

Disclosures

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Effects of Age on Vestibular and Balance Systems

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Mountain Home VAMC



EPIDEMIOLOGY OF DIZZINESS:

HOW COMMON IS IT?

Presenter: Kristal Riska, PhD

Epidemiology of Dizziness

- Measuring prevalence and incidence is difficult
- Prospective/retrospective large and small scale cross-sectional studies
 - National Ambulatory Medical Survey (NAMCS)
 - National Health and Nutrition Examination Surveys (NHANES)
 - National Health Interview
 - National Medical Surveys in other countries (Netherlands, Germany, Sweden, Taiwan, England, Australia)
 - ICD-9 codes
- Prevalence rates across studies are highly variable

Prevalence of dizziness increases with age

- Demonstrated increased prevalence with age across many studies
- Dizziness is #1 reason for visiting MD after age 75
(O'Loughlin, 1993)

Matheson et al., 1999; Tinetti et al, 2000; Jönsson et al., 2004; Aggarwal et al 2000; Colledge et al 1994; Kroenke & Price, 1993; Maarsingh et al 2010; Sloane et al 2001; vander Linden et al 2004; Yardely et al 1998

Prevalence of Falls Also Increases With Age

	65 to 84 years	85 + years
	2012	2012
Dizziness, vertigo	17.3%	21.0%
Falls	10.9%	30.7%

Adapted from Melzer et al 2015, appendix 3 table 2s

All Dizziness ≠ Vestibular Dysfunction

Common Causes of Dizziness

- Vestibular/Otological Disorders
- Neurological Disorders
- Cardiovascular/Circulatory Disorders
- Psychiatric Disorders
- Medication Use/Polypharmacy
- Infectious Disease/Poisoning/Injury
- Metabolic/Other Medical Conditions

Epidemiology of Vestibular Dysfunction

- No national estimate of the prevalence of vestibular dysfunction
- Prevalence Rates of Vestibular Dysfunction vary by clinical specialty
 - Range from 20% to 50%
 - BPPV very common—may account for 7-10% of all dizziness and vertigo
 - 15.1% prevalence of BPPV among Veterans at MHVAMC
- ~4.5 million clinic visits for vestibular issues between 2005-2007

(Lin & Bhattacharyya, 2011; Lai et al 2011; Agrawal et al 2009; Neurhaser et al 2008; Bisdorff et al 2013; Polensek et al 2009; von Brevern et al 2007; Yin et al 2009; Mizukoshi et al 1988; Froehling et al 1991)

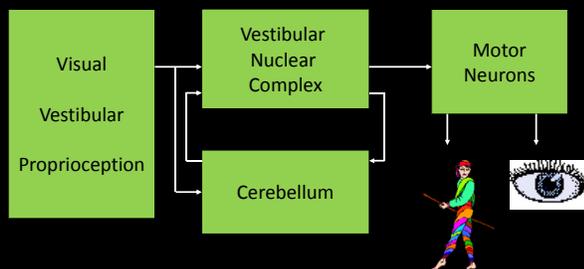
Take Home Points

- Prevalence of dizziness increases with age
- Common reason older adults seek medical care
- All dizziness \neq vestibular dysfunction

Vestibular Anatomy Review

Overview of balance system

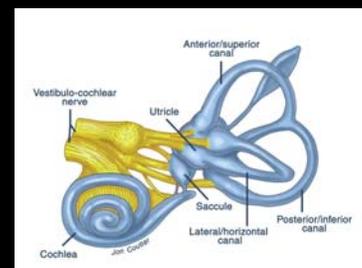
Sensory Input Central Processing Motor Output



Vestibular System

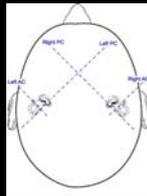
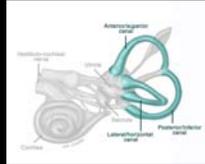
3 primary tasks:

- Stabilizes gaze with head movements
- Adjusts skeletal muscle tone
- Provides CNS with spatial information regarding linear and angular movements



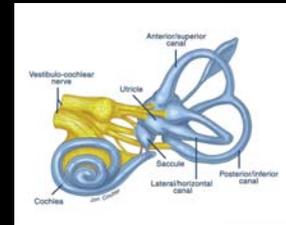
Semicircular Canals

- SCCs are paired and responds to 3 dimensional motion
- Lie in planes approximately 90°
- Stimulus is angular acceleration

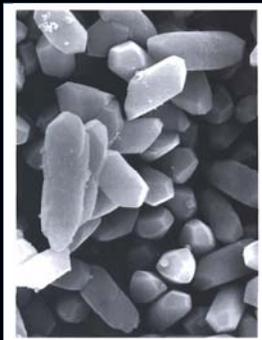


Otolith Organs

- Utricle and saccule located in vestibule
- Stimulus is linear acceleration, tilt, & gravity

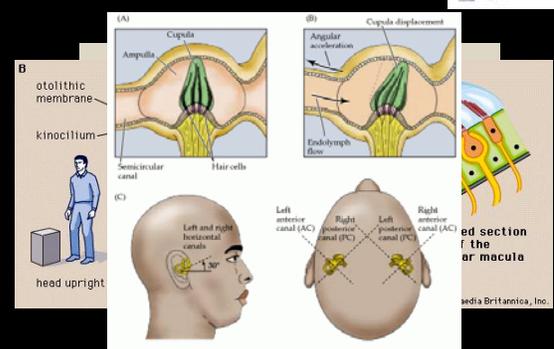


Otoconia



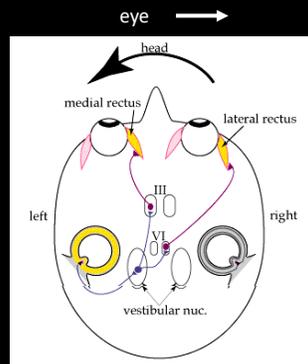
- Made of calcium carbonate
- Increases the density of otolithic membrane vs. endolymph

End Organ Activation



Vestibulo-Ocular Reflex (VOR)

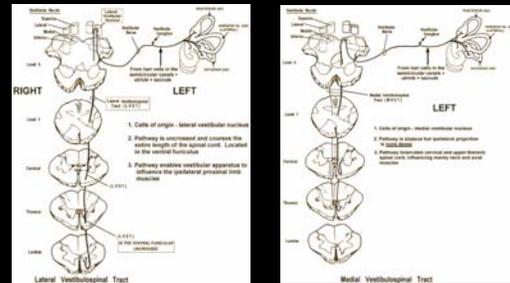
- Vestibular ganglion
 - Vestibular Nucleus
 - Ocular motor nuclei
-
- Goal is to stabilize gaze during angular head acceleration



<http://thalamus.wustl.edu/course/audvest.html>

Vestibulo-Spinal Reflex (VSR)

The purpose of the VSR is to help stabilize the body



<http://www.neuroanatomy.wisc.edu/virtualbrain/BrainStem/13VNNAN.html>

Anatomical Evidence for Vestibular Aging

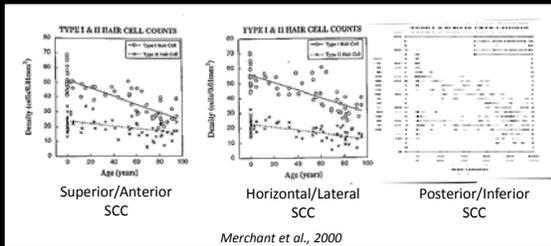
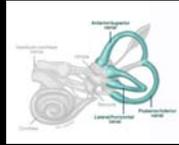
Anatomical evidence for age-related changes in the vestibular system

Morphological studies report that sensory hair cells degenerate with age in both the cristae of the semicircular canals and the maculae of the saccule and utricle

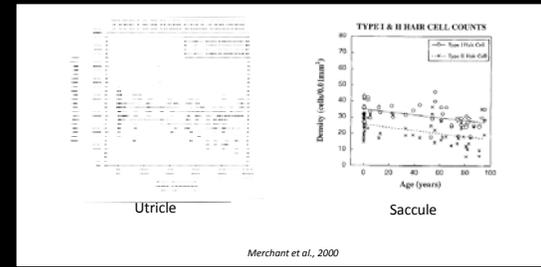
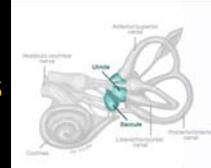
Jahnsson, 1971; Rauch & Rosenhall, 1973; Velazquez-Villasenor et al., 2000

Age-related loss hair cells in SCCs

(Merchant et al 2000; Rosenhall et al 1973)



Type 1 & 2 hair cells decline at similar rates in macular organs



Age Related Changes to Otoconia

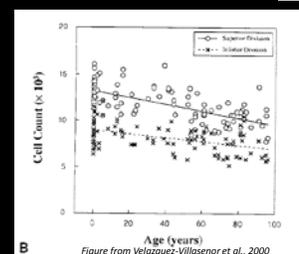
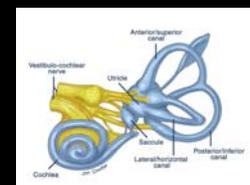
- Otoconia and otoconial matrix degeneration observed in aging animals
- Presence of "giant" otoconia in older animals
- Cellular changes relative to calcium concentrations noted in aging animals

(Jang et al 2006; Takumida & Zhang, 1997; Suzuki et al., 1997, Campos et al 1990)

Images: Vijayakumar et al 2015

A parallel age-related reduction occurs in fibers of the vestibular nerve and in Scarpa's ganglion

Richter, 1980; Park et al., 2001, Tang, Lopez, Balah 2001, Velazquez-Villasenor et al., 2000



Age-related neuronal loss occurs in the vestibular nucleus (VN)

- Decrease in the number of neurons with age
- 3% decrease in neurons per decade of life between 40-90 years of age
- Volume and density of neurons also decreased

Alvarez et al., 1998, Lopez et al 1994; Lopez et al 1997; Sturrock, 1989

- Consistent evidence of age-related declines in the vestibular pathway
 - Hair cells
 - Otoconial changes
 - Neuronal changes
 - Primary afferents
 - VNC

Clinical Evidence for Aging

Background

- Purpose: To determine the prevalence of vestibular end-organ dysfunction among those Veterans referred for assessment.
- WHY examine this?
 - Higher Prevalence of Dizziness/vestibular dysfunction in key Veteran Populations:
 - older adults
 - patients with TBI and noise exposure
 - patients with psychiatric disorders
 - Preliminary data to help develop screening tools and to target clinical evaluation

- 796 clinical charts reviewed of patients seen between 2010-2012.
 - 244 had comprehensive assessment
 - 33 excluded due to mixed hearing loss/conductive hearing loss, or technical issues and errors
- 211 subjects included in the analysis

Demographics

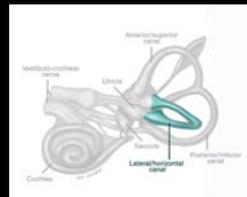
- All Veterans
- Age Range: 25 to > 90 (mean age 55 years)
- 203 Males/8 Females

Aging Effects

	Mean Age	t	p
Simple Interpretation		2.18	.031
Normal (n=106)	56.6		
Abnormal (n=105)	60.9		

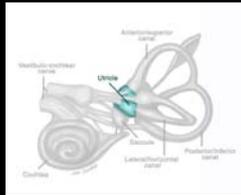
Calorics / rotary chair results

- 82% normal caloric/rotational tests
- 16% unilateral vestibular loss
- 2% bilateral weakness
- No effect of age noted between those with normal and abnormal caloric/rotary chair exam



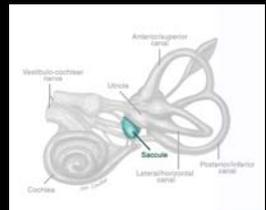
oVEMP Results

- 84% normal oVEMP responses
- 14% asymmetric responses
- 2% bilaterally absent
- No effect of age noted between those normal and abnormal oVEMP result



cVEMP Results

- 71% normal cVEMP responses
- 18% asymmetric responses
- 11% bilaterally absent



Significant Age Effect of Results of Saccular Tests and Aging

	Mean Age	t	p
cVEMP outcome		3.25	.001
Normal (n=149)	56.7		
Abnormal (n=62)	63.7		

Significant Effect of Age on Number of Abnormalities

Outcome	Mean Age	F	p
Number of Abnormalities*		5.02	.007
None (n=106)	56.5		
Single Abnormality (n=74)	59.2		
Multiple Abnormalities(n=31)	65.6		

* Contrast LSD – None and Multiple significantly different (p=.002), Single and Multiple significantly different (p=.037)

Relative Risk

Outcome	Relative Risk	95 th % Confidence Interval
Presence of Any Vestibular Exam Abnormalities	2.52	1.40-4.52
Abnormal Caloric test	1.04	.47-2.29
Abnormal oVEMP test	1.61	0.71-3.66
Abnormal cVEMP test	3.40	1.64-7.04

Take Home Points

- Approximately 50% of patients show evidence for possible peripheral vestibular pathology
- A significant effect of age was observed on cVEMP test results
 - Functional consequence of abnormal cVEMPs in light of cVEMP results in normal (asymptomatic) individuals is unknown
- All patients were symptomatic for dizziness/imbalance and consider the implications for function and ADLs and need for rehabilitation