic problem]
**Brown syndrome: Management**

-- In acute-onset cases, image…sinuses & orbits
-- Consider… steroids (systemic and/or local)
-- If present, treat…systemic inflammatory disease
-- Consider surgery only if…hypotropist in primary gaze

**Vertical Deviations**

2° to oblique dysfunction

**Superior Oblique (SO)**
- Overaction
- Palsy
- Brown syndrome

**Inferior Oblique (IO)**

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - ?
  - ?

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)  Inferior Oblique (IO)

- Overaction
- Palsy
- Brown syndrome

Uncertain mechanism

- Overaction
- Palsy
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Overaction
--Eye elevates in...[position]

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome
- Inferior Oblique (IO)
  - Overaction
  - Palsy

IO Overaction
--Eye elevates in... adduction

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - Overaction
  - Palsy

Uncertain mechanism

IO Overaction
--Eye elevates in adduction
--Develops in % of congenital ET cases
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

Uncertain mechanism

IO Overaction
--Eye elevates in...adduction
--Develops in ~2/3 of congenital ET cases
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Palsy
- [How common?]

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Palsy
- Uncommon

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Palsy
- Uncommon
- Etiology uncertain

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Palsy
- Uncommon
- Etiology uncertain
- Clinically similar to... [another strabismic entity]
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
- Palsy
- Brown syndrome

Inferior Oblique (IO)
- Overaction
- Palsy

IO Palsy
- Uncommon
- Etiology uncertain
- Clinically similar to SO overaction
  (can be a difficult differentiation)

Uncertain mechanism
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - Overaction
  - Palsy

Uncertain mechanism

?
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - Overaction
  - Palsy

Uncertain mechanism

- Double Elevator Palsy
- DVD
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
- DVD

Double Elevator Palsy
--aka…
**Vertical Deviations**

- **2° to oblique dysfunction**
  - Superior Oblique (SO)
  - Inferior Oblique (IO)

- **Uncertain mechanism**
  - Double Elevator Palsy
  - DVD (Double Double Deficiency)

*Double Elevator Palsy*

--aka... *Monocular Elevation Deficiency*
**Vertical Deviations**

- **2° to oblique dysfunction**
  - Superior Oblique (SO)
  - Inferior Oblique (IO)

- **Uncertain mechanism**
  - Double Elevator Palsy
  - DVD

---

**Double Elevator Palsy**

---aka…**Monocular Elevation Deficiency**

---Catch-all term for a strabismus involving…*[basic problem]*
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
- DVD

Double Elevator Palsy

- *aka*... Monocular Elevation Deficiency
- *catch-all term* for a strabismus involving... decreased elevation in all fields of gaze
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
- DVD

**Double Elevator Palsy**
- *aka*...Monocular Elevation Deficiency
- Catch-all term for a strabismus involving...decreased elevation in all fields of gaze
- Due to...[two explanations]
Vertical Deviations

- Superior Oblique (SO)
- Inferior Oblique (IO)
- Uncertain mechanism
- Double Elevator Palsy
- DVD

**Double Elevator Palsy**
- aka... Monocular Elevation Deficiency
- Catch-all term for a strabismus involving... decreased elevation in all fields of gaze
- Due to... restriction or elevation insufficiency (or both)
Vertical Deviations

Differentiating between IR restriction and elevator insufficiency as the cause of a double elevator palsy

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Uncertain mechanism

Double Elevator Palsy

DVD

Catch-all term for a strabismus involving...decreased elevation in all fields of gaze

--Due to...restriction or elevation insufficiency (or both)
Vertical Deviations

Differentiating between IR restriction and elevator insufficiency as the cause of a double elevator palsy

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Double Elevator Palsy

Uncertain mechanism

--Catch all term for a strabismus involving decreased elevation in all fields of gaze
--Due to restriction or elevation insufficiency (or both)

Forced ductions?

Elevation saccades?

DVD
### Vertical Deviations

**Uncertain mechanism**

**Double Elevator Palsy** ---aka… Monocular Elevation Deficiency ---Catch-all term for a strabismus involving decreased elevation in all fields of gaze ---Due to restriction or elevation insufficiency (or both)

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Differentiating between IR restriction and elevator insufficiency as the cause of a double elevator palsy
Vertical Deviations

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Double Elevator Palsy

Catch-all term for a strabismus involving decreased elevation in all fields of gaze

--Due to...restriction or elevation insufficiency (or both)
Vertical Deviations

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--- Double Elevator Palsy

Uncertain mechanism

Catch-all term for a strabismus involving...decreased elevation in all fields of gaze

--Due to...restriction or elevation insufficiency (or both)
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
- DVD

**Double Elevator Palsy**

- aka… **Monocular Elevation Deficiency**
- Catch-all term for a strabismus involving… decreased elevation in all fields of gaze
- Due to… restriction or elevation insufficiency (or both)
- Presents with…
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Uncertain mechanism

Double Elevator Palsy

--aka... Monocular Elevation Deficiency
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--Due to... restriction or elevation insufficiency (or both)
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DVD

Double Elevator Palsy
Vertical Deviations

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- Catch-all term for a strabismus involving...decreased elevation in all fields of gaze
- Due to...restriction or elevation insufficiency (or both)
- Presents with...hypotropia that worsens in upgaze
- Often adopt a...[head position]
**Vertical Deviations**

2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

Uncertain mechanism

**Double Elevator Palsy**

--aka...**Monocular Elevation Deficiency**

--Catch-all term for a strabismus involving...decreased elevation in all fields of gaze

--Due to...**restriction or elevation insufficiency** (or both)

--Presents with...hypotropia that worsens in upgaze

--Often adopt a...chin-up position
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
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**Double Elevator Palsy**

--aka... *Monocular Elevation Deficiency*

--Catch-all term for a strabismus involving... decreased elevation in all fields of gaze

--Due to... restriction or elevation insufficiency (or both)

--Presents with... hypotropia that worsens in upgaze

--Often adopt a... chin-up position

--50% have... [another EOM problem]
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
- Inferior Oblique (IO)

Uncertain mechanism

- Double Elevator Palsy
- DVD

**Double Elevator Palsy**

- *aka*...**Monocular Elevation Deficiency**
- Catch-all term for a strabismus involving...decreased elevation in all fields of gaze
- Due to...**restriction or elevation insufficiency** (or both)
- Presents with...hypotropia that worsens in upgaze
- Often adopt a...chin-up position
- 50% have...**concomitant ptosis** (1/3 of these with...[eponymous condition])
**Vertical Deviations**

2° to oblique dysfunction

- Superior Oblique (SO)
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2° to oblique dysfunction

Superior Oblique (SO)

Inferior Oblique (IO)

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Broadly speaking, what sort of disorder is Marcus-Gunn jaw wink (MGJW)?

It is one of…synkinesis

The…involuntary movement of one bodypart in response to the…voluntary movement of another

Is the ptosis of MGJW unilateral, or bilateral?

Unilateral

What is the clinical hallmark of MGJW?

The ptotic lid elevates in response to voluntary masticatory movements of the jaw

Which jaw movements are involved?

--Lateral displacement
--Protrusion
--Wide opening
--Clenching

Marcus-Gunn jaw wink
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Vertical Deviations

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Superior Oblique (SO)

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Brown syndrome

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What does synkinesis refer to?

Marcus-Gunn jaw wink
**Vertical Deviations**

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What does synkinesis refer to?
The involuntary movement of one bodypart in response to the voluntary movement of another.

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Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)  Inferior Oblique (IO)

Overaction  Underaction

Double Elevator Palsy
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--Lateral displacement
--Protrusion
--Wide opening
--Clenching
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
Inferior Oblique (IO)

Overaction
Paralysis

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Marcus-Gunn jaw wink
**Vertical Deviations**

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Marcus-Gunn jaw wink (MGJW)
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- It is while the infant is nursing...
**Vertical Deviations**

2° to oblique dysfunction

Superior Oblique (SO)  Inferior Oblique (IO)

Overaction  Underaction

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Vertical Deviations

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--Catch-all term

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Another congenital cranial dysinnervation disorder involving an ophthalmic movement should readily come to mind—what is it?

Duane syndrome, as discussed previously

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Movements of the jaw
--Lateral displacement
--Protrusion

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Which jaw movements are involved?—Lateral displacement—Protrusion—Wide opening—Clenching

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Vertical Deviations

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Briefly, what is Duane syndrome? A motility disorder with the following key findings:
--At least some limitation of horizontal movement
--Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

What is the cause? The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III

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If a patient has a double elevator palsy, but Bell’s phenomenon is intact, what can be inferred regarding etiology?
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The ‘palsy’ is probably supranuclear in origin; i.e., a problem with the cortical ‘elevation center’
Vertical Deviations

2° to oblique dysfunction

- Superior Oblique (SO)
  - Overaction
  - Palsy
  - Brown syndrome

- Inferior Oblique (IO)
  - Overaction
  - Palsy

Uncertain mechanism

- Double Elevator Palsy
  - Management
  -- If IR restricted:
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
- Overaction
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Inferior Oblique (IO)
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Uncertain mechanism

Double Elevator Palsy

Double Elevator Palsy: Management
--If IR restricted: Recess it
Vertical Deviations

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Double Elevator Palsy: Management
-- If IR restricted: Recess it
-- If no IR restriction: Knapp procedure

DVD
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Uncertain mechanism

- Double Elevator Palsy
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**Double Elevator Palsy: Management**

- If IR restricted: Recess it
- If no IR restriction: **Knapp procedure**

*What is the Knapp procedure?*
Vertical Deviations

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Double Elevator Palsy

Double Elevator Palsy: Management
-- If IR restricted: Recess it
-- If no IR restriction: Knapp procedure

What is the Knapp procedure?
Relocating the LR and MR insertions toward the SR
Vertical Deviations

2° to oblique dysfunction

Superior Oblique (SO)
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Double Elevator Palsy

**Double Elevator Palsy: Management**
-- If IR restricted: Recess it
-- If no IR restriction: Knapp procedure
-- Be sure to address ptosis if present

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Why is it important to address the ptosis concurrently?
Vertical Deviations

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Why is it important to address the ptosis concurrently? You don’t want to elevate an eye behind a ptotic lid—it could lead to amblyopia.
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Vertical Deviations

- **2° to oblique dysfunction**
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*In this context, what does DVD stand for?*

- **Dissociated vertical deviation**

**Who is the typical DVD pt?**
- A child with infantile/congenital ET or XT

**What is the classic clinical finding?**
- An eye will slowly elevate and extort, either spontaneously (*manifest DVD*) or when occluded (*latent DVD*). A crucial finding occurs when the drifting eye reorients downward, and it is this— the fellow eye does *not* move downward simultaneously (as would normally be the case).
Vertical Deviations

2° to oblique dysfunction

Uncertain mechanism

In this context, what does DVD stand for?
Dissociated vertical deviation

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Vertical Deviations

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Why would it ‘be the case’ that both eyes would move downward simultaneously?

In order to maintain visual cooperation, eye movements are tightly linked—EOMs on each eye are ‘yoked’ to one another to ensure the eyes move in a coordinated fashion. For example, for rightward gaze the right LR and left MR are yoke muscles.

Hering’s law of motor correspondence states that yoke muscles receive equal innervation.

How does Hering’s law relate to DVD?

As noted, in DVD the downward reorientation movement by the drifting eye is not accompanied by a downward movement of the fellow eye. As the muscles that depress the eyes are yoke muscles, this means that DVD represents a violation of Hering’s law.

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Another good potential OKAP question, IMO…

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As an aside: Is there such a thing as a dissociated horizontal deviation?
Vertical Deviations

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As an aside: Is there such a thing as a dissociated horizontal deviation? A DHD? Indeed there is. There is also a dissociated torsional deviation (DTD). Together, DVD, DHD and DTD comprise the dissociated strabismus complex. (All that being said, the only one the Peds book discusses at length is DVD.)