Neuro-Optometry is More than Brain Injury Alzheimer's (AD) and Parkinson's (PD)

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NORA 2019

Alzheimer's Disease (AD)

A neuro--degenerative disease that causes deterioration of brain nerve cells

>>that leads to progressive impairment of memory, cognitive functions and ultimately death.

Begins with loss of ST memory
Later loss of cognitive abilities
No longer able to sustain ADL's

Neurofibrillary Tangles / Amyloid Plaques

defining histological feature of AD Plaques

Amyloid plaques
found between the neurons

Neurofibrillary tangles
found inside the neurons

Alzheimer's Disease (AD)

- First area affected--- temporal lobe
- Frontal
- Parietal

Alzheimer's Disease (AD)

- Progressive memory loss
- Challenges in planning or solving problems
- Difficulty completing familiar tasks at home
- Confusion with time or place
- Problems with words in speaking or writing
- Misplacing things
- Decreased or poor judgment
- Withdrawal from work or social activities
- Changes in mood and personality
- Agitation

Ophthalmic Findings in AD

- Inaccurate saccades with difficulty reading
- Loss of stereopsis
- Color vision changes
- Pupil function
- Visuospatial defects
- Visual field changes
- Glaucoma and AMD

AD and Saccades

Inaccurate horizontal forward saccades

Large variability of accuracy and speed
>> Difficulty reading

Correlation between scores of the Mini Mental State Exam (MMSE) and latencies of saccades

AD and Stereopsis

Mediated by neural pathways involving areas likely to be affected by AD

Related to severity of dementia

AD and Contrast Sensitivity

Increasing the contrast has been correlated with increased speed of letter identification while reading

Pupil Function and AD

Altered pupillary light reflex in AD
Impaired maximum constriction acceleration

Pharmacologic pupillary hypersensitivity to cholinergic antagonist (Tropicamide)

Mydriatic response to phenylephrine

Miotic response to pilocarpine

AD and Visuo---Spatial Function

Hippocampal damage --- RISK FOR FALLS

Correlated with increased chance of hallucinations with progression

AD and Visual Field Studies

Accelerated VF loss in glaucoma patients with AD

Inferior VF loss reported – mobility concerns

Damaged to Retina and Higher Pathways

Damaged to Retina and Higher Pathways

M--cell pathway damage (M pathway extends to LGN)

Contributor to circadian rhythm dysfunction
(this also occurs with glaucoma)

Retinal scans as a predictor of Alzheimer's

Using Optical Coherence Tomographic Angiography (OCTA)

Cognitively healthy individuals with preclinical AD have retinal microvascular abnormalities - significant areas without blood vessels in the centers of their retinas in addition to retinal thinning

(People with mild cognitive impairment did not show these changes)

these changes occur at earlier stages of AD than has previously been demonstrated

Connection with other eye disease

Patients with
age-related macular degeneration,
diabetic retinopathy,
OR glaucoma

had a 40 to 50 percent greater risk of developing Alzheimer's disease compared with similar people without these eye conditions

Before signs or symptoms of brain disease

Retina and Brain Scans of 400 people who had a family history of Alzheimer's but no symptoms themselves

The inner layer of the retina is thinner in people with a family history of Alzheimer's.
The brain scan showed that the area of the brain that's first affected by the disease had already begun to shrink.

RetiSpec

An imaging system that scans how the retina reflects light* to detect small quantities of the protein beta amyloid — a biological sign of Alzheimer's disease

*The technology uses Hyperspectral imagery, computer vision and machine-learning algorithms and takes only a few seconds to process the imagery

This system spots beta amyloid aggregates in the retina long before they collect in large enough clusters to form plaques in the brain

Parkinson's disease (PD)

Chronic, progressive neurodegenerative disease affecting the central nervous system
>> leading to abnormalities in movement, muscle control, and other non---motor symptoms

Affects both men and women
men are 1.5x more likely to have PD than women

Average onset is age 60

Cause is unknown in most cases
genetic and environmental factors
15% of PD patients have first degree relatives who also suffer PD

Parkinson's disease (PD)

Affects an estimated 7---10 million people worldwide

Medication costs averages $2,500/year

Treatment goal is to restore neurotransmitter function in the brain

PD Disease Process

Dopamine
Cell death in substantia nigra
- Reduced dopaminergic transmission in basal ganglia
- Motor system nerves are unable to control movement and coordination

Lewy body formation
- Main finding in post-mortem exam
- Abnormal deposits of alpha-synuclein

Systemic Presentation

Bradykinesia
-- Slowness of movement
-- Occurs because dopamine is responsible for activating movement and this is lost in PD

Rigidity
-- Stiffness of limbs and trunk
-- Resting tremor --- hands, arms, legs, jaw, face
-- Postural instability - impaired balance and coordination

PD Features

Gait abnormalities
- Shuffling
- Festination
  short accelerating steps
- Freezing
  substitute visual feedback to improve gait

Craniofacial changes
- Hypomimia -- decrease in facial expression
- Dysphagia
- Hypophonia--- reduction in the tone of the voice

Parkinson's disease (PD)

Ophthalmic Features

- Dyskinesia/blurred vision
- Double vision, ocular motor dysfunction, convergence insufficiency
- Ocular discomfort, difficulty reading
- Dry eye, infrequent blinking
- Photophobia
- Color vision changes
- Visual field/Glaucoma and PD
- Reduced Contrast Sensitivity
- Visual Hallucinations

Dystonia and Dyskinesia

Dystonia is a prolonged contraction of a particular muscle or increased muscle tone that results in abnormal posturing or a muscle spasm.

Dyskinesia is more like a rhythmic contraction of large muscle groups, often described as a rolling or writhing motion

Dyskinesia and Dystonia

Blepharospasm/Dystonia (prolonged muscle contractions)
- muscles tighten involuntarily

"Off" dystonia – in the context of chronic levodopa usage
- ipsilateral to the more severely parkinsonian side
- when medication is wearing off

"On" dystonia – dystonia when medication levels are adequate

Dyskinesia - uncontrolled, involuntary movement
- blurred vision

more common in patients receiving L---dopa treatment

PD and Oculomotor/Binocular Function

Inaccurate horizontal forward saccades
Hypometric

Large variability of accuracy and speed
Longer latency
>>> Difficulty reading

Some patients may need to blink to change saccadic direction

Convergence insufficiency and diplopia common
may be a side effect of anticholinergic medications

Blink Rate and Pupil Reactions

Blink Rate is reduced and more reduced while reading

Larger pupil diameters
Longer latency in blink reflex
Anisocoria and light adaptation

Normal pupil size with age

Contrast Sensitivity

Reduction in low contrast is orientation specific
- horizontal gratings

May contribute to impaired depth perception
- mobility considerations

Visual Hallucinations

30---60% of PD pts
Usually takes the form of brightly colored people or animals
- can last several minutes and occur daily

May be mistaken for VP errors

Presence of visual hallucinations can differentiate between:
PSP and PD/DLB (Dementia with Lewy bodies)

? Related to Treatment ?

Levodopa--- Carbidopa - converted into dopamine
most common drug prescribed to treat PD
generally first line of treatment, but effects wear off

Dopamine Agonist Medications - act like dopamine in the brain
not as effective as L--Dopa but lasts longer
can cause hallucinations

MAO---B Inhibitors -- help stop dopamine breakdown
may reduce "off" time and extend "on" time
may extend the effect of L---dopa
hallucinations very common

Anticholinergics – younger patients with tremor
side effects include hallucinations and decreased ST memory
(along with typical anticholinergic sx)

The Eye as a Mirror of the Brain

New research on the role of the retina in AD and PD (and MS)

Pupils, Contrast Sensitivity, Electrophysiology and more

Retinal Ganglion Cells and Circadian Rhythms in Alzheimer's Disease, Parkinson's Disease, and Beyond
Published on 04 May 2017
Front. Neurol. doi: 10.3389/fneur.2017.00162
The Eye As a Biomarker for Alzheimer's Disease
Published on 17 November 2016
Front. Neurosci. doi: 10.3389/fnins.2016.00536
Amyloidosis in Retinal Neurodegenerative Diseases
Published on 08 August 2016
Front. Neurol. doi: 10.3389/fneur.2016.00127
Association of Preclinical Alzheimer Disease With Optical Coherence Tomographic Angiography Findings
Published November 1, 2018
JAMA Ophthalmol. doi:10.1001/jamaophthalmol.2018.3556

Visual and Ocular Manifestations of Alzheimer's Disease and Their Use as Biomarkers for Diagnosis and Progression
Published on 19 April 2016
Front. Neurol. doi: 10.3389/fneur.2016.00055
Association Between Alzheimer's Disease and Glaucoma: A Study Based on Heidelberg Retinal Tomography and Frequency Doubling Technology Perimetry
Published on 18 December 2015
Front. Neurosci. doi: 10.3389/fnins.2015.00479
Pathogenic microRNAs Common to Brain and Retinal Degeneration;
Recent Observations in Alzheimer's Disease and Age-Related Macular Degeneration
Published on 03 November 2015
Front. Neurol. doi: 10.3389/fneur.2015.00232