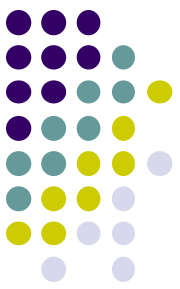


Motility Disorders



1

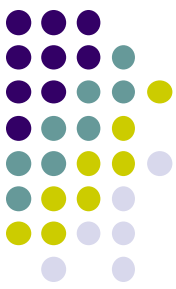
CN3

CN6

CN4

The extraocular muscles (EOMs) are innervated by cranial nerves 3, 4 and 6.
(The reason they're not in numerical order above will become clear shortly.)

Motility Disorders



CN3

CN6

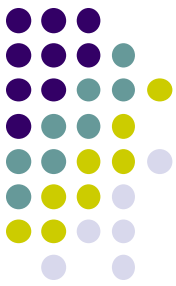
CN4

The extraocular muscles (EOMs) are innervated by cranial nerves 3, 4 and 6. (The reason they're not in numerical order above will become clear shortly.)

CN3 innervates the *superior*, *inferior* and *medial rectus* muscles and the *inferior oblique* (as well as the *levator palpebrae superioris*, the main elevator of the upper lid). CN6 innervates the *lateral rectus*; CN4, the *superior oblique*.

Motility Disorders

3



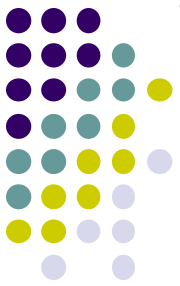
CN3

CN6

CN4

With respect to EOM issues, it is useful to divvy the system into four levels or pathways. (We will identify/introduce the four first, then discuss each in some detail.)

Motility Disorders



Nuclear

CN3
Nucleus

CN6
Nucleus

CN4
Nucleus

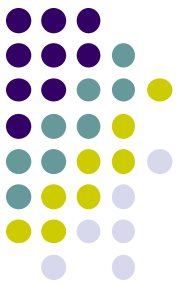
With respect to EOM issues, it is useful to divvy the system into four levels or pathways. (We will identify/introduce the four first, then discuss each in some detail.)

The first level is the *nuclear*. This level consists of the nuclei (ie, the collection of cell bodies within the CNS) that give rise to the axons forming each nerve. Take note: *Every other level is defined in terms of its relationship to the nuclear level.*

Motility Disorders

Supranuclear

The ***supranuclear pathways*** consists of inputs to the nuclei from centers in the cortex, cerebellum, vestibular system, etc.



Nuclear

CN3
Nucleus

CN6
Nucleus

CN4
Nucleus

Motility Disorders

Supranuclear

The ***supranuclear pathways*** consists of inputs to the nuclei from centers in the cortex, cerebellum, vestibular system, etc. These locations are 'supra' in that they carry signals *to* the nuclei.



Nuclear

CN3
Nucleus

CN6
Nucleus

CN4
Nucleus

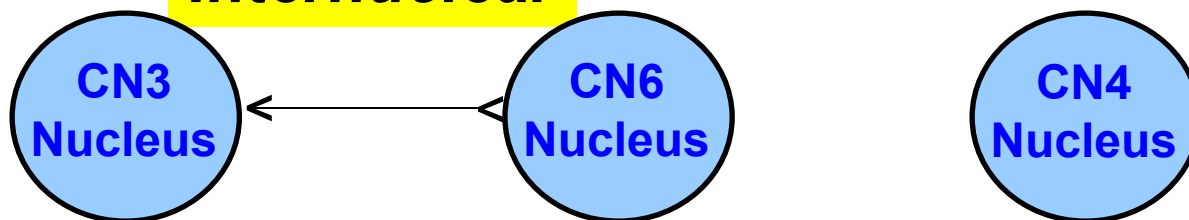


Motility Disorders

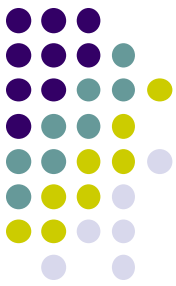
Supranuclear

Nuclear

Internuclear



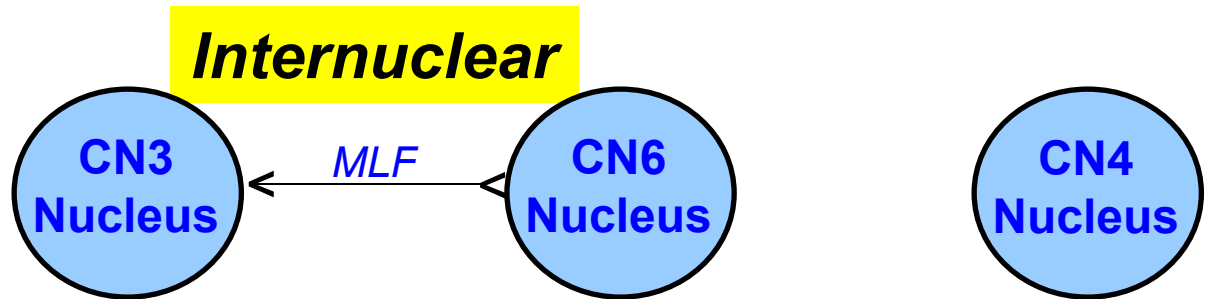
The ***internuclear pathway*** consists of a set of axons projecting from the CN6 nucleus on one side to the CN3 nucleus on the other.



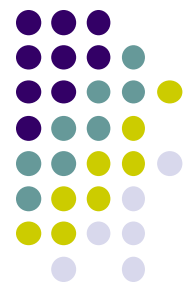
Motility Disorders

Supranuclear

Nuclear



The ***internuclear pathway*** consists of a set of axons projecting from the CN6 nucleus on one side to the CN3 nucleus on the other. This pathway is called the *medial longitudinal fasciculus* (MLF).

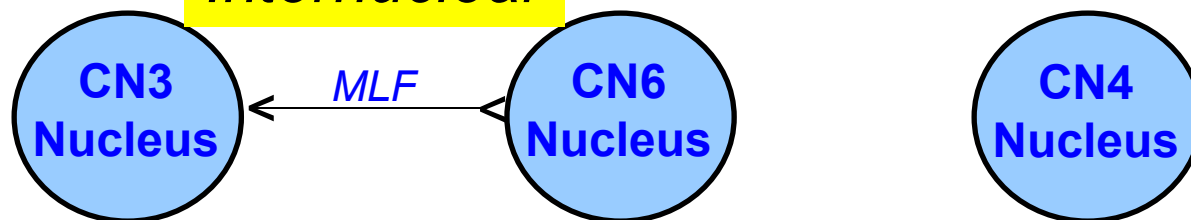


Motility Disorders

Supranuclear

Nuclear

Internuclear



Infranuclear

The ***infranuclear pathway*** consists of everything below the nuclei: the axons as they run from the nuclei to the neuromuscular junction; the junction itself; and finally the EOMs themselves. (There are many subsections in this pathway; we will identify them shortly.)

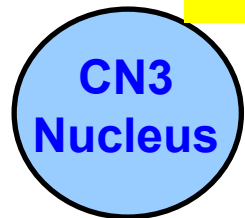
Extraocular muscle

This slide summarizes the basic organization of EOM control.

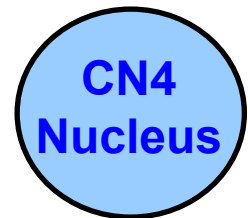
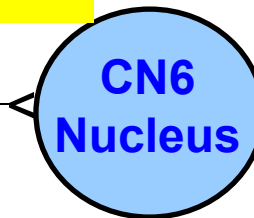
Supranuclear

Nuclear

Internuclear

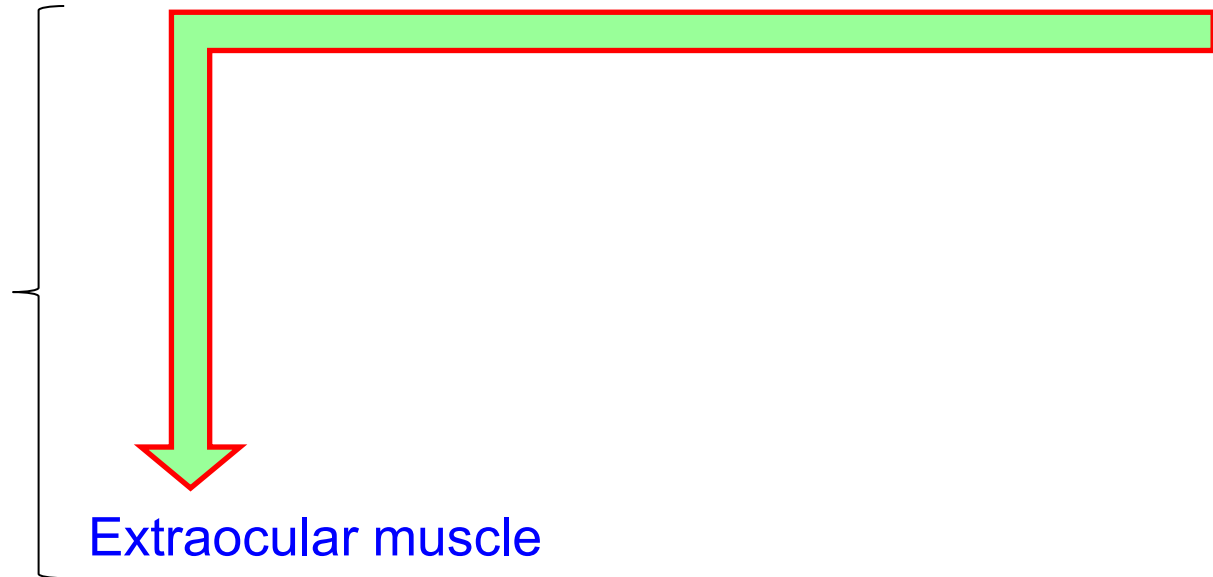


MLF



Infranuclear

Extraocular muscle



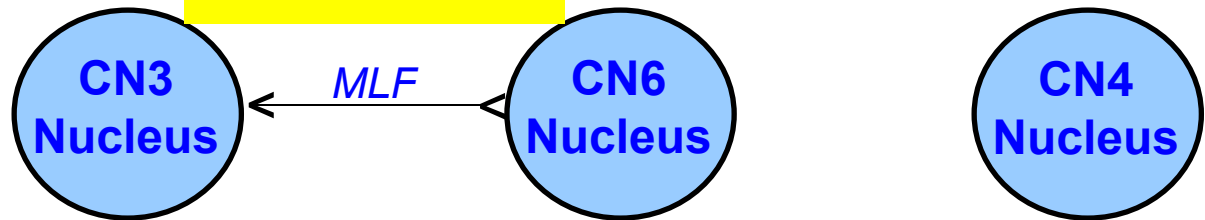
This slide summarizes the basic organization of EOM control. When you encounter a pt with a motility issue, your first thought should be: *Is this issue **nuclear**, **supranuclear**, **internuclear**, or **infranuclear** in origin?*

Supranuclear

Nuclear

Infranuclear

Internuclear



Extraocular muscle

Supranuclear

This slide summarizes the basic organization of EOM control. When you encounter a pt with a motility issue, your first thought should be: *Is this issue **nuclear**, **supranuclear**, **internuclear**, or **infranuclear** in origin?*

Internuclear

Nuclear

CN3

MLF

CN6

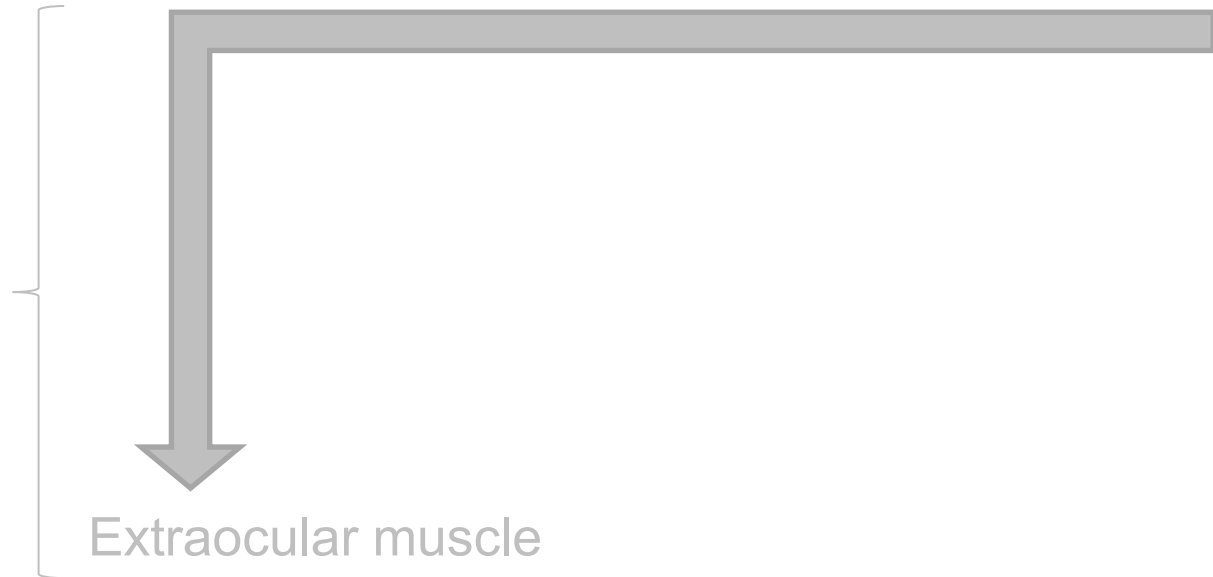
CN4

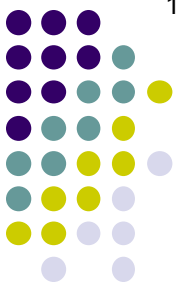
S

Next we will look at each level/pathway in more detail

Infranuclear

Extraocular muscle





Motility Disorders

Supranuclear

Nuclear

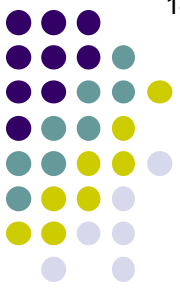
Internuclear



Let's start with the infranuclear pathway.

Infranuclear

Extraocular muscle



Motility Disorders

Supranuclear

Nuclear

Internuclear



Infranuclear

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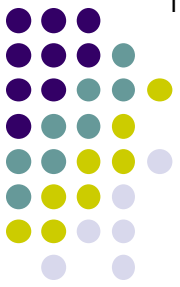
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Let's start with the **infranuclear pathway**. There are a number of locations along this pathway at which a motility disorder might be induced; we will address them in anatomic order from central → peripheral.

Extraocular muscle

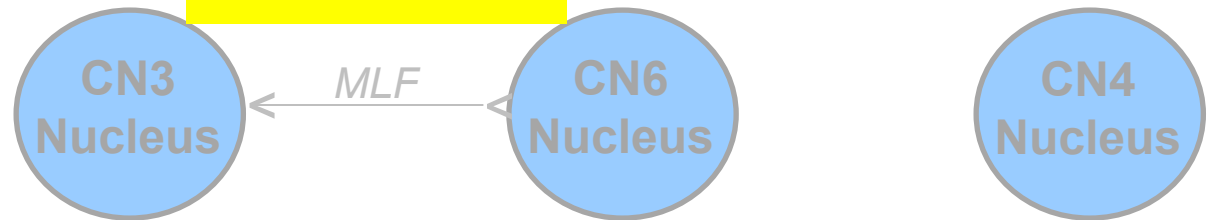


Motility Disorders

Supranuclear

Nuclear

Internuclear



The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

Fascicle

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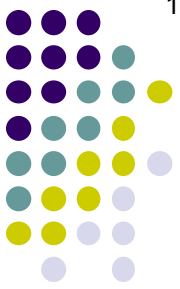
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Extraocular muscle

Infranuclear

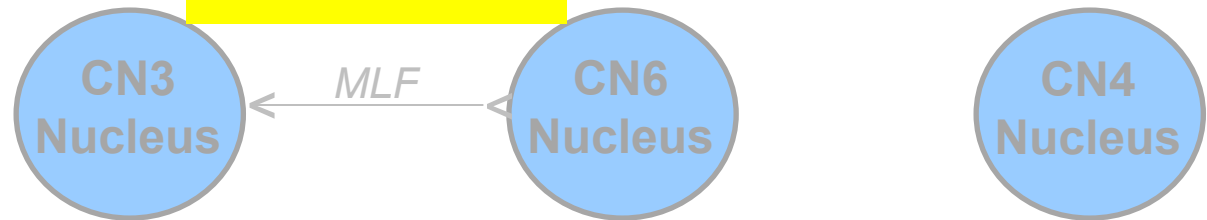


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

A **fascicular syndrome** is one in which an EOM issue is due to damage of a fascicle.

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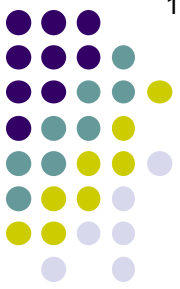
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Extraocular muscle

Infranuclear

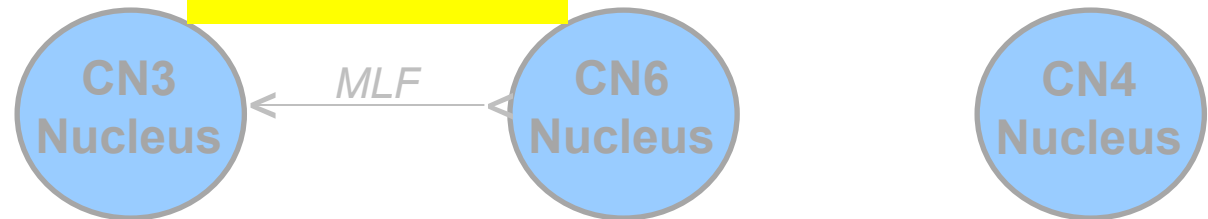


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular



The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

A **fascicular syndrome** is one in which an EOM issue is due to damage of a fascicle. Because the fascicles are located within the brainstem, it should come as no surprise that fascicular lesions do not present with *isolated* EOM abnormalities

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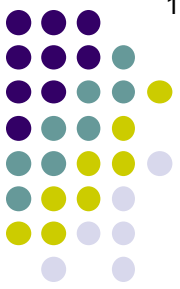
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Extraocular muscle

Infranuclear

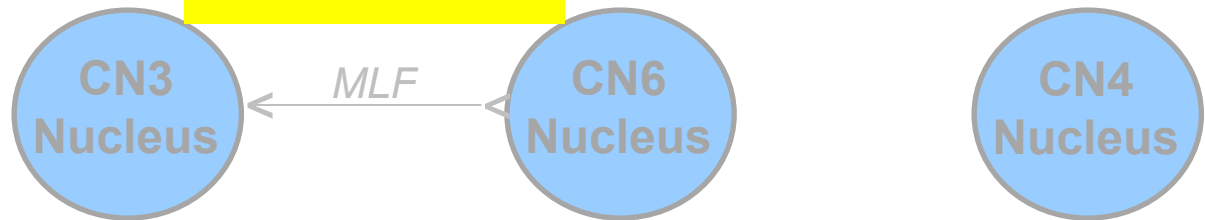


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular



The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

A **fascicular syndrome** is one in which an EOM issue is due to damage of a fascicle. Because the fascicles are located within the brainstem, it should come as no surprise that fascicular lesions do not present with *isolated* EOM abnormalities; rather, the ophthalmoparesis is accompanied by *nonocular* findings consistent with a CNS lesion.

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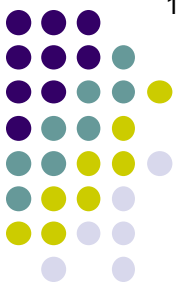
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Extraocular muscle

Infranuclear

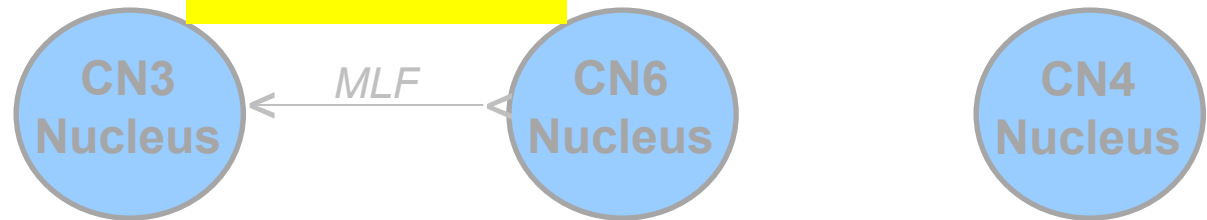


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular



The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

A **fascicular syndrome** is one in which an EOM issue is due to damage of a fascicle. Because the fascicles are located within the brainstem, it should come as no surprise that fascicular lesions do not present with *isolated* EOM abnormalities; rather, the ophthalmoparesis is accompanied by *nonocular* findings consistent with a CNS lesion. Thus, each fascicular syndrome consists of paresis of one or more EOMs along with a particular set of nonocular signs and symptoms.

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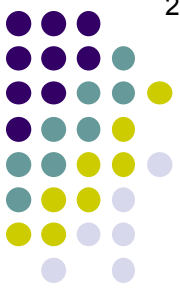
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Extraocular m

Infranuclear

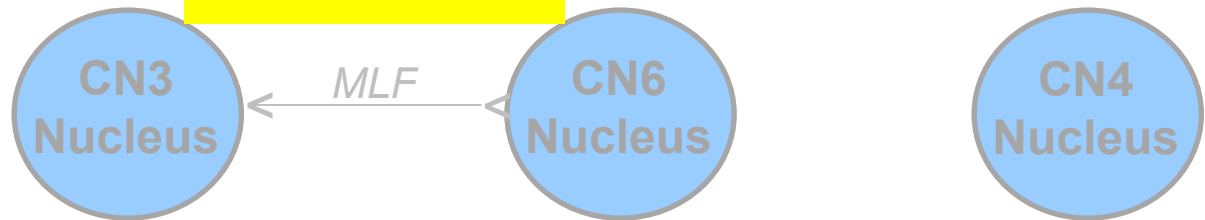


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

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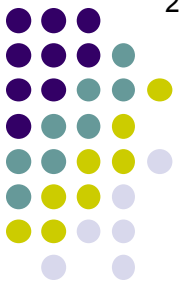
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Extraocular m

The bundle of axons that leave a nucleus, but are still within the brainstem, is called a *fascicle*.

A **fascicular syndrome** is one in which an EOM issue is due to damage of a fascicle. Because the fascicles are located within the brainstem, it should come as no surprise that fascicular lesions do not present with *isolated* EOM abnormalities; rather, the ophthalmoparesis is accompanied by *nonocular* findings consistent with a CNS lesion. Thus, each fascicular syndrome consists of paresis of one or more EOMs along with a particular set of nonocular signs and symptoms. It is by this set of nonocular signs/symptoms that you will be expected to both recognize a fascicular syndrome as well as identify the location within the brainstem of the insult that caused it.

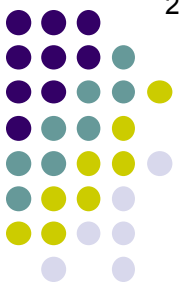
Infranuclear



CN3 Fascicular Syndromes

Syndrome	Ipsilateral 3 rd	
<i>Weber</i>		
<i>Benedikt</i>		
<i>Claude</i>		
<i>Nothnagel</i>		

These are the **CN3 fascicular syndromes** covered in the *BCSC*

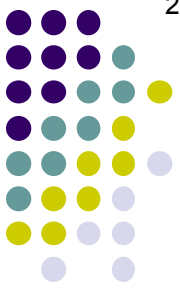


Motility Disorders

CN3 Fascicular Syndromes

Syndrome	Ipsilateral 3 rd plus...	
<i>Weber</i>	Contralateral hemiplegia	
<i>Benedikt</i>	Contralateral involuntary movements (often a hand flap)	
<i>Claude</i>	Contralateral ataxia	
<i>Nothnagel</i>	Ipsilateral ataxia	

These are the **CN3 fascicular syndromes** covered in the *BCSC*, along with their nonocular signs/symptoms

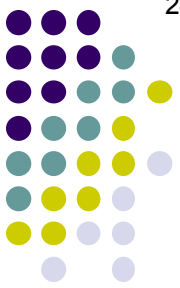


Motility Disorders

CN3 Fascicular Syndromes

Syndrome	Ipsilateral 3 rd plus...	Lesion location
<i>Weber</i>	Contralateral hemiplegia	Cerebral peduncle
<i>Benedikt</i>	Contralateral involuntary movements (often a hand flap)	Red nucleus & substantia nigra
<i>Claude</i>	Contralateral ataxia	Cerebellar peduncle
<i>Nothnagel</i>	Ipsilateral ataxia	Cerebellar peduncle

These are the **CN3 fascicular syndromes** covered in the *BCSC*, along with their nonocular signs/symptoms, and their lesion locations.

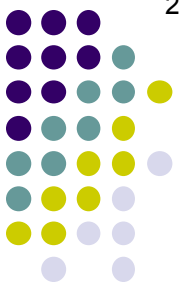


Motility Disorders

CN3 Fascicular Syndromes

Syndrome	Ipsilateral 3 rd plus...	Lesion location
<i>Weber</i>	Contralateral hemiplegia	Cerebral peduncle
<i>Benedikt</i>	Contralateral involuntary movements (often a hand flap)	Red nucleus & substantia nigra
<i>Claude</i>	Contralateral ataxia	Cerebellar peduncle
<i>Nothnagel</i>	Ipsilateral ataxia	Cerebellar peduncle

These are the **CN3 fascicular syndromes** covered in the *BCSC*, along with their nonocular signs/symptoms, and their lesion locations. **Do not try to memorize the entire Table right now.** Rather, just look over the names until you are passingly familiar with them.

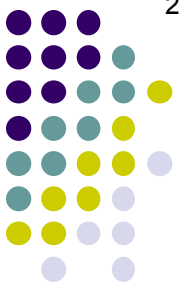


Motility Disorders

CN3 Fascicular Syndromes

Syndrome	Ipsilateral 3 rd plus...	Lesion location
<i>Weber</i>	Contralateral hemiplegia	Cerebral peduncle
<i>Benedikt</i>	Contralateral involuntary movements (often a hand flap)	Red nucleus & substantia nigra
<i>Claude</i>	Contralateral ataxia	Cerebellar peduncle
<i>Nothnagel</i>	Ipsilateral ataxia	Cerebellar peduncle

These are the **CN3 fascicular syndromes** covered in the *BCSC*, along with their nonocular signs/symptoms, and their lesion locations. **Do not try to memorize the entire Table right now.** Rather, just look over the names until you are passingly familiar with them. You will be way ahead of the game at this juncture if you are simply able to identify the four CN3 fascicular syndromes.



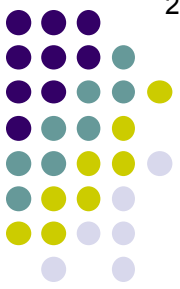
Motility Disorders

CN6 Fascicular Syndromes

Syndrome	Ipsilateral 6 th plus...	Lesion location
<i>Millard-Gubler</i>	Ipsilateral CN7 and contralateral hemiplegia	Ventral pons
<i>Foville</i>	Ipsilateral CN7 and contralateral hemiplegia and facial hypoesthesia and loss of taste to anterior tongue	Tractus solitarius

Likewise, these are the **CN6 fascicular syndromes**. Again, just being able to identify the two of them is enough for now.

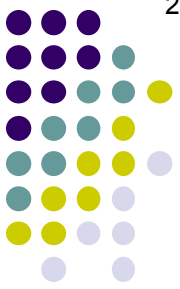
Motility Disorders



CN4 Fascicular Syndromes

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Finally, note that there are **no** CN4 fascicular syndromes covered in the *BCSC*.

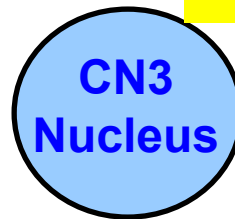


Motility Disorders

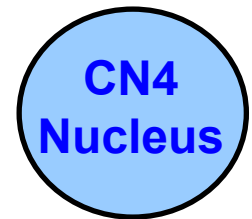
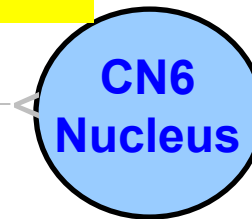
Supranuclear

Internuclear

Nuclear



MLF



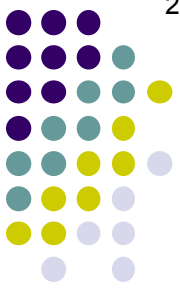
Changing gears momentarily: Motility disorders secondary to **Nuclear-level** lesions are uncommon.

Infranuclear

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Extraocular muscle

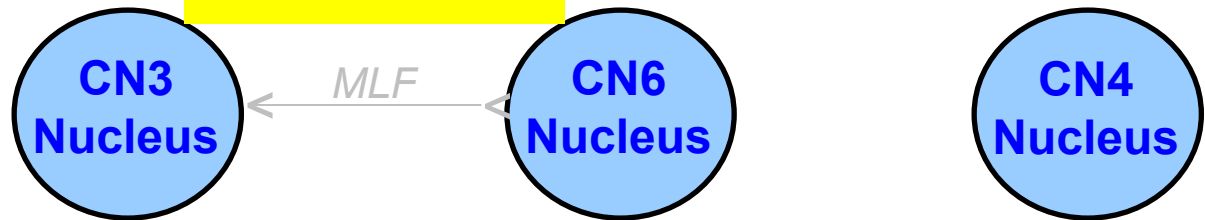


Motility Disorders

Supranuclear

Nuclear

Internuclear



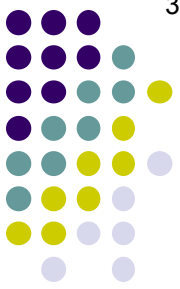
Changing gears momentarily: Motility disorders secondary to **Nuclear-level** lesions are uncommon. That said, and because the cranial-nerve nuclei are located within the brainstem, it shouldn't come as a surprise that, like fascicular lesions, most motility disorders secondary to nuclear lesions present in concert with nonocular CNS findings.

Infranuclear

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Extraocular muscle

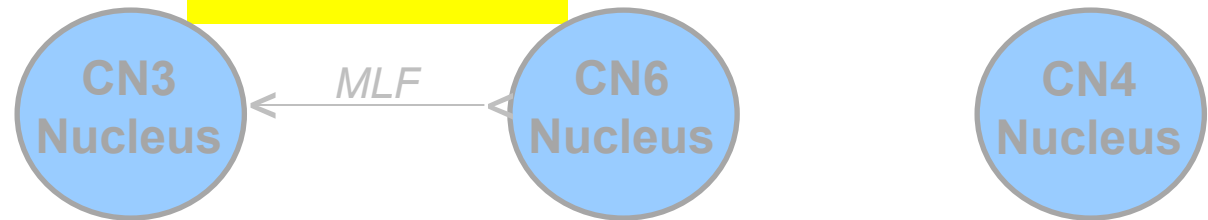


Motility Disorders

Supranuclear

Internuclear

Nuclear



Changing gears momentarily: Motility disorders 2ndry to **Nuclear-level** lesions are uncommon. That said, and because the cranial-nerve nuclei

Now back to our tour of the infranuclear pathway...

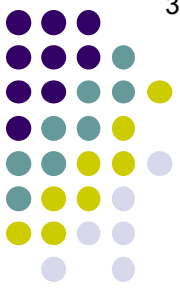
like fasciculus lesions, most motility disorders 2ndry to nuclear lesions present in concert with nonocular CNS findings.

Infranuclear

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Extraocular muscle

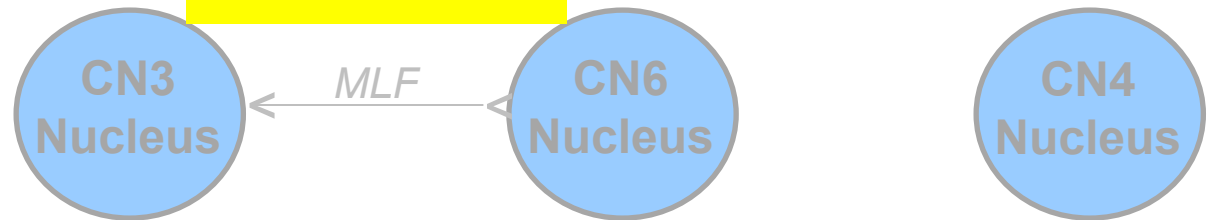


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

The next portion commences once the axonal fibers exit the brainstem and enter the subarachnoid space. Now the fibers officially constitute a **nerve**.

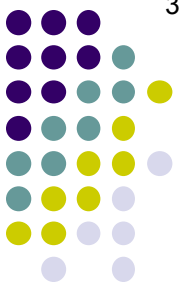
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Extraocular muscle

Infranuclear

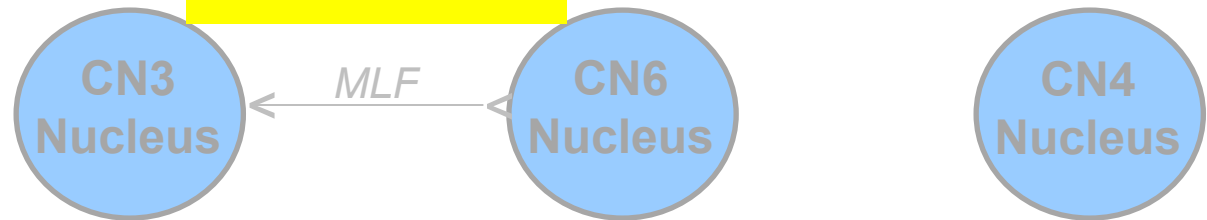


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

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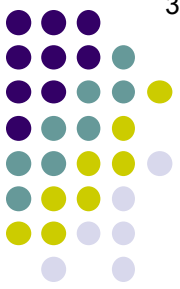
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Extraocular muscle

The next portion commences once the axonal fibers exit the brainstem and enter the subarachnoid space. Now the fibers officially constitute a **nerve**. One of the most common causes of CN palsies—ischemic damage, usually related to systemic vasculopathic conditions such as HTN and DM—usually occurs in the subarachnoid portion of the infranuclear pathway.

Infranuclear

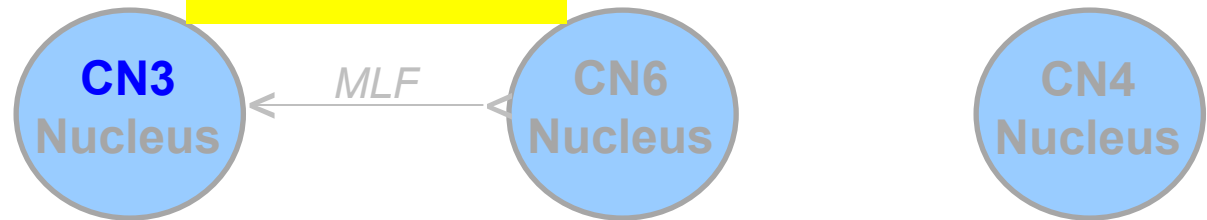


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

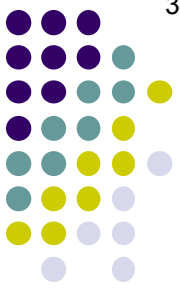
The next portion commences once the axonal fibers exit the brainstem and enter the subarachnoid space. Now the fibers officially constitute a **nerve**. One of the most common

Later in the slide-set, we will drill down on some important considerations regarding **CN3 palsies** secondary to insults in the subarachnoid portion of the infranuclear pathway

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Extraocular muscle

Infranuclear



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

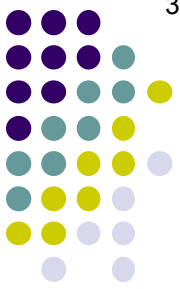
The nerves leave the subarachnoid space when they enter the cavernous sinus (CS).

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Extraocular muscle

Infranuclear



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

?

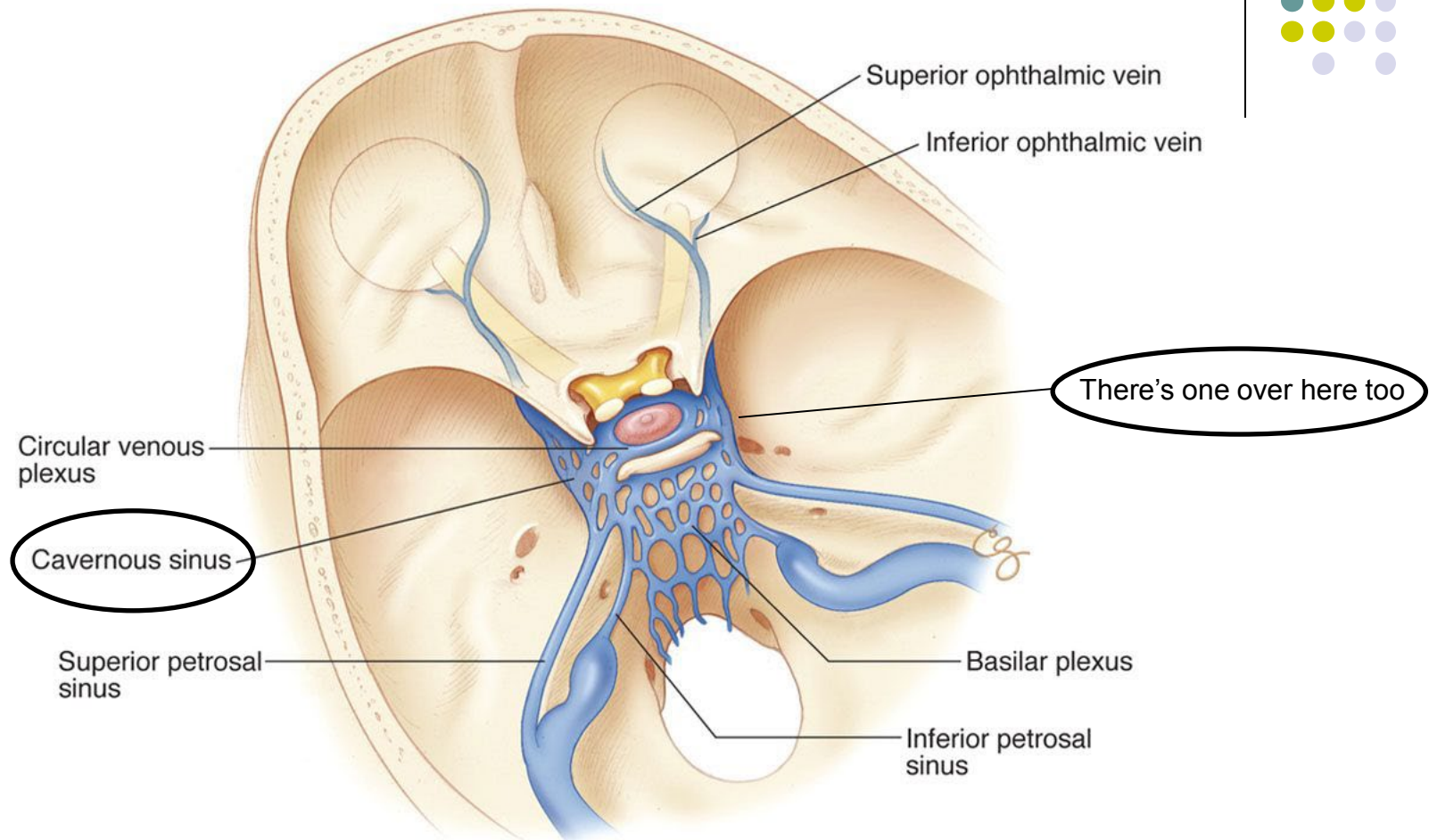
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Extraocular muscle

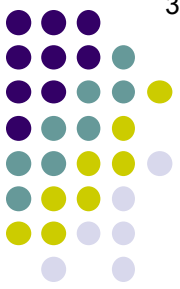
The nerves leave the subarachnoid space when they enter the cavernous sinus (CS). The CS are venous sinuses located just behind the orbits and lateral to the sella turcica/pituitary fossa.

Infranuclear

Motility Disorders



Cavernous sinuses



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

?

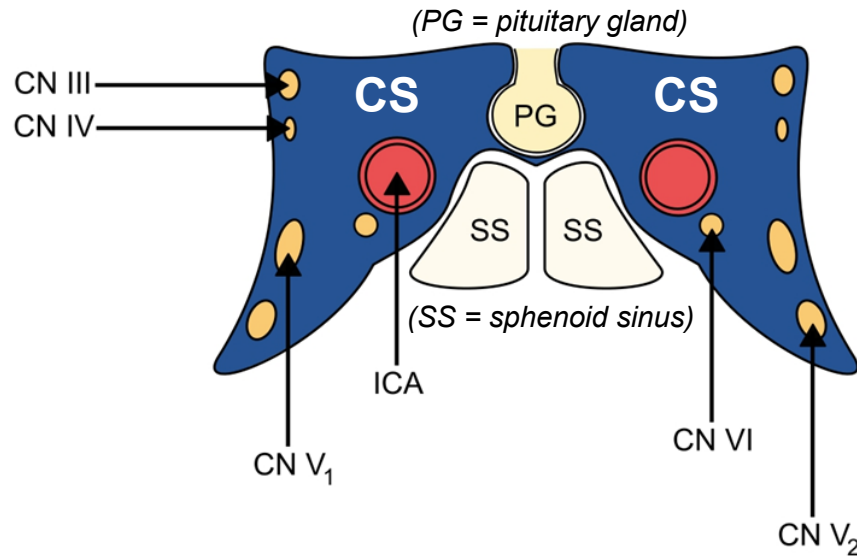
?

Extraocular muscle

The nerves leave the subarachnoid space when they enter the cavernous sinus (CS). The CS are venous sinuses located just behind the orbits and lateral to the sella turcica/pituitary fossa. The hallmark of ophthalmoplegia 2ndry to a CS process is the involvement of multiple nerves simultaneously.

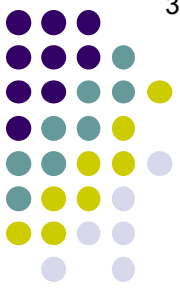
Infranuclear

Motility Disorders



--CN6
 --CN3
 --CN4
 --V1
 --V2
 --Postganglionic sympathetics

Simultaneous deficits involving structures innervated by some (or all!) of these nerves is highly suggestive of CS pathology



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

?

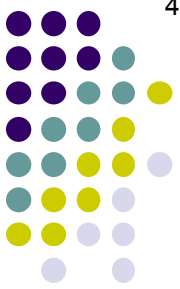
?

Extraocular muscle

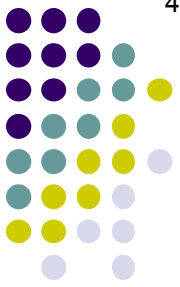
Infranuclear

The nerves leave the subarachnoid space when they enter the cavernous sinus (CS). The CS are venous sinuses located just behind the orbits and lateral to the sella turcica/pituitary fossa. The hallmark of ophthalmoplegia 2ndary to a CS process is the involvement of multiple nerves simultaneously. **Additionally, CS pathology can impede venous drainage of the eye, resulting in engorged conj vessels, chemosis, and/or increased IOP.**

Motility Disorders



Engorged conj vessels and chemosis 2ndry to CS pathology—take note!

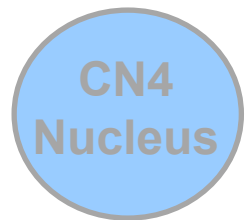


Motility Disorders

Supranuclear

Nuclear

Internuclear



Infranuclear

Fascicular

Subarachnoid

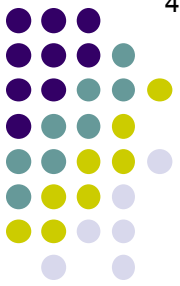
Cavernous sinus

Orbital ←

?

Extraocular muscle

After the CS, the next well-defined space is the *orbit*.



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

Superior orbital fissure

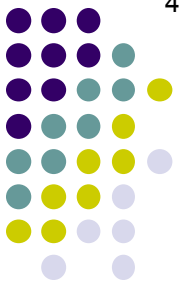
Orbital

?

Extraocular muscle

Infranuclear

After the CS, the next well-defined space is the *orbit*. But, *superior orbital fissure* (SOF) is also good, if not better (the *Neuro* book breaks out the fissure as a separate structure in the pathway).



Motility Disorders

Supranuclear

Nuclear

Internuclear



CN4 Nucleus

Fascicular

Subarachnoid

Cavernous sinus

Superior orbital fissure
Orbital apex

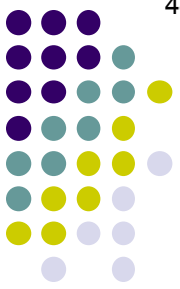
Orbital

?

Extraocular muscle

Infranuclear

After the CS, the next well-defined space is the *orbit*. But, *superior orbital fissure* (SOF) is also good, if not better (the *Neuro* book breaks out the fissure as a separate structure in the pathway). Likewise, *orbital apex* is also legit as a 'locale' on the infranuclear pathway.



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

Superior orbital fissure

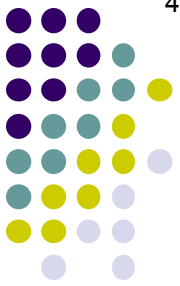
Orbital apex

Orbital

After the CS, the next well-defined space is the orbit. But, superior orbital fissure (SOF) is also good, if not better (the *Neuro* book

Infranuclear

Frequently, CS and SOF lesions are clinically indistinguishable, because both can present with involvement of any subset of nerves that pass through both.



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

Superior orbital fissure

Orbital apex

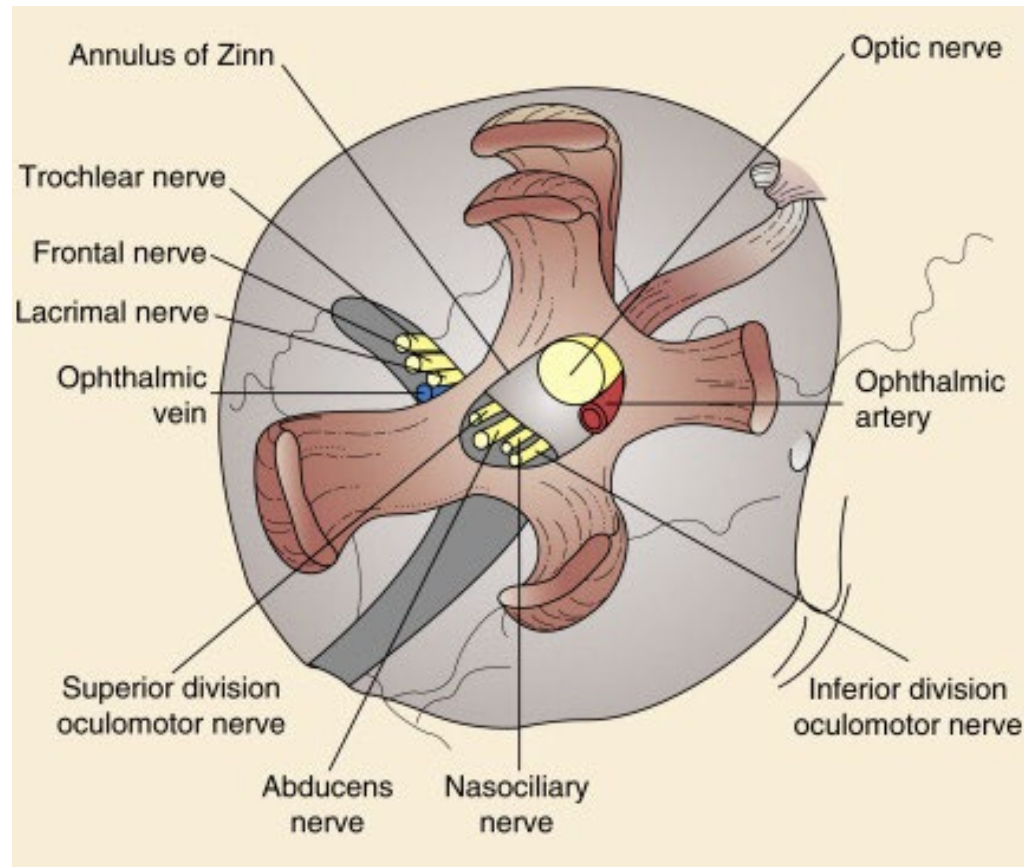
Orbital

After the CS, the next well-defined space is the orbit. But, superior orbital fissure (SOF) is also good, if not better (the *Neuro* book

Infranuclear

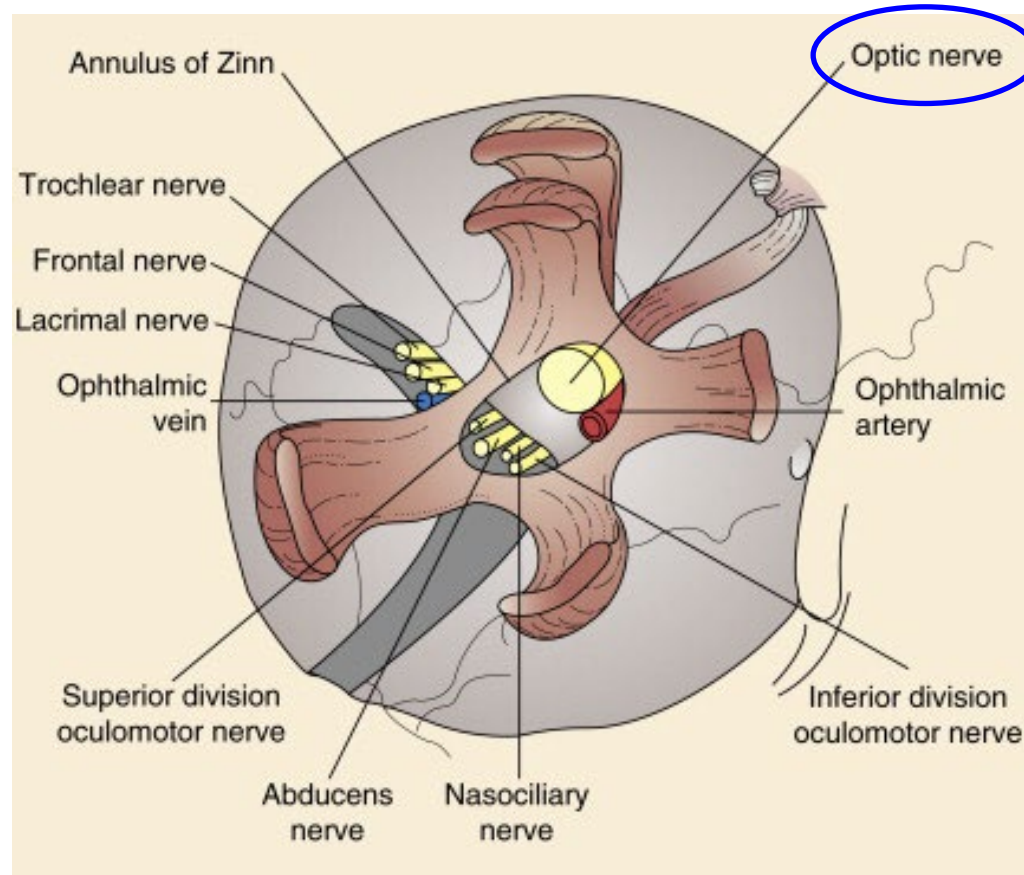
Frequently, CS and SOF lesions are clinically indistinguishable, because both can present with involvement of any subset of nerves that pass through both. However, lesions of the orbital apex are easily recognized differentiated from CS and SOF lesions, because apical lesions involve the optic nerve as well.

Motility Disorders

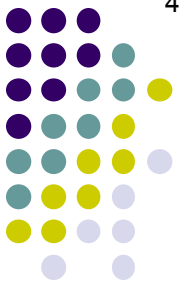


Orbital apex: All the nerves...

Motility Disorders



Orbital apex: All the nerves...including the 'optic' one

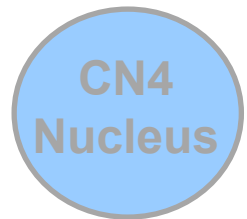


Motility Disorders

Supranuclear

Nuclear

Internuclear



Infranuclear

Fascicular

Subarachnoid

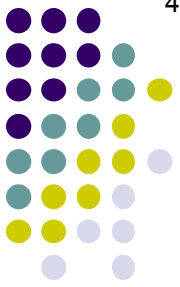
Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle

The NM junction is where the journey ends for the nerves.



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

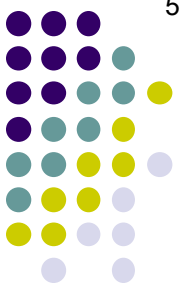
Orbital

Neuromuscular junction

Extraocular muscle

The NM junction is where the journey ends for the nerves.
The “prototypical” disease of the NM junction is *myasthenia gravis*.

Infranuclear



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

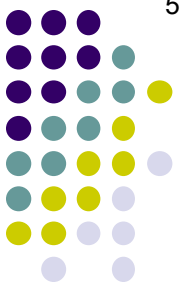
Orbital

Neuromuscular junction

Extraocular muscle

And finally...There is pathology localized to the EOMs themselves.

Infranuclear



Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Subarachnoid

Cavernous sinus

Orbital

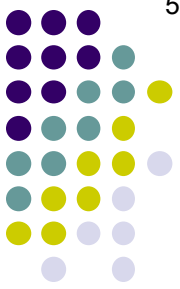
Neuromuscular junction

Extraocular muscle

And finally...There is pathology localized to the EOMs themselves.

This includes conditions such as thyroid eye dz, orbital myositis, and myopathy (eg, CPEO.)

Infranuclear



Motility Disorders

Supranuclear

Nuclear

Internuclear

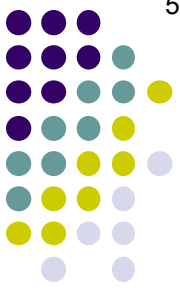


Fascicular

Subarachnoid

Infranuclear

One commonly encountered motility issue is the *nontraumatic, isolated unilateral CN3 palsy*. (*Isolated* means 'absent nonocular of other signs or symptoms.')

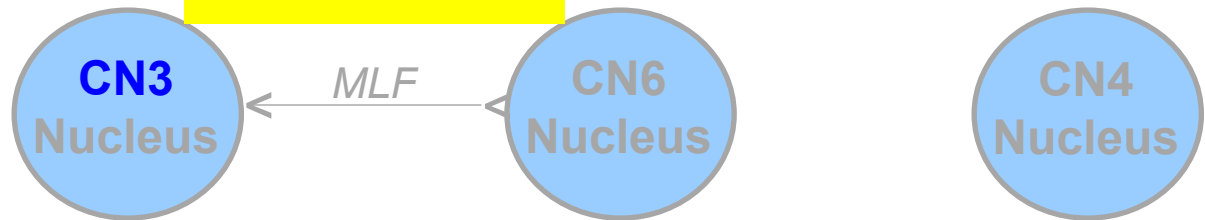


Motility Disorders

Supranuclear

Nuclear

Internuclear

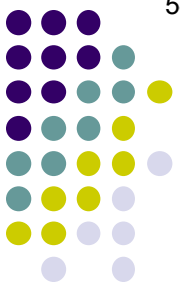


Fascicular

Subarachnoid

Infranuclear

One commonly encountered motility issue is the *nontraumatic, isolated unilateral CN3 palsy*. (*Isolated* means ‘absent nonocular of other signs or symptoms.’) **The majority of nontraumatic, isolated CN3 palsies are secondary to an insult to the subarachnoid portion of the infranuclear pathway.**

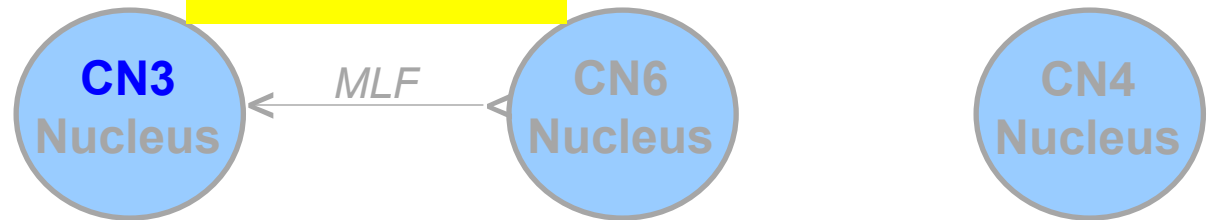


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

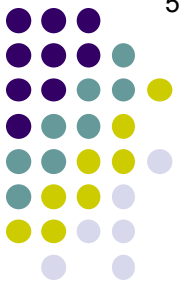
Subarachnoid

Infranuclear

One commonly encountered motility issue is the *nontraumatic, isolated unilateral CN3 palsy*. (*Isolated* means ‘absent nonocular of other signs or symptoms.’) **The majority of nontraumatic, isolated CN3 palsies are secondary to an insult to the subarachnoid portion of the infranuclear pathway.** Two such insults are of particular note: an *ischemic* event, and a *compressive* event. These are noteworthy because of how common they are (ischemic), and of how potentially dire the consequences are (compressive).

Motility Disorders

CN3 palsy



A nontraumatic, isolated unilateral CN3 palsy will present with unilateral ophthalmoparesis involving some or all of the EOMs innervated by CN3: the *superior*, *inferior* and *medial rectus* muscles; the *inferior oblique*; and the *levator* muscle of the lid.

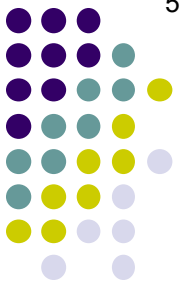
Motility Disorders



CN3 palsy. Note the classic 'down and out' eye position. Note also the presence of 'thumb sign' (ie, that the lid had to be manually elevated to see the eye in the first place)

Motility Disorders

CN3 palsy



A nontraumatic, isolated unilateral CN3 palsy will present with unilateral ophthalmoparesis involving some or all of the EOMs innervated by CN3: the *superior*, *inferior* and *medial rectus* muscles; the *inferior oblique*; and the *levator* muscle of the lid. Of particular note, The pupil might be affected as well. This is because CN3 carries preganglionic parasympathetic fibers to the pupil, and if these are bagged, that pupil will be larger (because of the dilatory inputs from the unopposed sympathetics) than the fellow eye's.

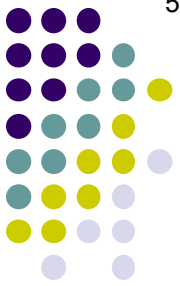
Motility Disorders



Did you notice the dilated pupil?

Motility Disorders

CN3 palsy

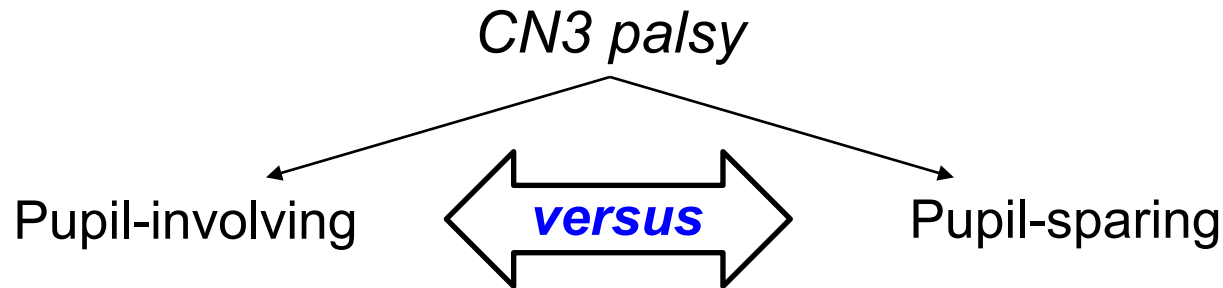


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This last point must be emphasized, because clinical status of the pupil plays a pivotal role in the management of CN3 palsies.

**that pupil will be larger
than the fellow eye's.**

Motility Disorders

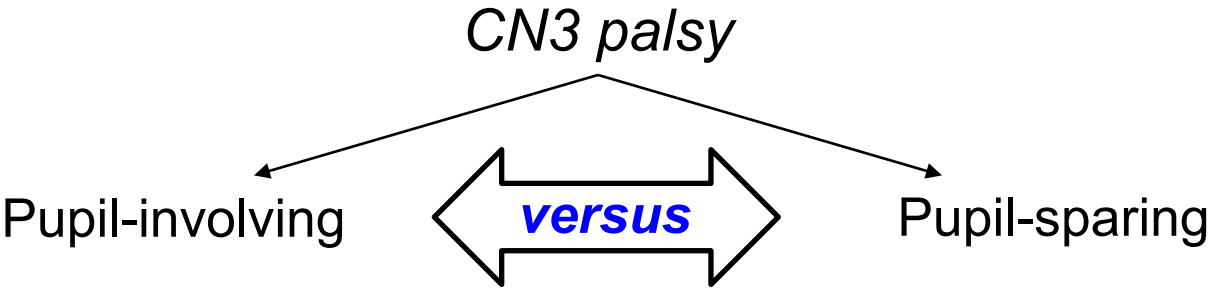
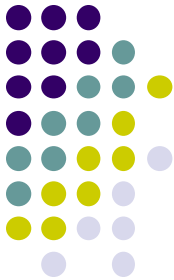


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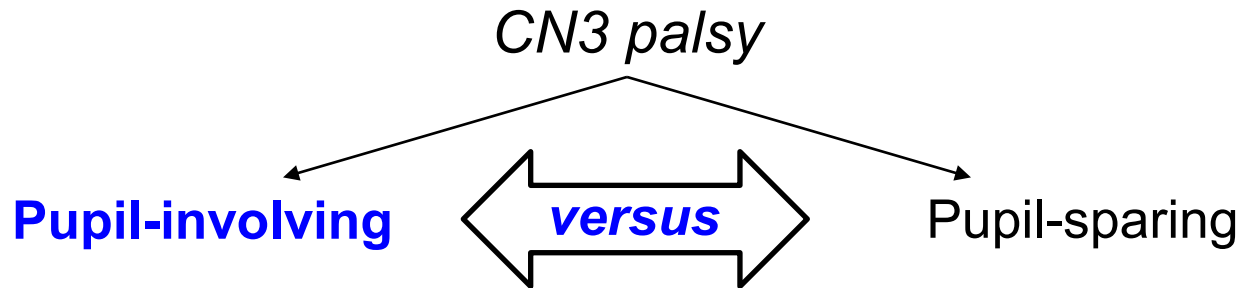
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Motility Disorders



CN3 palsy

Motility Disorders

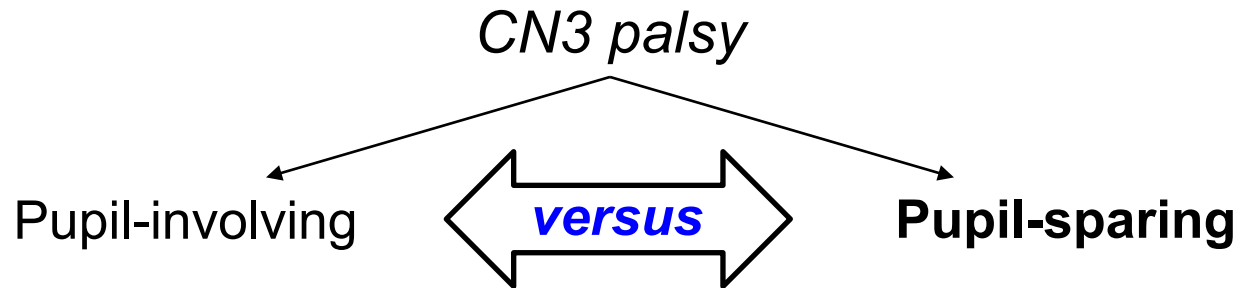


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that pupil will be larger than the fellow eye's.

Motility Disorders

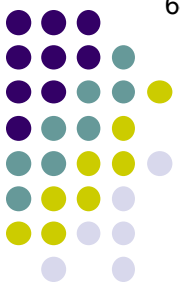
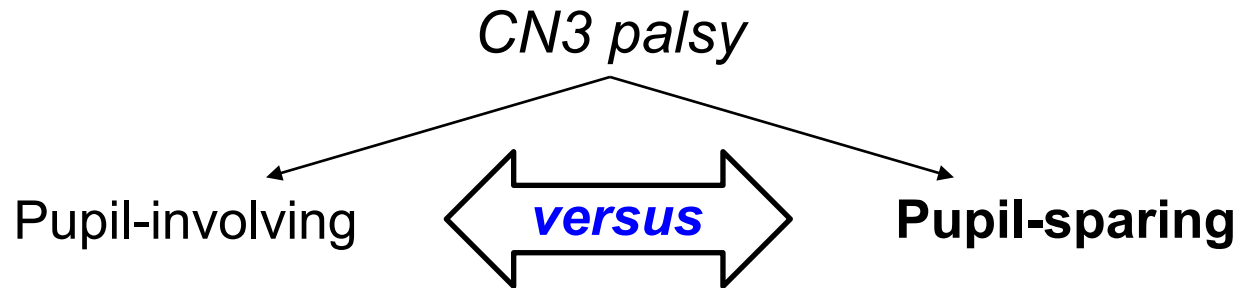


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that pupil will be larger than the fellow eye's.

Motility Disorders



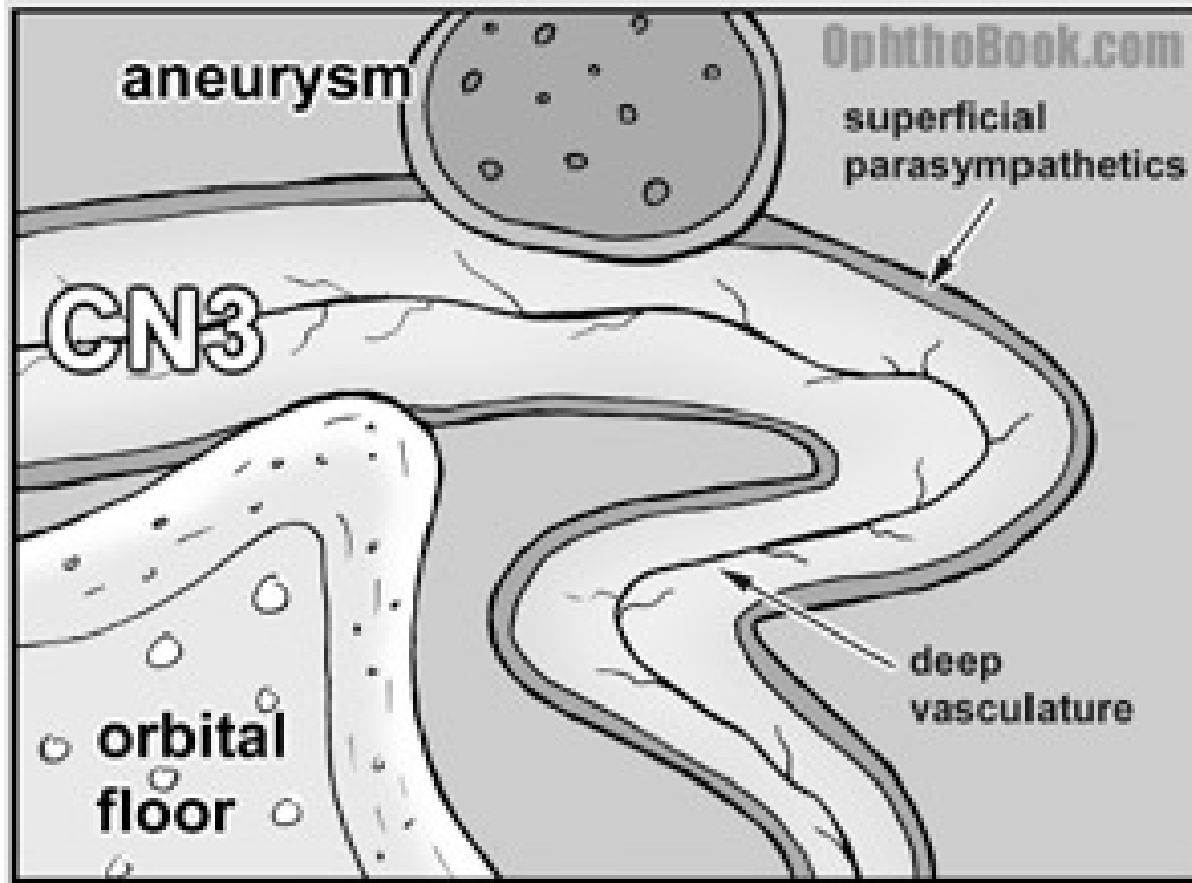
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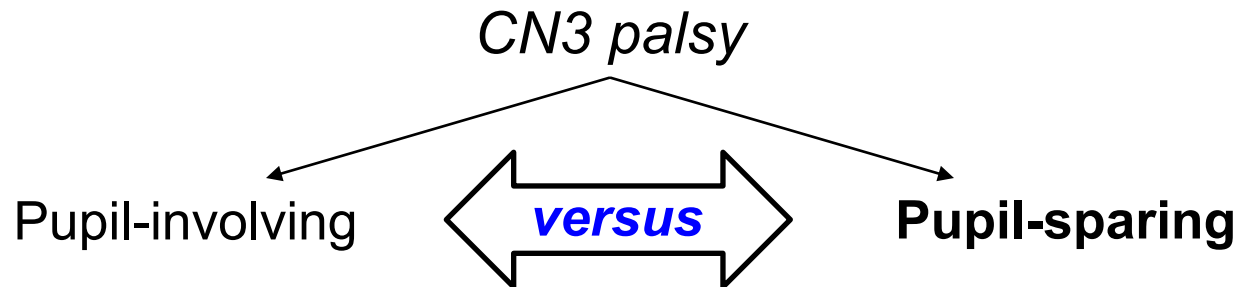
How can the status of the pupil implicate an aneurysm as causing a CN3 palsy? It has to do with the topography of the third nerve. The pre-ganglionic parasympathetics run in the superficial, outermost portion of the nerve.

Motility Disorders



CN3 topography—check out the arrowed part

Motility Disorders

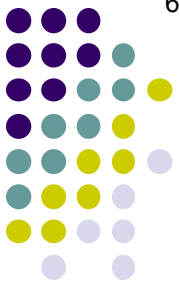


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that pupil will be larger than the fellow eye's.

How can the status of the pupil implicate an aneurysm as causing a CN3 palsy? It has to do with the topography of the third nerve. The pre-ganglionic parasympathetics run in the superficial, outermost portion of the nerve. Given this, it stands to reason that *a lesion compressing the nerve will bag these fibers.*

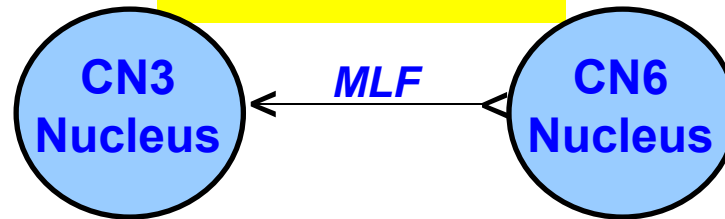


Motility Disorders

Supranuclear

Nuclear

Internuclear

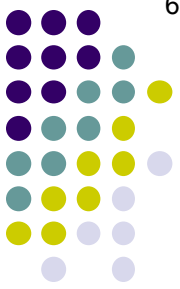


Fascicular

Now let's look at the **internuclear pathway**.

Neuromuscular junction

Extraocular muscle

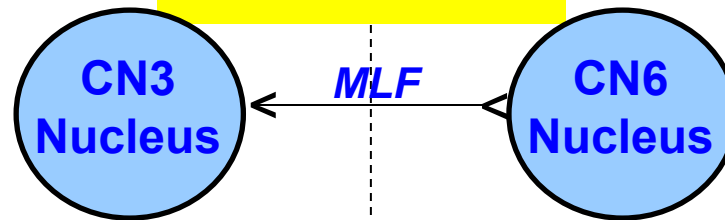


Motility Disorders

Supranuclear

Nuclear

Internuclear



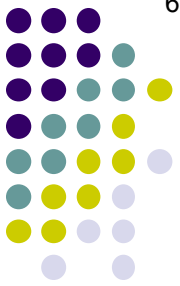
Fascicular

Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3 nucleus on the other.

Neuromuscular junction

Extraocular muscle

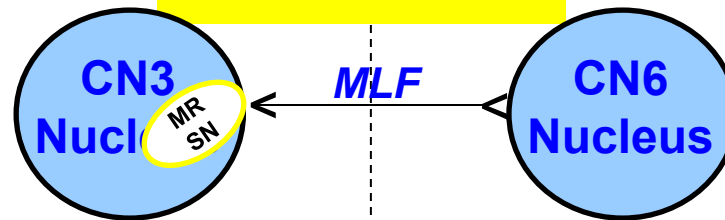


Motility Disorders

Supranuclear

Nuclear

Internuclear



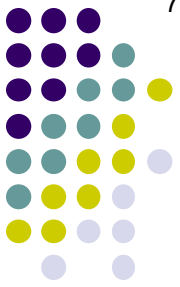
Fascicular

Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3 nucleus on the other. More specifically, the MLF runs to the medial rectus (MR) subnucleus on that side.

Neuromuscular junction

Extraocular muscle

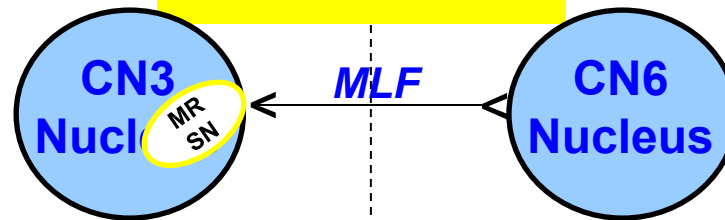


Motility Disorders

Supranuclear

Nuclear

Internuclear



Fascicular

Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3 nucleus on the other. More specifically, the MLF runs to the medial rectus (MR) subnucleus on that side. The MLF facilitates coordinated lateral gaze of both eyes by causing the contralateral MR to fire simultaneously with the ipsilateral lateral rectus (LR), thus ensuring both eyes turn into lateral gaze together.

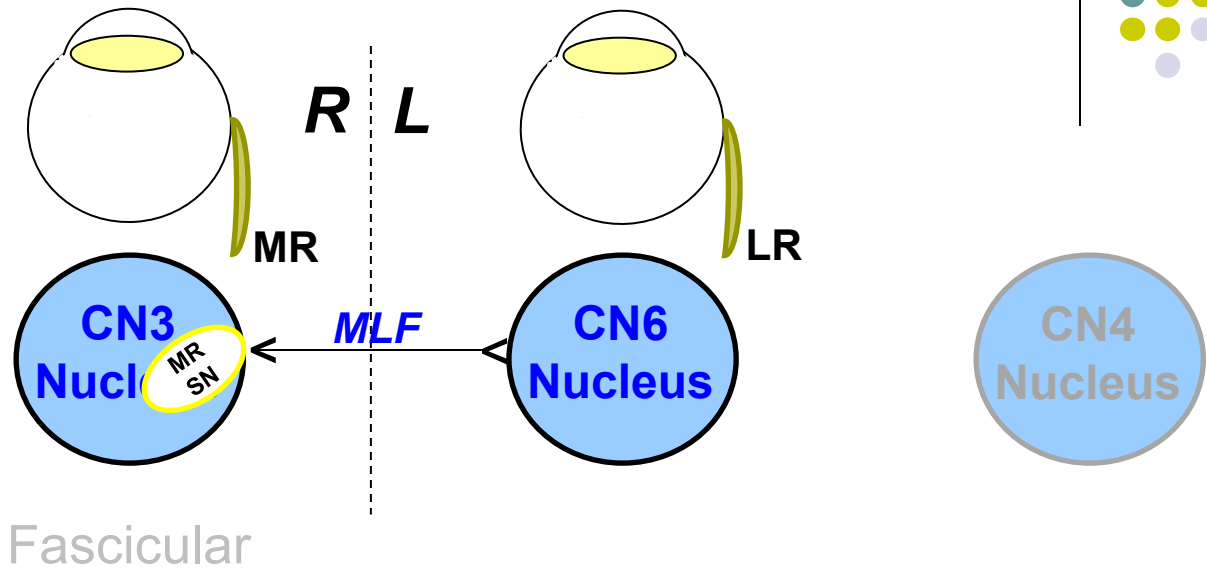
Neuromuscular junction

Extraocular muscle

Motility Disorders

Supranuclear

Nuclear



Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3

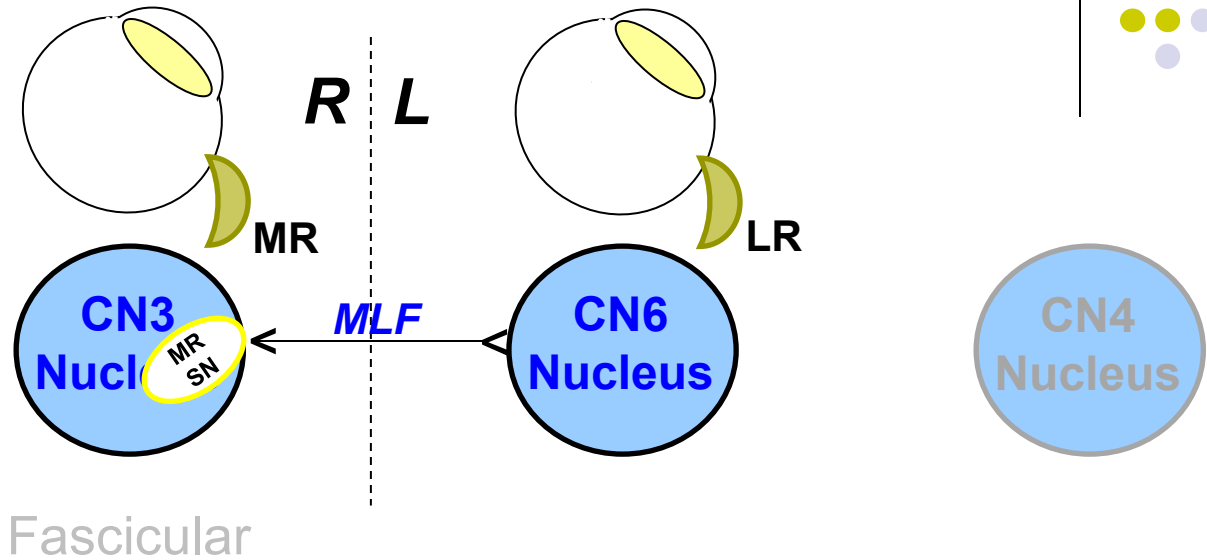
nucleus on the other side. The MLF is a longitudinal tract that runs through the brainstem, connecting the CN6 nucleus on one side to the CN3 nucleus on the other side. It is responsible for coordinating eye movements and maintaining binocular vision.

So if the depicted CN6 nucleus is on a pt's left side, the depicted MLF runs to her right MR subnucleus.

Motility Disorders

Supranuclear

Nuclear



Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3

nucleus on the other side. The MLF is a bilateral pathway that runs from the CN6 nucleus on one side to the CN3 nucleus on the other side.

on that side. When the MLF is damaged, the eyes will drift in the opposite direction of the gaze.

contralateral. When the MLF is damaged, the eyes will drift in the opposite direction of the gaze.

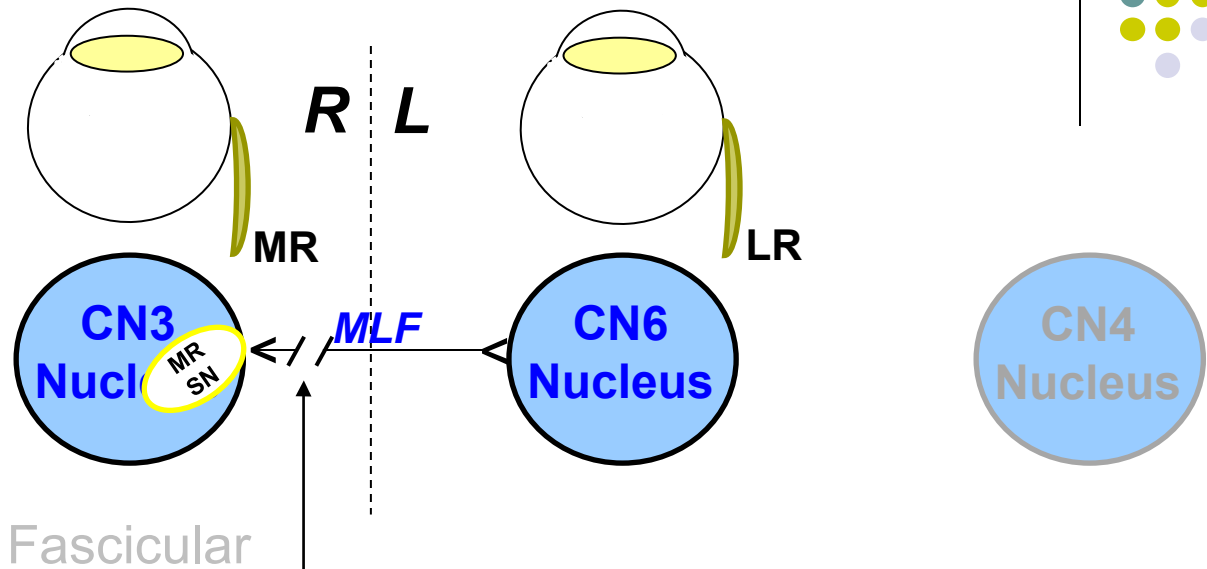
both eyes. When the MLF is damaged, the eyes will drift in the opposite direction of the gaze.

So if the depicted CN6 nucleus is on a pt's left side, the depicted MLF runs to her right MR subnucleus. When the pt endeavors to look to her left, the left CN6 nucleus causes the left LR to contract while also sending impulses (via the MLF) to her right MR subnucleus, which in turn causes the right MR to contract simultaneously—and both eyes shift into left gaze in coordinated fashion.

Motility Disorders

Supranuclear

Nuclear



Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3

nucleus on the other side. If the MLF is damaged, the impulse intended to result in the firing of the contralateral MR is affected...

...resulting in a loss of coordinated eye movement.

...resulting in a loss of coordinated eye movement.

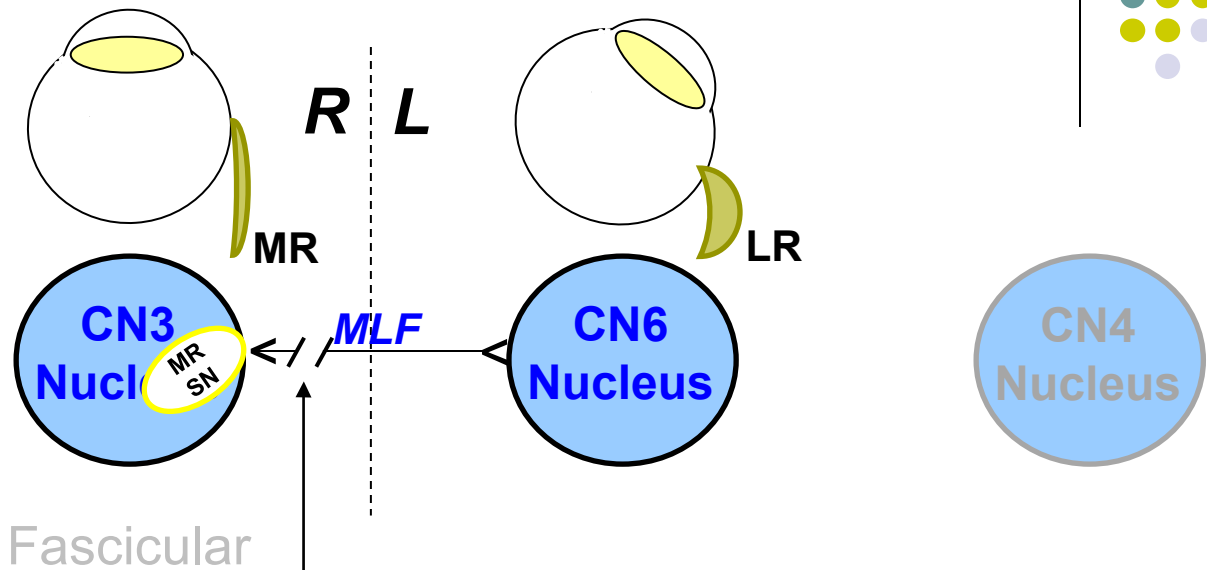
...resulting in a loss of coordinated eye movement.

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Motility Disorders

Supranuclear

Nuclear



Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3

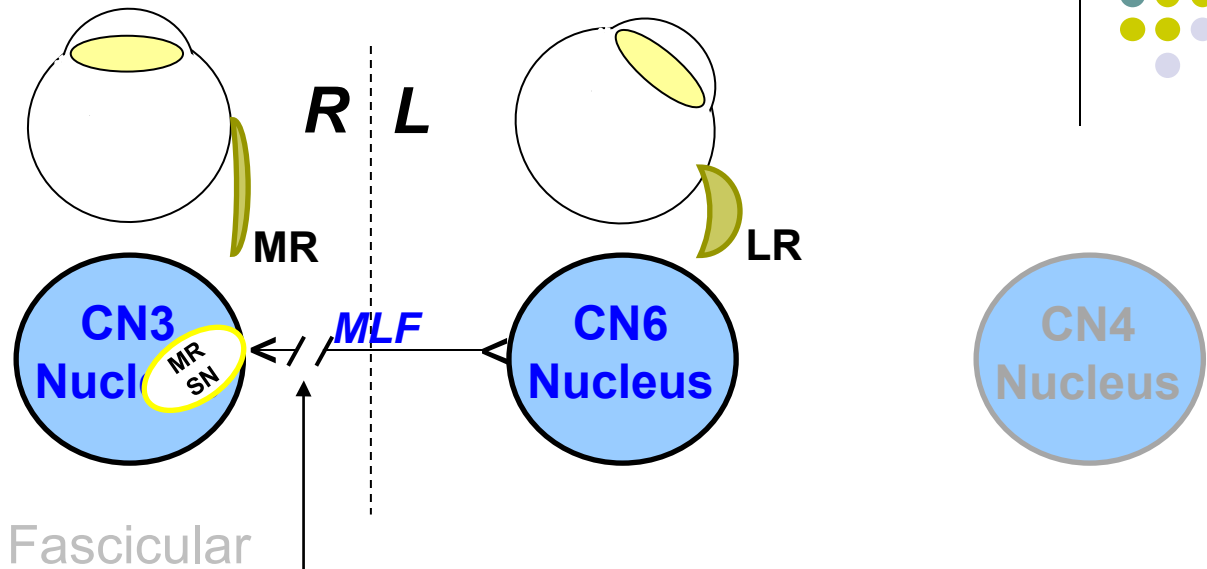
nucleus on the other. If the MLF is bagged (damaged), the impulse intended to result in the firing of the contralateral MR is affected...but the impulse to the ipsilateral LR gets through unscathed.

sending impulses (via the MLF) to her right MR subnucleus, which in turn causes the right MR to contract simultaneously—and both eyes shift into left gaze in coordinated fashion.

Motility Disorders

Supranuclear

Nuclear



Now let's look at the **internuclear pathway**.

As mentioned previously, the MLF runs from the CN6 nucleus on one side to the CN3 nucleus on the other side.

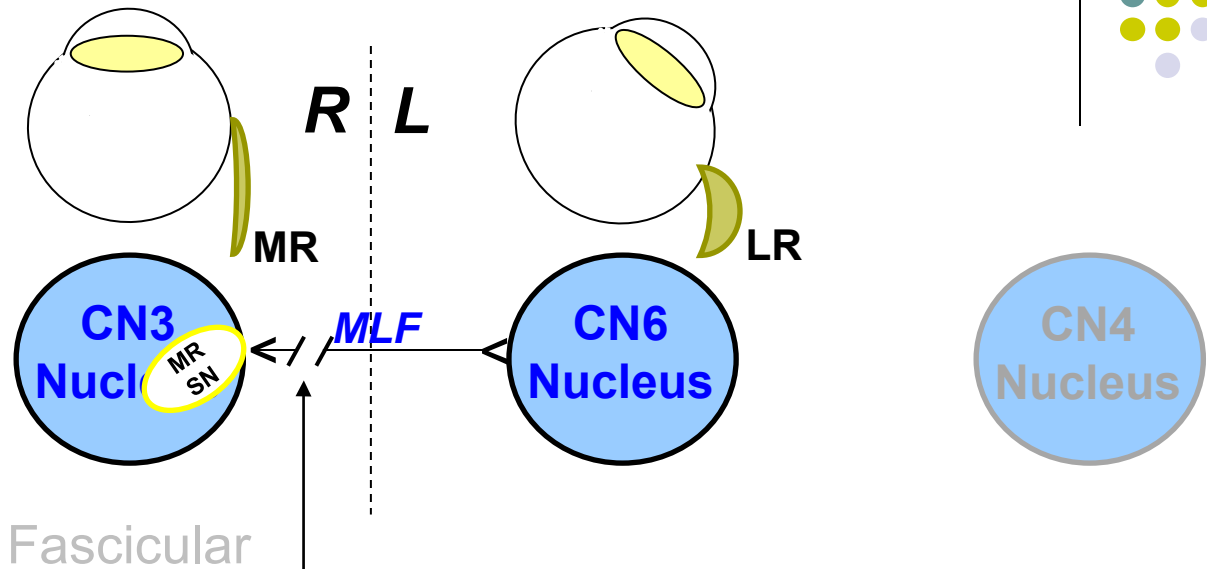
If the MLF is bagged, the impulse intended to result in the firing of the contralateral MR is affected...but the impulse to the ipsilateral LR gets through unscathed. Thus, attempted lateral gaze results in normal ABduction of the ipsilateral eye, but impaired ADduction of the contralateral eye.

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Motility Disorders

Supranuclear

Nuclear



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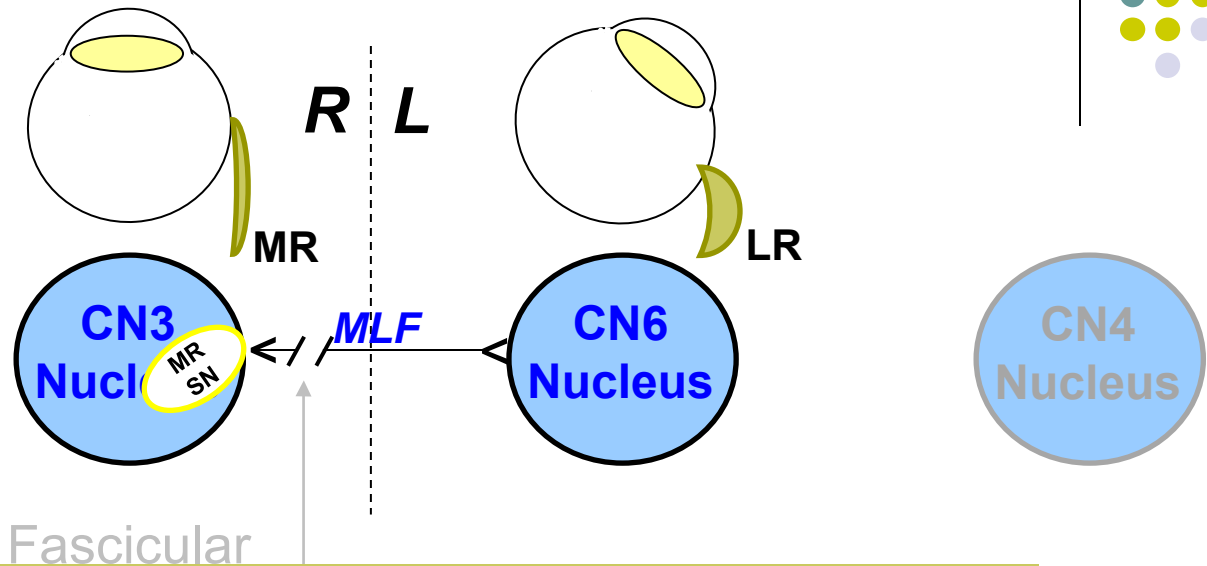
Sending impulses (via the MLF) to her right MR subnucleus, which in turn causes the right eye to shift into right gaze in coordinated fashion.

This is an internuclear ophthalmoplegia (INO)

Motility Disorders

Supranuclear

Nuclear



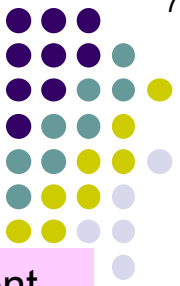
The causative event for an INO is a function of pt age:

- In a teen/young adult, it is usually demyelinating dz (ie, MS)
- In an older adult, it is usually 2ndry to a CVA

Always consider **pseudo-INO** 2ndry to myasthenia gravis (MG)—
MG can mimic *any* motility disorder that does not involve the pupil!

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Motility Disorders

Supranuclear

Before discussing **supranuclear lesions**, we need to define the role of the efferent (ie, motor) component of the visual system. But before we do *that*, we have to define the role of the *afferent* system.

Infranuclear

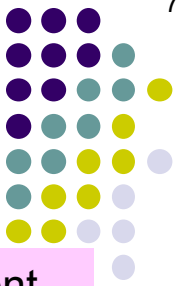
Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

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Infranuclear

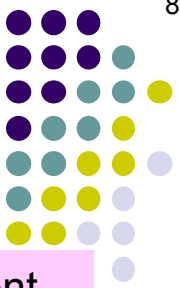
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Infranuclear

Subarachnoid

Cavernous sinus

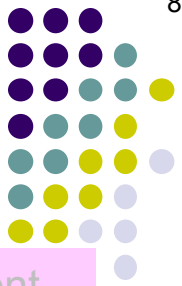
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Motility Disorders

Supranuclear

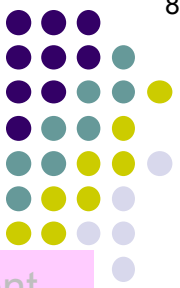


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Extracocular Muscles



Motility Disorders

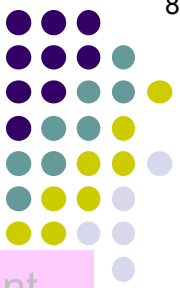
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Extracocular Muscles



Motility Disorders

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Motility Disorders

Supranuclear

The *supranuclear pathways* consist of six systems in the primate CNS that deal with these fixation-related issues.

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Extracocular Muscles



Motility Disorders

Supranuclear

The *supranuclear pathways* consist of six systems in the primate CNS that deal with these fixation-related issues. Thus, lesions of a supranuclear pathway manifest as difficulties with either the **maintenance** or **acquisition** of bifixation.

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Extracocular Muscles



Motility Disorders

Supranuclear

six systems in the primate CNS that deal
with these fixation-related issues

Internuclear

1) The **ocular fixation system** is responsible for maintaining a high-quality image of a stationary object when the head is still.

Infranuclear

Fascicular

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal

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Internuclear

1) The **ocular fixation system** is responsible for maintaining a high-quality image of a stationary object when the head is still. It does this via continuous *microsaccadic refixation movements*, which produce a constant shifting among the PRs regarding which are responsible for the retinal image. This shifting prevents PR fatigue (and subsequent image loss) from occurring.

Infranuclear

Fascicular

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal
with these fixation-related issues

Internuclear

1) The **ocular fixation system**

2) The **smooth-pursuit system** is responsible for maintaining fixation on a moving object. When it is impaired, pursuit movements may either lag behind the object or jump ahead of it.

Infranuclear

Fascicular

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal

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Infranuclear

Fascicular

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal with these fixation-related issues

Internuclear

1) The ***ocular fixation system***

2) The ***smooth-pursuit system***

3) The ***vergence system*** is responsible for maintaining fixation on an object that is moving toward or away from the eyes, thus necessitating they converge or diverge.

Infranuclear

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal with these fixation-related issues

Internuclear

1) The **ocular fixation system**

2) The **smooth-pursuit system**

3) The **vergence system** is responsible for maintaining fixation on an object that is moving toward or away from the eyes, thus necessitating they converge or diverge. Many forms of vergence dysfunction can occur, including *convergence insufficiency*, *divergence insufficiency*, *accommodative esotropia*, and *spasm of the near*.

Infranuclear

Subarachnoid

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal with these fixation-related issues

Internuclear

1) The **ocular fixation system**

2) The **smooth-pursuit system**

3) The **vergence system**

4) The **vestibulo-ocular reflex (VOR) system** and the 5) **optokinetic nystagmus (OKN) system** are responsible for holding an image steady during head rotations—either brief and rapid (VOR) or slower and sustained (OKN).

Infranuclear

Cavernous sinus

Orbital

Neuromuscular junction

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Motility Disorders

Supranuclear

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Internuclear

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Infranuclear

Cavernous sinus

Orbital

Neuromuscular junction

Extraocular muscle



Motility Disorders

Supranuclear

six systems in the primate CNS that deal with these fixation-related issues

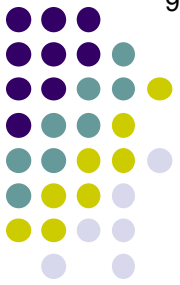
Internuclear

- 1) The **ocular fixation system**
- 2) The **smooth-pursuit system**
- 3) The **vergence system**
- 4) The **vestibulo-ocular reflex (VOR) system** and the 5) **optokinetic nystagmus (OKN) system**
- 6) The **saccadic system** is responsible for rapidly shifting fixation from the current object of interest to a new one located in the visual periphery.

Infranuclear

Cavernous sinus
Orbital
Neuromuscular junction
Extraocular muscle

Motility Disorders



That's it! Go through this slide-set a couple of times (at least) until you feel like you have a handle on it. [When you're ready, do slide-set N18](#), which covers this material in a Q&A format (and more detail).