

# Sleep Apnea & the Eye

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SLEEP APNEA IS A NEWLY DISCOVERED DISEASE (1966)

- Still learning about it, including it's effects on the eyes

THE MOST COMMON "MEDICAL" SLEEP DISORDER

- excluding shift-work and self-induced sleepiness (late night partying)
- Most prevalent disease discovered in the 20<sup>th</sup> century – 20% of adult population in Western countries
- Prevalence is growing b/c primary risk factor for developing OSA is obesity

## Sleep Apnea & the Eye

- Sleep Apnea
  - Clinical consequences
  - Diagnosis
  - Treatment
- Ocular Manifestations
  - Asthenopia
  - CPAP-assoc red eye
  - Floppy eyelid syndrome
  - NAION
  - Papilledema
  - Normal tension glaucoma



### 1. NECK

- larger on outside, smaller on the inside
- Pickwickian: Obese male, 30-60yo, always sleepy, snores loudly

### 2. CPAP

- mask may leak into the eyes
- noncompliance

## Online Resources

- Lecture Notes
  - <http://richardtrevino.net/sleepapnea>
- Powerpoint Slides
  - <http://slideshare.net/rhodopsin>
- Free Texts
  - <http://jfonline.com> (Aug 2008)
  - <http://pubs.nrc-cnrc.gc.ca/cjo>  
Can J Ophthalmol 2007;42(2):238-43




Can J Ophthalmol April 2007

## Sleep Disorders

OSA is the “most physiologically disruptive and dangerous of the sleep-related disorders.”

- Sleep apnea
- Insomnia
- Narcolepsy
- Restless leg syndrome
- Parasomnias
- Circadian disorders
- Drug side effects
- Shift work



Source: J Am Board Fam Med. 2007;20:392-398

OSA is the most common medical sleep disorder

- prevalence growing in parallel with prevalence of obesity

IT IS NOT ONLY THE MOST COMMON SLEEP DISORDER, BUT ALSO THE MOST PHYSIOLOGICALLY DISRUPTIVE AND DANGEROUS SLEEP DISORDER

- Life threatening disease:

- Having OSA places pts at risk of developing MI and CVA

- A recently published longitudinal study found pts with severe OSA had 3-4x the death rate of persons without OSA.

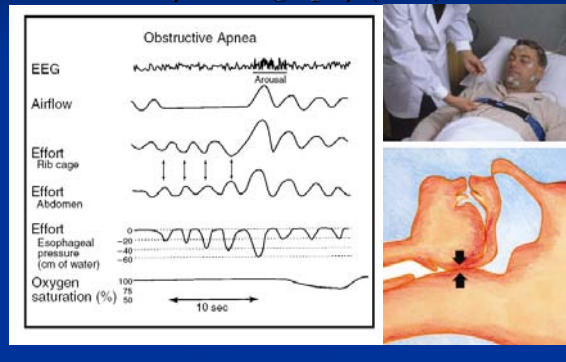
- Wide spread effects throughout the body – As we shall see, not even the somewhat remote and esoteric world of eye care is immune from the influences of this devastating disease

OSA is the most physiologically disruptive and dangerous of the sleep-related disorders

- OSA predisposes to MI and CVA
- higher mortality rate

To understand why, we must look at exactly what happens in OSA

# Obstructive Sleep Apnea Polysomnography (PSG)



What happens is this:

1. The airway closes shutting down airflow, and the patient continues to attempt to breath
2. The oxygen levels of the blood drop and eventually this triggers a sympathetic “fight or flight” response that arouses the pt from sleep and restores airflow

Three major pathophysiologic processes:

## HYPOXIA/HYPERCAPNIA

- oxidative stress and chronic inflammation
- CNS effects: vasodilation leading to increased intracranial pressure

## SYMPATHETIC ACTIVATION

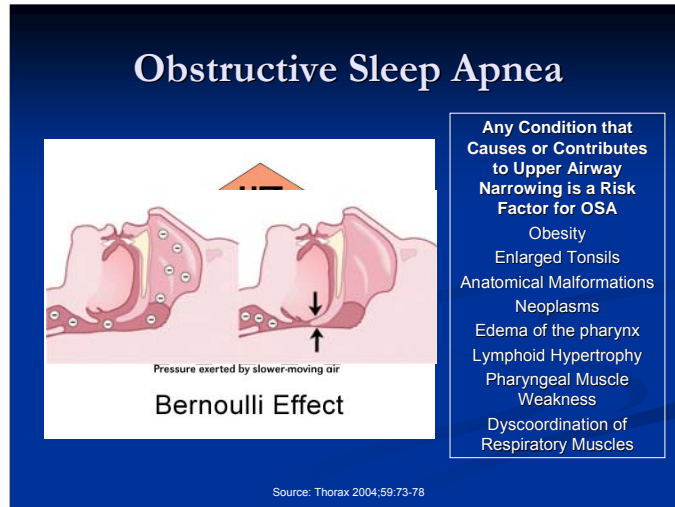
- Sleep is normally dominated by parasympathetic activity which helps support “rest and repose”
- bursts of sympathetic activity is response to cessation of respiration
- Sympathetic activation causes arousal, and restores airflow, but also causes: increases heart rate, increases blood pressure

## SLEEP FRAGMENTATION

- disruption of the normal sleep cycle
- leads to the principle symptom of OSA: sleepiness

## SUMMARY

Airway closure -> Apnea -> hypoxia -> sympathetic activation -> arousal -> sleep fragmentation



Upper airway collapse is the primary event that causes OSA

### WHY DOES THE AIRWAY CLOSE?

To understand why the airway closes, we have to understand the Bernoulli effect.

Lower pressure caused by rapidly moving air in the pharynx draws the walls of the airway inward

Pharynx is by nature very floppy. Unlike the trachea, which has cartilaginous rings to keep it open, the pharynx relies upon dilator muscles to counter the Bernoulli effect

When inhale, dilator muscles in the pharynx contract to keep the airway open

When asleep dilator muscles relax and their activity is relatively suppressed. Hence, there is a greater tendency for the pharynx to narrow during inspiration

**THE KEY VARIABLE IN WHETHER OR NOT AIRWAY CLOSURE WILL OCCUR IS THE INITIAL SIZE OF THE PHARYNX.**

Anything that narrows the pharynx will predispose to OSA

The most common contributory factor by far is obesity

# Obstructive Sleep Apnea

## Clinical Characteristics

- Excessive daytime sleepiness
  - Most common symptom
- Disruptive snoring
  - Also gasping/snorting during arousals
- Apneic events witnessed by bed partner
  - Disruptive snoring + witnessed apneas: 94% specificity
- Obesity
  - 30% of pts with a BMI > 30 have OSA, and 50% of pts with a BMI > 40 have OSA.
- Neck circumference
  - ≥40 cm had a sensitivity of 61% and a specificity of 93% for OSA
  - Correlates better than BMI
- Male
  - 2-3x more common than female
- Family history of OSA
  - Relatives have 2-4 fold ↑ risk

Source: eMedicine (<http://www.emedicine.com/med/topic163.htm>)

### TOP 3 SYMPTOMS:

#### 1. Sleepiness:

- Most common presenting symptom
- Described more often as tiredness, lack of energy, fatigue
- Most pts not aware that they have a sleep problem.

#### 2. Snoring:

- extremely loud, disturbing the bed partner, the entire household, and even neighbors
- Due to upper airway resistance

#### 3. Witnessed events:

- Cessation of breathing reported by the bed partner is usually a source of great anxiety because of fear that breathing may not resume.

### OBESITY:

- By far the most significant medical association with OSA is the reciprocal relationship between OSA and obesity
- Obesity narrows the airway and predisposes to closure; OSA causes fatigue and neurohormonal changes that predisposes to obesity
- 30% OSA pts are not obese

Neck circumference: The bigger the neck is on the outside, the smaller it is on the inside

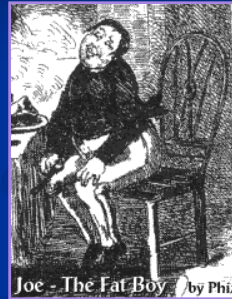
### SEX:

- fat distribution: more central in men (thicker necks)
- hormonal: more OSA in postmenopausal women. HRT provides some protection

FAMILY HX: craniofacial structure

## Obstructive Sleep Apnea

- Pickwickian Syndrome
  - Obesity, daytime somnolence, loud snoring
  - Charles Dicken's "Pickwick Papers" (1837)
- Prevalence increasing in parallel with prevalence of obesity
  - 30-60yo: 9%F, 24%M
  - Under-diagnosed



Source: Postgrad Med 2002;111(3):70-6.

### PICKWICKIAN SYNDROME

- Meaning has changed over time (ie: dyslexia)
- Recently refers to "Obesity Hypoventilation Syndrome" == OSA + COPD
- Classically refers to the typical OSA presentation: sleepy obese male who snores loudly
- Personified in the character Joe from Charles Dicken's "Pickwick Papers" (1837)

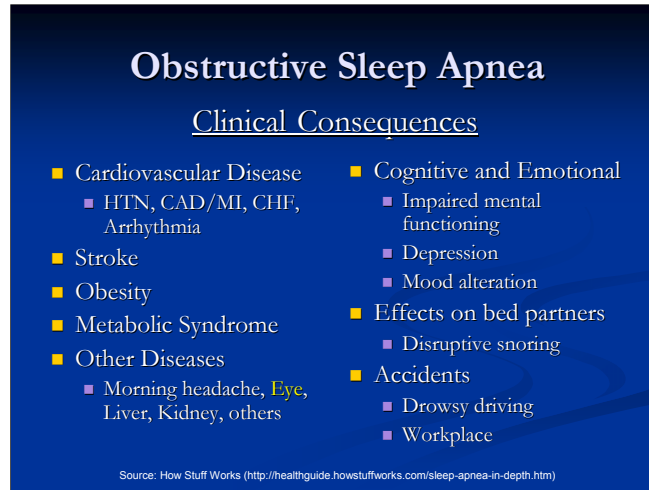
### PREVALENCE FIGURES:

The most prevalent dx to be discovered in the 20<sup>th</sup> century

Prevalence increases with age, and peaks in 50-60yo age group.

- increasing tissue laxity
- prevalence may plateau after 65 years (survivor effect)
- OSA can occur in any age group, incl children





This is by no means an exhaustive list of the many effects that OSA has on the patient.

### THE BIG THREE

#### CARDIOVASC DX

- OSA is #1 cause of secondary HTN
- Strength of relationship between OSA and HTN is second only to the relationship between OSA and obesity
- Dose-response relationship: increased severity of OSA -> increased risk of HTN
- Sympathetic activation: nocturnal spikes in BP
- OSA assoc with increased risk of MI

#### STROKE

- any degree of OSA almost doubles the risk of stroke
- moderate OSA are 3 times more likely to have a stroke than are members of the general population

#### OBESITY

- Obesity remains the single most significant risk factor for OSA
- Reciprocal relationship: Obesity is both a cause and a consequence of OSA
- Daytime sleepiness + decreased physical activity + neuroendocrine chgs (LEPTIN RESISTANCE)
- CPAP tx -> weight loss
- increased obesity -> worsen OSA

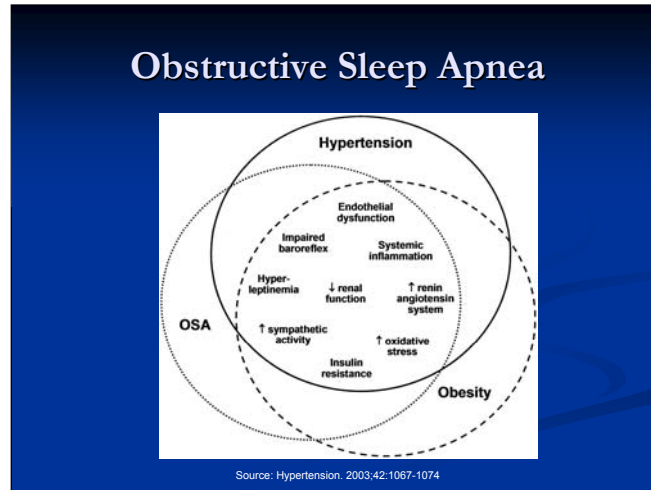
#### COGNITIVE

- the purpose of sleep is to refresh and restore the brain.
- diminished cognitive function stems from hypoxic brain injury, reduced alertness, or both

#### PUBLIC HEALTH

- In 2000, 1400 highway deaths attributable to OSA

# Obstructive Sleep Apnea



Relationship between OSA, HTN, and Obesity and metabolic syndrome

- each exacerbates one another, and all contribute to metabolic syndrome
- a combination of physiologic changes that gives rise to diabetes, heart disease, and CVA

OSA may contribute, at least in part, to some of the pathological processes traditionally ascribed to obesity alone,

- most notably sympathetic overactivity and humoral, metabolic, and neuroendocrine abnormalities.

Compelling data support the association of OSA with hypertension.

OSA probably contributes to or exacerbates the obesity-related hypertension.

Sleep apnea is at the top of the list of causes of secondary hypertension

# Obstructive Sleep Apnea

## Clinical Evaluation

- History
  - Sleepiness assessment
  - Disruptive snoring
  - Witnessed apneas
- Physical
  - Obesity
  - Neck circumference
  - Throat/Mouth exam
- PSG
  - Gold Standard
  - Respiratory Disturbance Index



Source: J Fam Prac. 2008;57(8) Suppl (<http://www.jfponline.com>)

## HOW TO SCREEN FOR OSA

### 1. Ask about fatigue

- Epworth sleepiness scale: fast validated office assessment

### 2. Ask about snoring problem

### 3. Ask bed partner about witnessed apneas

### 4. OSA Habitus (Pickwickian syndrome)

#### Obesity

- most common, but not only cause of airway crowding
- 30% OSA pts are not obese
- mouth and throat exam essential for r/o other causes

### 5. Overnight sleep study

- Sleep specialist or pulmonologist

RDI:

5-15

15-30

>30

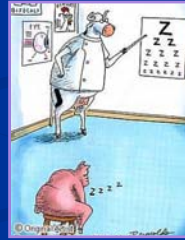
# Obstructive Sleep Apnea

## Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations?

0 = No chance, 1 = Slight chance, 2 = Moderate chance, 3 = High Chance

1. Sitting and reading
2. Watching TV
3. Sitting inactive in a public place (theater, meeting)
4. As a passenger in a car for an hour without a break
5. Lying down to rest in the afternoon when circumstances permit
6. Sitting and talking to someone
7. Sitting quietly after a lunch without alcohol
8. In a car, while stopped for a few minutes in traffic



Source: Sleep 1994;17:160-167

ESS: Best tool for the office assessment of sleepiness

a validated method of assessing the likelihood of falling asleep in a variety of situations

simple to use and interpret and takes less than 2 minutes to complete

SCORE  $\geq$  10 INDICATIVE OF EXCESSIVE SLEEPINESS

## Obstructive Sleep Apnea

### ■ Treatment Options

- Behavioral: Weight loss, EtOH avoidance, nonsupine position
- Positive Airway Pressure: CPAP, others
- Mandibular advancement device
- Surgery: UPPP, Tonsillectomy, Tracheostomy



Source: J Fam Prac. 2008;57(8) Suppl (<http://www.jfponline.com>)

### BEHAVIORAL

- Augment other therapies

### CPAP

- Mainstay therapy for most pts with OSA
- air splint
- Major limitation of CPAP: achieving acceptable compliance
- Complications: dry nose, Nasal congestion, skin irritation, eye irritation (from air leaks around the mask).

### ORAL APPLIANCES:

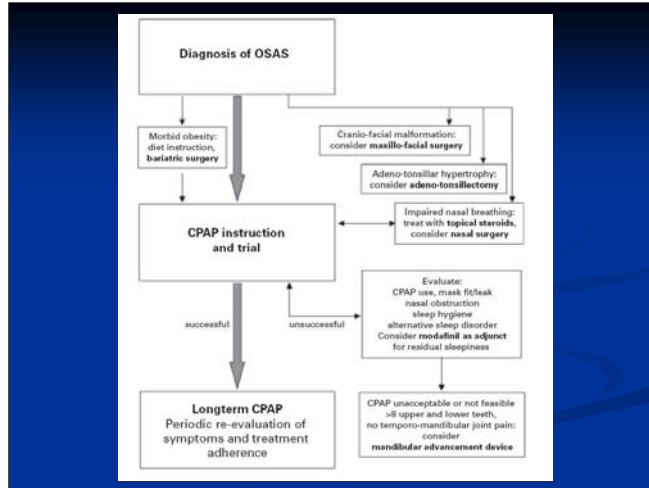
- unable or unwilling to use CPAP, less efficacious than CPAP

### SURGERY

- craniofacial or other structural abnormalities that can be corrected with surgery (2% of OSA cases)
- surgical intervention is not as effective in OSA as CPAP (except tracheostomy)

### UPPP: Uvulopalatopharyngoplasty

- most commonly performed surgical procedure for OSA
- removal of part of the soft palate and uvula
- success rate of 39% (defined as a 50% reduction in AHI score leading to an AHI  $\leq$ 20)



## Overview of management of OSA

### Inadequate CPAP

– apneas can occur despite CPAP if pressure too low, mouth breathing, nasal obstructions, etc

### RESIDUAL SLEEPINESS

- Up to half of patients with OSA have residual sleepiness,
- possibly due to irreversible hypoxic injury to wake-active neurons
- Modafinil is a wakefulness-promoting agent (?use may decrease compliance with CPAP)

## OSA & the Eye

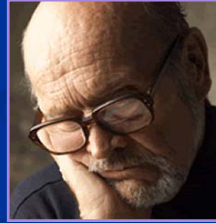
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- Excessive sleepiness
  - Disruptive snoring
  - Witnessed apneas
- Ocular Manifestations
  - Asthenopia
  - CPAP-associated red eye
  - Floppy Eyelid Syndrome
  - NAION
  - Papilledema
  - Normal Tension Glaucoma



## Asthenopia

### Common OSA-associated asthenopic symptoms

- Unexplained symptoms of blur
  - Trouble "focusing eyes"
  - Vision is 20/20 but the patient is c/o blur
- Misinterpreting what is seen
  - Incorrect recording or copying
  - Work-related errors
- Eye strain and/or fatigue
- Headaches
  - Worse in the morning



### IF OSA IS IN THE MED HX

- be on the lookout for sx's of fatigue
- possibly due to poor compliance or residual fatigue

### IF OSA NOT IN THE MED HX

- high index of suspicion for OSA whenever cc is fatigue or asthenopia
- esp if habitus is pickwickian
- screen for sleepiness

### If the pt is dx with OSA and presents with these sx's

- compliance?
- residual fatigue

### If pt is not dx with OSA

- pickwickian?
- sleepiness screening
- question bed partner



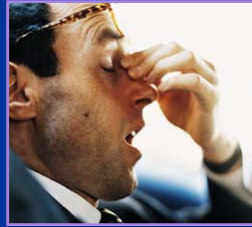
## Asthenopia

- If OSA is in the medical history
  - Be on the lookout for sx's of fatigue
  - Possibly due to poor compliance or residual fatigue
  - Offer supportive management
- If OSA is not in the medical history
  - High index of suspicion whenever the chief complaint is fatigue or asthenopia
  - Especially if habitus is Pickwickian
  - Be prepared to screen for sleepiness

# Asthenopia

## OSA Supportive Management

- Encourage CPAP compliance
  - 50% compliance rate, high drop-out rate
- Quit smoking
  - OSA 3x more common in smokers
- Weight reduction
  - Weight loss decreases OSA severity
- Avoid sleeping on back
  - Sew golf ball into pocket on back of shirt
- Avoid alcohol within 4 hours of bedtime
- Avoid sleeping pills



Source: JAMA 2004;291:2013-2016

## CPAP compliance stats

- 46% use regularly (4 hrs/night at least 5 nights/week)
- 50% drop out 1st year

## Weight and OSA

- loss of 10% of body weight -> 26% reduction in risk of having OSA
- 10% gain in weight -> 6x increase in odds of getting OSA

EDUCATE PTS THAT OSA CAN CAUSE PERMANENT EYE DAMAGE



## OSA & the Eye

- Obese middle-aged men
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## CPAP-associated Red Eye

- Clinical Problems
  - Dry eye
  - EXW CL intolerance
  - Conjunctivitis
  - Reactivation of RCE
- Causes
  - Air leaks
  - Retrograde air flow thru nasolacrimal apparatus
- Treatment
  - CPAP refitting: adjust headgear and pressure
  - Lubricating ointments HS, punctal plugs

Source: Optometry, 2007;78:352-355

A variety of common ocular problems have been associated with CPAP use

As a reminder, CPAP delivers air under pressure to the nose.

- during the night, air may escape from around the mask and blow onto the eyes resulting in morning sx's of dry, irritated eyes
- alternatively air may find its way up through the naso-lac duct, and cause similar problems

There are a series of valves that inhibit retrograde flow up the duct, but in many people these valves are not totally effective in preventing retrograde flow.

- many of these people learn as children that they can perform cool schoolyard tricks to impress their classmates such as blowing their lunch milk out of their eye

**INCLUDE CPAP-USE IN THE DIFFERENTIAL DIAGNOSIS OF THESE COMMON EYE PROBLEMS**

It is important that OSA be included in our history forms because most pts will not necessarily associate eye problems with it

## OSA & the Eye

- Obese middle-aged men
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  - **Floppy Eyelid Syndrome**
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## Floppy Eyelid Syndrome

### Clinical Characteristics

#### Eyelid hyperlaxity

- Rubbery, easily everted upper eyelids
- Eyelash ptosis with loss of parallelism

#### Papillary conjunctivitis

- Chronic ocular irritation, worse upon waking
- SPK, mucoid discharge common
- Rubbing on pillow case



Source: Clin Exp Ophthalmol 2005;33:117-125.

FES is the classic ocular manifestation of sleep apnea

- the first ocular condition to be associated with the disease
- originally described in 1981, the same year that CPAP was introduced as a tx for OSA

FES = hyperlaxity + conjunctivitis/keratitis

- clinically, many asymptomatic pts with floppy lids encountered who do not have conjunctivitis
- others will simply have complaints of dry eye

Degree of floppiness may vary

- no grading or quantification system exists
- subjective impression of how easily the lid self-everts

## Floppy Eyelid Syndrome

- Eyelash ptosis
  - Downward displacement of eyelashes
  - Lashes may point in various directions
    - Loss of parallelism
  - Pts may trim with scissors



Source: Ophthalmology 1998;105:165-169

Conspicuous finding that may be the presenting sign of OSA

Eyelash ptosis may also be age-related

- not associated with floppy lids

When a pt with down-pointing lashes are encountered, pull the lid upward to assess whether the lid will self-evert

## Floppy Eyelid Syndrome



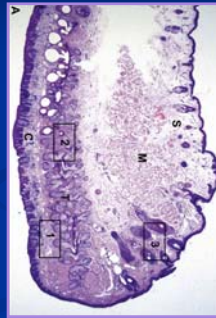
May be Unilateral or bilateral – presumable based upon what side the pt usually sleeps on



# Floppy Eyelid Syndrome

## Pathophysiology

- Loss of elastic fibers in tarsus and skin of lid
- Upregulation of elastin-degrading enzymes (matrix metalloproteinases)
- Caused by repeated mechanical trauma, possibly eye rubbing or sleeping with the face buried in the pillow



Source: Ophthalmology, 2005;112:694-704

# Floppy Eyelid Syndrome

## Treatment

- Lubrication therapy
  - Poor lid-eye contact
  - Inadequate tear distribution
- Protect eye during sleep
  - Ointments HS
  - Fox shield, patching, taping
- May improve or resolve with CPAP
- Surgical therapy deferred until OSA treated
  - Horizontal lid shortening



Source: Curr Opin Ophthalmol. 2007;18:430-433

## Floppy Eyelid Syndrome

### Relation to OSA

- Pts with FES are a subset of all OSA pts
  - 96% pts with FES have OSA *(almost 100%)*
  - 5-15% pts with OSA have FES
- OSA tends to be more severe in pts with FES



Source: Clin Exp Ophthalmol 2005;33:117-125

Almost all pts with FES have OSA

But only a small number of pts with OSA have FES

- A pattern we will see repeated with other ocular manifestations of the disease

FES associated with more severe OSA

- More severe OSA associated with higher mortality rates (3-4x normal)

**FES PTS HAVE OSA UNTIL PROVEN OTHERWISE!**

## OSA & the Eye

- Obese middle-aged men
- Excessive sleepiness
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# NAION

## Clinical Characteristics

- Most common acute optic neuropathy in pts >50yo
- Sudden painless visual loss, *usually upon awaking*
- Nerve fiber bundle VF defects
- Diffuse or sectoral disc edema
- **Disc at risk:** small, crowded
  - Mean C/D = 0.2
  - All  $\leq 0.4$



Source: Rev Ophthalmol ([http://www.revophth.com/index.asp?page=1\\_13156.htm](http://www.revophth.com/index.asp?page=1_13156.htm))

Hayreh (1997):

50% upon awakening

25% early morning

25% other times

- suggests that a nocturnal events play a role in the disease process

Disc-at-risk

- bjo 2006 osa/naion study

- 27 consecutive naion cases

# NAION

## Pathophysiology

- Idiopathic ischemic process
  - Disorder of posterior ciliary artery circulation
  - Transient poor circulation in the ONH
  - **Trigger Event:** Fall in blood pressure below a critical level?
  - There is no actual blockage of the posterior ciliary arteries
- Cascade Effect
  - Mechanical crowding caused by small crowded disc
  - Ischemia → Swelling → Compression → Ischemia

Source: <http://webeye.ophth.uiowa.edu/dept/AION/index.htm>

## Trigger event

- precipitating event that triggers onset in predisposed individuals
- nocturnal arterial hypotension suspected

# NAION

## Treatment

- Aspirin
  - Decreases incidence in fellow eye at 2 years, but not at 5 years
- Control of predisposing systemic disease
  - May slow progression or reduce incidence in fellow eye
  - Hypertension, Diabetes, Hyperlipidemia, OSA
- Avoid phosphodiesterase 5 inhibitors (Viagra, Levitra, Cialis)
  - May increase risk of NAION in fellow eye

Vasculopathic risk factors

Erectile dysfunction drugs (EDD)

\*Medicolegal obligation to inform them of risk to fellow eye\*

- lawsuits against Pfizer

Viagra

- cause/effect unclear, may impair autoregulation (increased nitric oxide levels)
- onset of NAION within 24hrs of using Viagra
- Avoid if: disc-at-risk, TVL, MI, NAION

# NAION

## Relation to OSA

### NAION Patients with OSA

Mojon (2002)	71% (Controls: 18%)
Palombi (2006)	89% (HTN: 59%, DM: 37%)
Li (2007)	30% (Controls: 18%)

#### ■ Conclusions

- OSA may play an important role in pathogenesis of NAION
- OSA is the most frequent disorder associated with NAION
- Patients with NAION should be screened for OSA

How to screen?

- Sleepiness assessment (ESS)



## OSA & the Eye

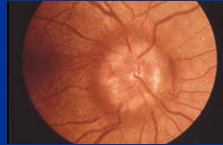
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# Papilledema

## Clinical Characteristics

- Disc swelling associated with increased ICP
- Symptoms of elevated ICP: Headache, tinnitus, TOV
- Chronic papilledema (months) may lead to optic atrophy and vision loss



## Papilledema

- Work-up
  - Urgent MRI or CT scan
  - Lumbar puncture if imaging normal
- Idiopathic Intracranial Hypertension
  - “Pseudotumor cerebri”
  - Secondary pseudotumor cerebri syndromes
    - Venous sinus thrombosis, vitamin A toxicity, COPD, OSA



Source: Arch Ophthalmol 2000;118:1626-1630

### Lumbar puncture

- measure CSF pressure
- collect sample of CSF for [biochemical](#), [microbiological](#), and [cytological](#) analysis
- inflammation, infection, evidence of intracranial bleed, tumor cells

If after neuroimaging and CSF analysis a cause for the elevated ICP is not found, the pt is said to have IIH

COPD and OSA -> Increase CO<sub>2</sub> levels -> vasodilation -> Increase ICP

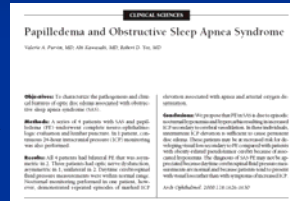
Vitamin A toxicity -> brain edema -> Increase ICP

Diamox 250mg po QID – suppresses CSF production, lowering ICP, and helping to speed resolution of papilledema

# Papilledema

## Relation to OSA

- 4 pts with unexplained disc edema and OSA
- ICP is normal during the day but elevated at night
  - Intermittent ↑ ICP can cause sustained papilledema
- Hypercapnia-induced cerebral vasodilatation elevates ICP
- Papilledema resolved with successful tx of OSA



Source: Arch Ophthalmol 2000;118:1626-1630

## Elevated ICP in OSA

- Cerebral vasodilation: Primary cause is cerebral vasodilation secondary to decreased oxygen and increased CO<sub>2</sub>
- contributing factors may be elevated central venous pressure due to forced expiration against a closed glottis and arterial hypertension

pressure elevation during sleep ranging from 50 to 750 mm H<sub>2</sub>O (normal < 220 mm H<sub>2</sub>O)

## OSA & the Eye

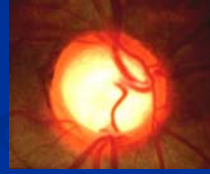
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# Normal Tension Glaucoma

## Clinical Characteristics

- Probably a variant of POAG
- IOP is never documented above 21 mmHg
- Peripapillary hemorrhages may be more frequent
- Peripapillary atrophy may be more marked
- VF defects tend to be deeper and more localized



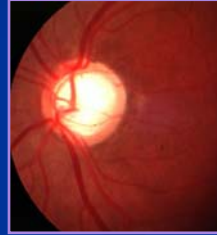
Source: Shields Textbook of Glaucoma, 2005

## Normal Tension Glaucoma

### Pathophysiology

- NTG differs from NAION only in that the latter is a more acute process.

- Hayreh, 1975



Source: Anterior Ischemic Optic Neuropathy, 1975

Collaborative Normal-Tension Glaucoma Study

Low-Pressure Glaucoma Treatment Study

# Normal Tension Glaucoma

## Relation to OSA

Glaucoma Patients with OSA <i>(50-60% NTG pts have OSA)</i>	
Mojon (2000)	20% (POAG)
Marcus (2001)	57% (NTG)
Mojon (2002)	50-60% (NTG, varies with age)
OSA Patients with Glaucoma <i>(5-10% OSA pts have NTG)</i>	
Mojon (1999)	7%
Geyer (2003)	2%
Sergi (2007)	6% (NTG)
Bendel (2007)	27%
Karakuck (2008)	10% (NTG), 3% (POAG)

This question has received lots of research attention: 8 studies

Incidence of OSA in general population: 10-20%

Incidence of glc in general population: 1.5-3%

Very few (<10%) OSA pts have glaucoma (but perhaps higher than general pop)

Many (perhaps most) NTG pts have OSA

Similar to situation with FES!

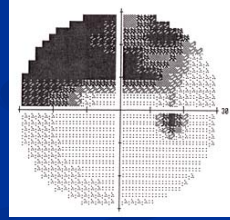
Big range (2% - 27%) may reflect difficulty deciding what constitutes glaucoma



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### OSA May Cause VF Loss Without Glaucoma

- VF loss may occur due to optic nerve damage caused by cerebral ischemia and intermittent ICP elevation
- Batisse (2004)
  - 35 consecutive pts undergoing PSG
  - VF mean deviation correlated with RDI
- Tsang (2006)
  - Compared VF of 41 pts with OSA with 35 controls
  - VF indices of OSA pts were significantly worse
- Karakucuk (2008)
  - VF defects in 10 OSA pts without evidence of glaucoma.



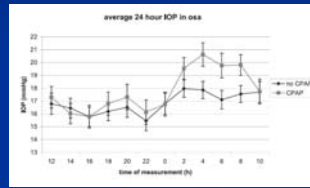
OSA may cause VF defects independent of glaucoma secondary to intermittent ICP elevation

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### CPAP Increases IOP

#### ■ Kiekens (2008)

- Diurnal IOP in 21 OSA pts with and without CPAP
- Average IOP and diurnal fluctuation higher with CPAP
- 30 min after CPAP cessation a significant decrease in IOP was recorded
- Speculate that CPAP elevates intrathoracic pressure, leading to higher central venous pressure, and ultimately higher IOP
- **Recommend regular screening of VF and the optic disc for all patients with OSA, especially those treated with CPAP**



Source: Invest Ophthalmol Vis Sci. 2008;49:934-940

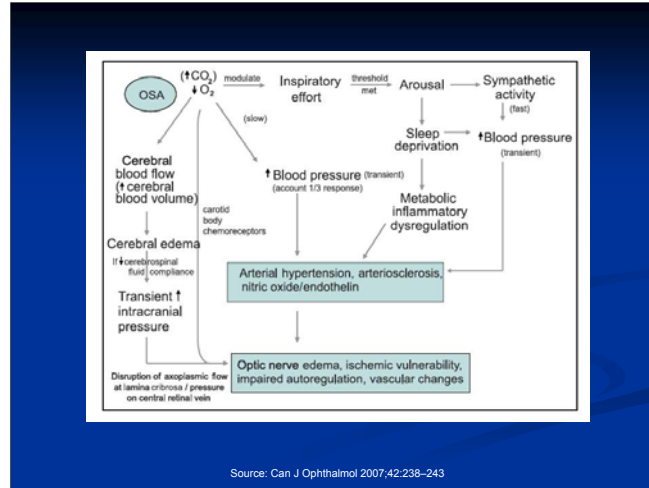
Pts may appear to have NTG, but IOP is elevated nocturnally due to CPAP

First session: Dx with OSA but not yet started on CPAP

During the second session, the CPAP mask remained applied during the overnight measurements.

Immediately after CPAP cessation in the morning, the patients were asked to remain supine.

Thirty minutes later, IOP was measured to evaluate the effect of acute CPAP withdrawal.



The immediate physiological effects of OSA involve hypoxia, hypercapnia, and inspiratory effort.

#### Hypoxia and hypercapnia

- Large fluctuations in vascular oxygen and carbon dioxide function as metabolic stresses that may overwhelm the autoregulatory capacity of the optic nerve head and retina.
- hypoxia-induced cerebral vasodilatation impedes cerebral perfusion pressure, which may ultimately hinder autoregulation.
- The effect of hypercapnia during sleep is circumvented because chemoreceptor sensitivity is decreased nocturnally and also because of the body's high buffering capacity.
- Hypoxia, detected by carotid chemoreceptors, leads to increases in blood pressure and hemodynamic changes.

#### Inspiratory effort

- activates the sympathetic system and creates sleep disturbance.
- Since the optic nerve is not innervated by the autonomic nervous system, direct effects of sympathetic arousal are unlikely.
- Decreased intrathoracic pressure created by inspiratory effort leads to increased stroke volume and cardiac output. This results in transient elevations in blood pressure and a number of hemodynamic changes.

**Thank You!**