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NEUROLOGIC GAIT ANALYSIS, TREATMENT & MEASUREMENT

Case-Based Interventions for the PTA
Part I: Lesions of the Cortex

6/14/2017    Jennifaye V. Brown, PT, PhD, NCS

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Objectives

1. Correctly identify at least two areas of the brain given the functional anatomy.
2. Accurately predict one impairment typically seen during gait based on a given cortical lesion post-stroke.
3. Independently devise and modify at least three therapeutic interventions related to muscle weakness, sensory loss, and cognitive impairment.
4. Correctly identify at least two gait impairments seen post-stroke given a case study.

Outline

1. Cortical Brain Functional Anatomy
2. Normal Gait Analysis
3. Gait Impairments Related to Cortical Brain Lesions
4. Treatment Interventions to Improve Gait Impairments as a Result of Cortical Brain Lesions
5. Case Study
6. Knowledge Summary
How many of you have had a continuing education course in neurorehabilitation targeting the PTA? Yes or No

Poll Question 1

In which setting have or do you currently work?

a. Acute hospital
b. Inpatient rehab
c. Outpatient rehab
d. Subacute rehab
e. Home health

Poll Question 2
What is considered the brain cortex?

- 6 layers (3 layers olfactory medial temporal cortex)
- Surface is gray matter – primarily nerve cell bodies, but also axons & dendrites (white matter)
- Depending on lobe – fxns to mediate memory, attention, perception, awareness, personality language & consciousness

Waxman, 2013¹ & Lundy-Ekman, 2013²

https://en.wikipedia.org/wiki/Cerebral_cortex#/media/File:Brainmaps-macaque-hippocampus.jpg
Lobes of the brain – cortical regions

- Blue: frontal lobe
- Yellow: parietal lobe
- Green: temporal lobe
- Pink: occipital lobe

Within the hemispheres:
- Insula: body location in space
- Limbic: emotions & processing some types of memory

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Frontal Lobe

Key Functions & Areas
- Initiation
- Problem solving
- Judgment
- Inhibition of behavior
- Planning/anticipation
- Self-monitoring
- Motor planning
- Personality/emotions
- Awareness: abilities/limitations
- Organization
- Attention/concentration
- Mental flexibility
- Speaking (expressive language)
Motor Homunculus

- Cortical homunculus: a neurological "map" of the anatomical divisions of the body
- Location:
  - Precentral gyrus
  - Primary motor area or motor strip

Speech

- Broca’s Aphasia

Motor Agnosia

- Apraxia
Temporal Lobe

Key Functions & Areas
- Memory
- Hearing
- Understanding language (receptive language)
- Organization and sequencing
- Musical awareness

Speech: Wernicke’s Aphasia

- Problem of language comprehension; hearing is normal
- Able to speak, but spoken word(s) is meaningless
- Location is base of sensory homunculus in superior gyri of temporal lobe
Occipital Lobe

Key Functions & Areas
- Depth perception
- Color perception
- Difficulty tracking moving objects
- Partial or total blindness
- Reading (perception and recognition of printed words)

Vision

- Sight for object location & recognition
- Eye movement control
- Info used for postural & limb control of movement
Parietal Lobe

Key Functions & Areas
- Sense of touch
- Differentiation: size, shape, color
- Spatial perception
  - Body position in space
  - Body position in relation to objects/people in space
- Visual perception
- Academic skills (reading)

Sensory Homunculus

- Primary sensory cortex in postcentral gyrus
- Receives information from thalamus
- Distributes info to brain stem & spinal cord via corresponding motor nerves
Perceptual Responsibilities

Neglect: inability to attend to a something despite no deficits in the function of the “sense”

1. Sensory: unaware of sensory stimuli on the side of the body or space opposite of the lesion
   - Visual neglect (sight not impaired)
   - Auditory neglect (hearing not impaired)
   - Tactile (somatosensory) neglect

2. Spatial neglect (failure to acknowledge stimuli on the contralesional side of space be it peripersonal [near space] or extrapersonal [far space like walking into a door frame])

A person presents with Wernicke’s Aphasia. The lesion is at the base of the motor homunculus. True or False

Poll Question 3
Normal Gait Analysis

Locomotion of human body
Bipedal, biphasic forward propulsion of the body's center of gravity (COG) of the human body; alternating movements of different body segments using the least amount of energy
Walk, jog, run, sprint = types of GAIT

1 foot in contact with the ground at all times
1. Lift 1 leg off of the ground
2. Using leg in contact w/ ground, push body forward
3. Swing lifted leg forward until it is in front of body
4. Fall forward to allow lifted leg to contact the ground
5. Repeat steps 1–4 for opp LE
6. Repeat steps 1–5 to continue walking

Wikipedia.org
**GAIT: Definitions**

E. Step Length: heel of one foot to heel of opposite foot  
F. Stride Length: heel to heel same foot  
C. Angle of Toe Out  
D. Width of Base of Support  
   - Velocity: distance/time; (feet/min)  
   - Cadence: # of steps/time  
   - 100-120 steps/min: normal speed of gait

**3 Main Functions of Gait**

1. Weight Acceptance: IC & LR  
   - outstretched limb/shock absorption  
   - forward momentum/progression  
   - limb stability  
2. Single Limb Support: MS & TS  
   - body weight advances over (forward progression) & ahead of single stable limb
3 Main Functions of Gait

3. Single Limb Advancement: PSw, Isw, MSw, & TSw
   a. from behind to ahead of body
   b. foot clears the ground

Review of Gait Functions

Illustration courtesy of Carson Schneck, MD
Gait Cycle: 1° contact to 1° contact of same foot

- 62% STANCE: initial contact to preswing
- 38% SWING: initial swing to terminal swing

Initial Contact

Critical Features
1. Heel strike
   - Initiate heel rocker
   - Decelerate impact
**Loading Response**

Critical Features
1. Controlled heel rocker
2. Stable hip
3. Controlled knee flexion
4. Controlled ankle plantarflexion

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**Midstance**

Critical Features
1. Controlled ankle [midfoot] rocker & tibial advancement
2. Knee extension 0°-5°
3. Frontal plane pelvic stability

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Terminal Stance

Critical Features
1. Controlled forefoot rocker (30° metatarsal-phalangeal joint extension)
2. Dorsiflexion 10° with heel rise
3. Trailing limb
4. Forward momentum - COM

Preswing

Critical Features
1. Passive knee flexion to 40°
2. Ankle plantarflexion 15°
3. 60° metatarsal-phalangeal extension – forefoot rocker
Initial Swing

Critical Features
1. Hip flexion 10°-15°
2. Knee flexion 45°-60°

Midswing

Critical Features
1. Hip flexion 25° (maximum flexion)
2. Ankle dorsiflexion 0°; tibial vertical; neutral inversion/eversion
Terminal Swing

Critical Features
1. Full knee extension 0°-5°
2. Forward pelvic rotation needed for increase step length
3. Hip deceleration
4. Ankle 0°

Initial contact and loading response is a part of ________.

a. swing phase
b. reciprocal phase
c. weight acceptance
d. suspensory acceptance

Poll Question 4
Gait Impairments\textsuperscript{7-9}

Related to Cortical Brain Lesions

Steppage Gait\textsuperscript{7,9}  
Trunk Lean & Pelvic Hike\textsuperscript{7,9}
Foot Drop\textsuperscript{7,9}  

Knee Hyperextension\textsuperscript{7,9}  

Decrease WB – Sensory Impairment\textsuperscript{9}  
Irregular Hip & Knee Flexion Sensory Impairment\textsuperscript{9}
#4 Optic tract in subcortical region

#7 Optic radiation that splits; in occipital lobe, lesion to 4 parts to get the hemianopsia

Hemianopsia

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The client demonstrates trunk flexion during midstance. There are no musculoskeletal impairments at the knee or ankle. Which muscle has a grade of 2?
Treatment Interventions

To Improve Gait Impairments Related to Cortical Brain Lesions

Foot Drop

Ace Bandage

Theraband

AFO: Shelf or custom

allegromedical.com
Foot drop = Foot slide

Focus swing phase at hip & knee

Fun Slides Carpet Skate

Furniture slider
To decrease pelvic hike & trunk lean

To decrease pelvic hike & trunk lean

To decrease trunk flexion

Pelvic Drop

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Knee Hyperextension¹⁰,¹²

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Knee Hyperextension¹⁰,¹²

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Sensory & Motor Deficits

- Lower level in terms of fxnl mobility
- Load hemi LE
- Tilt table

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Sensory Deficits

- Load the Hemi LE
Therapeutic Activities to Enhance Gait

Muscle Weakness & Sensory Deficits

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Electrical Stimulation

Muscle Weakness & Sensory Deficits
Physical Therapy Management of Gait

- Energy conservation techniques to help with fatigue
- Increase reps before resistance
- Try different exercises: PNF
- Customize home ex program, based on
  1. Pt level of fxn
  2. CG level of assistance/training/understanding
  3. Home environment
Evidence across studies Middleton, Fritz, Lusardi JAPA 2015

Assistant Devices: depends on strength & sensory deficits

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Patient & Caregiver Education

Communicate clearly before & after tx to summarize interventions

Ask if there is understanding of intervention purpose and how to perform/modify

Promote and encourage safety

The client snaps the knee backwards at loading response for stability.

You opt to strengthen the quadriceps muscle how?

a. eccentrically
b. concentrically
c. isometrically
d. none of the above

Poll Question 6
Case Study


- 61 yom with a large lesion of middle cerebral artery ischemic stroke of thrombotic origin
- Left handed prior to stroke
- Impairments:
  1. Significant expressive aphasia, but comprehension was intact
  2. Proprioception: significantly decreased at baseline
  3. Stereognosis: significantly decreased at baseline
  4. Graphesthesia: significantly decreased at baseline
  5. Sensory response to light touch, temperature, pin prick, & vibration - significantly decreased at baseline
Participated in a research study over 2yr period

Improvements noted in:
1. Fugl-Meyer Assessment
   □ 17 points - 49% indicating improved ability to move
2. Wolf Motor Function Test
   □ Decrease: 38sec – 22%
   □ Indicating able to do a motor task faster

Let’s use this data to answer some questions and apply what you have learned

The patient has significant expressive aphasia but comprehends everything you say.
1. What is/are the best ways to instruct him in gait training and any prefunctional exercises/activities for gait training?
2. Does he have a primary sensory or motor problem?
3. Which side of the body is impacted?
4. What is the evidence supporting your answer in #2?
5. What primary impairment will you address that will most affect gait?
State 2 treatment techniques/interventions to address your answer in #5?

- Air splint
- Tilt table

External Aid

- Stabilize the hemi LE and have him step forward/backwards/sideways

Manual Technique

The patient cannot feel his LE.

- You advise him to:
  1. 
  2. 

- You use a _______________ and have him walk towards it.

- The client is ready to walk, but leans to the opposite side to advance his LE. What are you going to do during gait training?
The patient has hyperextension during...

- Terminal Swing
  - Where will you place the theraband on the hemi LE if using it with the rolling walker and why?

- Loading Response
  - What is a close chain treatment intervention to maintain knee flexion at loading response?

The patient needs to improve initial swing knee flexion.

- What is the range for knee flexion?

- If the knee strength is a 2/5, how will you position the patient using a skate?

- A skate is available, but standing is unsafe; the pt is in a w/c for a home health visit; how will you strengthen the knee?

- How would you superimpose resistance for the above activity?
You want to address foot slap after heel strike.

☐ Describe an activity in sitting?

☐ The patient is not getting 15 degrees of dorsiflexion at terminal stance. The patient wants to keep the AFO on as he does not trip during midswing. What do you suggest to the PT?

Any questions regarding the case study?
Based on this case study, the lesion was caused by an infarct impacting which side/lobe of the brain?

a. left/frontal & parietal
b. Left/temporal & occipital
c. Right/frontal & brain stem
d. Right/temporal & frontal

Poll Question 7

Knowledge Summary
Key Points

1. Know your basic functional anatomy of the cortex & resulting impairments
2. Impairments will guide your treatment interventions
3. Tailor the treatment interventions based on what is available to the patient – e.g.
   a. What was spared from the stroke
   b. Environment
   c. Support system

Question and Answer Period
Required References < 5 years old


Required References < 5 years old


Required References < 5 years old


Other References


Strength Assessment