

Pathology Related to Balance



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Balance and Fall Prevention in the Elderly
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Presentation Overview

- Introduction
 - The Big Picture
 - Balance and Aging
- Components Required for Balance
 - Pathologies Affecting Each Component
 - Implications of Pathology
 - Pathologies Affecting Multiple Components
- Additional Factors that Increase Fall Risk
- Implications for Reducing Fall Risk

The Big Picture

- Control of Balance and Prevention of Falls
 - Multiple components
 - Multiple sources for increased fall risk
 - Intrinsic and extrinsic factors
- Elderly More at Risk
 - Combined effects
 - Normal aging
 - Accumulated pathologies
 - Medication effects
 - Higher risk for injurious falls



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Balance and Aging

- Balance Declines with Increased Age^{B,A}
 - Reduced balance leads to:
 - Increased fall risk^{1,2}
 - Falls increase morbidity^{1,2,3}
 - Falls increase mortality^{1,2,3}
 - Falls decreased quality of life
 - Falls increased expenses^{2,3}
 - health care costs
 - reduced independence
- Role of Health Care Professionals

Components Required for Balance

- Many systems contribute to maintaining balance
 - Sensory systems
 - Vestibular system
 - Musculoskeletal system
 - Cardiovascular system

Components of Balance: Sensory Systems

■ Vision



■ Touch



- Proprioception
 - location in space



Components of Balance:

Sensory Systems (continued)

■ Vision

- Acuity
- Contrast Sensitivity
- Horizon
- Environment
 - Light
 - Dark
- Visual Attention⁴
- Visual Dominance



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Components of Balance:

Sensory Systems (continued)

■ Proprioception

- Awareness of Body/Limb Position
- Ankle Sway
- Counterbalance
 - head
 - trunk
 - arms



Components of Balance:

Sensory Systems (continued)

■ Touch

- Pressure on soles of feet
 - changes in pressure
- Arms/Hands
 - Additional Point of Input
 - Comparisons



Components of Balance:

Sensory Systems (continued)

■ Review

- **Sensory systems** contribute to maintaining balance
 - seeing the environment
 - feeling the body's position in the environment
 - feeling the body interacting with the environment
 - hands and/or feet
 - Detecting **CHANGES** between body and environment

Pathology of the Sensory Systems: Consequences

- Reduced visual acuity and/or attention
 - Increases postural instability⁵
 - Self-restricted activity level⁶
 - disuse weakness
 - Increases fall risk⁵⁻⁷
- Reduced proprioceptive/touch/pressure input²
 - Reduced postural control
 - Increased sway
 - Delayed reaction time to perturbations

Pathologies Affecting Visual Function

- Cataracts
 - increase postural instability⁵
 - improves following cataract surgery³
- Glaucoma⁷
- Macular Degeneration⁸
- Smoking Related Visual Loss⁷
- Medication Effects⁷

Pathologies Affecting Proprioceptive Function

- Peripheral Neuropathy
 - nerve compression
 - ischemia (less oxygen)
- Joint/Nerve Damage
 - Sprained ankles
 - Knee/ankle/foot surgery

Pathologies Affecting Touch/Pressure Sensation

- Peripheral Neuropathy
- Nerve Damage
 - central
 - peripheral

Components of Balance

- Many systems contribute to maintaining balance
 - Sensory systems
 - Vestibular system
 - Musculoskeletal system
 - Cardiovascular system

Components of Balance: Vestibular System



- Inner ear
 - fluid filled chamber
 - responds to changes in movement
 - horizontally
 - vertically
 - angular
- Left and Right Vestibular Systems
 - Nervous System
 - communication
 - integration

Image adapted from: http://www.healio.com/management/uploads/news/071008_atbalance.jpg

Components of Balance: Vestibular System (continued)

- Vestibular System
 - Left and Right Sides
 - Interpret changes in body movement
 - head turning/nodding
 - body moving through space
 - elevator
 - car/plane
 - Reflex connections
 - neck
 - trunk
 - legs

Pathology of the Vestibular System: Consequences

- Unilateral Pathology⁹
 - Flawed integration of left and right sides
 - spinning sensation
 - dizziness
 - nausea
 - imbalance
- Bilateral Pathology
 - Rely exclusively on vision/proprioception
 - Initial difficulties with eye control
- Increased Fall Risk¹⁰

Pathologies Affecting the Vestibular System

■ Unilateral

- **Benign Positional Vertigo (BPV)**
 - OR Benign Paroxysmal Positional Vertigo (BPPV)
 - Object in the fluid-filled cavity (otoconia)
- **Acoustic Neuromas**
 - Tumor of the support cells of Cranial Nerve VIII
 - Hearing and vestibular function involved
- **Labyrinthitis**
 - Inflammation of the membranous labyrinth
 - Typically viral
 - Elderly
 - May be lack of blood supply
- **Head Trauma**



Components of Balance

- Many systems contribute to maintaining balance
 - **Sensory systems**
 - **Vestibular system**
 - **Musculoskeletal system**
 - **Cardiovascular system**

Components of Balance: Musculoskeletal System

■ Muscles

- **Active contraction**
 - Hips, knees and/or ankles
 - Timing of contraction
 - Anticipatory
 - Compensatory
- **Static balance**
 - Maintain a posture
- **Dynamic balance**
 - Changes during movement



Components of Balance: Musculoskeletal System (continued)

■ Bones and Joints

- **Range of Motion**
 - Amount of joint movement available
 - Hips, knees and/or ankles
- **Allow movement**
 - Slow and/or fast
 - Flexibility
- **Efficient movements**



Pathology of the Musculoskeletal System: Consequences

- | | |
|---|--|
| <ul style="list-style-type: none"> ■ Reduced range available to respond <ul style="list-style-type: none"> □ ankles, hips, knees □ alters balance strategies available ■ Reduced strength to respond to changes <ul style="list-style-type: none"> □ alters balance strategies available □ changes functional task strategies <ul style="list-style-type: none"> ■ self-restricted activities ■ leads to disuse and further weakness | <ul style="list-style-type: none"> ■ Delayed reaction time <ul style="list-style-type: none"> □ further from stable base before correcting ■ Pain <ul style="list-style-type: none"> □ alters reactions □ alters balance strategies available □ self-restricted activities ■ Increased Fall Risk |
|---|--|

Pathologies Affecting the Musculoskeletal System

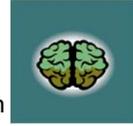
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|---|---|
| <ul style="list-style-type: none"> ■ Arthritis <ul style="list-style-type: none"> □ Reduces joint range of motion <ul style="list-style-type: none"> ■ less flexibility ■ stiff □ Joint pain ■ Osteoporosis <ul style="list-style-type: none"> □ weak bones □ fracture BEFORE the fall | <ul style="list-style-type: none"> ■ Amyotrophic Lateral Sclerosis (ALS) <ul style="list-style-type: none"> □ loss of nerve supply to the muscle <ul style="list-style-type: none"> ■ weakness ■ Disuse <ul style="list-style-type: none"> □ NOT A DISEASE <ul style="list-style-type: none"> ■ more sedentary ■ muscle weakness |
|---|---|

Components of Balance

- Many systems contribute to maintaining balance
 - Sensory systems
 - Vestibular system
 - Musculoskeletal system
 - Cardiovascular system

Components of Balance: Cardiovascular System

- Adequate blood supply to the brain
 - pumped against gravity in standing
- Adequate blood supply to the arms and legs



Pathology of the Cardiovascular System: Consequences

- May not keep brain adequately supplied
 - Changes in position
 - sitting up from laying down
 - sit to stand
 - dizziness
 - unsteady, insecure
 - syncope
 - falls
- Peripheral Supply
 - tissue ischemia distally
 - reduced sensation in feet and ankles

Pathologies Affecting the Cardiovascular System

Postural Hypotension¹¹

- Changing positions
 - lying down to sitting OR standing
 - Blood pressure drops
 - Dizzy, light headed, or may pass out
- May be influenced by medications
- Peripheral Vascular Disease
 - Sensory nerves to the feet and ankles
 - Reduced proprioception and pressure sensation

Components of Balance

- Many systems contribute to maintaining balance
 - Sensory systems
 - Vestibular system
 - Musculoskeletal system
 - Cardiovascular system
- Many elderly people have more than one system affected

Some Pathologies Affect More than One System

- Diabetes¹²
 - Sensory System
 - damages nerves
 - vision (retinopathy)⁷
 - proprioception
 - pressure on the sole of the foot
 - reduces reaction time
 - Musculoskeletal
 - muscle metabolism
 - weakness
 - Cardiovascular
 - peripheral vascular disease
 - stocking-glove sensory loss
 - hands and feet

Some Pathologies Affect More than One System (continued)

- **Cancer**
 - Specific to form of cancer
 - Location of the tumor(s)
 - Sensory System
 - Vestibular System
 - Musculoskeletal System
 - Cancer Treatment
 - Radiation and/or Chemotherapy
 - Sensory System
 - Musculoskeletal System

Some Pathologies Affect More than One System (continued)

- **Stroke (Cerebrovascular Accident)**
 - Typically one side of the body
 - Sensory System
 - vision
 - lose ½ field of vision
 - double vision
 - proprioception
 - touch
 - Musculoskeletal System
 - reduced motor control of arm and leg on affected side
 - Vestibular System
 - Brain Stem location

Additional Factors that Increase Fall Risk

- **Normal Changes with Aging²**
 - Changes within the proprioceptive receptors
 - Fewer touch receptors
 - Slowed nerve conduction velocity
- **Changes in Cognitive Ability**
 - Dementia^{11,13,14}
 - Alzheimer's Disease
 - Age-associated changes^{15,16}
 - Reduced ability to make safe decisions^{13,17}
 - May not interpret environment adequately

Additional Factors that Increase Fall Risk (continued)

- **Taking Multiple Medications**
 - 4 or more medications¹⁰
 - ? interaction OR more systems involved
- **Fear of Falling¹⁸⁻²⁰**
- **Footwear^{11,21,22}**
- **Changes in Walking Ability**
 - Gait^{11,19}
 - Most likely linked to other system changes
 - Sensory
 - Musculoskeletal

Implications for Reducing Fall Risk

- Screen to Identify Those at Risk¹⁶
- Understand the Pathologies
 - Treat to Restore Losses
 - Medication
 - Flexibility/Strength/Endurance Programs
 - Compensate for Impaired Balance Systems
 - Assistive devices (cane, walker)
- Understand Additional Factors
 - Intrinsic and Extrinsic
- Education to Promote Safe Behavior
 - Who?
 - Elderly People
 - Care Providers
 - What?
 - Fall Prevention
 - Home/Community Safety

Summary

- Many Body Systems and Factors Influence Balance
- Pathology of One or More Systems May Reduce Balance
- Reduced Balance Increases the Risk for Falls
- Other Factors Also Increase Risk for Falls
- Comprehensive Screening and Intervention Needed
- Further Research is Needed

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Questions?



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