Freezing of Gait Phenomenon: What’s the hold up?

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Objectives

• Understand freezing of gait (FOG), its functional impact, and the characteristics of those likely to experience FOG
• Identify when FOG is likely to occur
• Understand the possible causes of FOG
• Identify key components of evaluation and outcome measures for FOG
• Identify specific physical therapy interventions to address FOG
Freezing of Gait

Medication improved your freezing a bit.
Gait in Parkinson’s Disease

- Parkinsonian gait (Spildooren et al)
  - Commonly see a decreased step length and reduced velocity
- Freezing of gait (FOG)
  - Inability to produce effective forward steps despite the intention to walk
  - Lasting seconds (< 1 minute) in which walking is halted
  - Often preceded by hastening or festination of gait
    - Small steps at a high frequency
- Poorly treated by dopaminergic medications or very large doses are required to improve FOG
- Not just specific to gait, but can be related to speech and movements of fingers (Nonnekes et al)
Freezing of gait

• ~50% of all patients with Parkinson’s disease (PD) will experience FOG (Spildooren et al)
  – 10% of FOG is seen in early stages of PD (mild symptoms)
  – 80% of FOG is seen in later stages of PD (severe symptoms) (Plotnik et al)

• Coincides with greater cognitive decline
Impact of FOG

• Increased risk for falls
• Depression
• Reduced quality of life
Atypical Parkinson’s

Side note:

- FOG is not specific to PD
  - Progressive Supranuclear Palsy
  - Pure Akinesia Syndrome
  - Multiple System Atrophy
  - Corticobasal Degeneration (Brownder et al)

- If FOG is one of the first signs the diagnosis may be Atypical Parkinson’s
Characteristics of “Freezers”

• Rigidity as early symptom is positive predictor for FOG (Macht et al)

• Tremor as early symptom negatively associated with development of FOG

• Early occurrence associated with global cognitive decline and depression (Browner et al, Heremans et al)
  – Deficits of executive functioning

• Visual impairments
When/Where does it occur?

• Turning
  – Most common task that induces FOG
  – Around an obstacle, returning to sit
  – Usually impaired in earlier stages of PD

• Narrow doorways

• Change of environment
  – Thresholds, changes in flooring

• Initiation of gait

• Walking under time pressure
  – Rushing to answer phone

• Dual tasking

• Stress and/or anxiety (Plotnik et al, Browner et al, Beck et al)
What causes FOG?

• Initially thought to be a purely motor system deficit
• Shifted to a multisystem deficit to include:
  – Neurochemical/Neurostructural
  – Cognitive
  – Sensory
  – Motor
  – Emotional
• Overload of processing resources may block motor output

(Heremans et al, Browner et al, Sarbaz et al)
Causes of FOG

• Neurochemical/Neurostructural
  – Decreased dopamine
    • Increased resistance to dopaminergic drugs
  – Scaling of lower limb amplitude impaired: controlled by higher levels of the CNS and then maintained by the basal ganglia
    • Under normal conditions basal ganglia match preselected stride length to achieve goal; basal ganglia is unable to do this mismatch in amplitude across all joints
  – Reduction in basal ganglia loops causing infiltration of non-motor information that disrupts the basal ganglia motor loop
Causes of FOG

• Sensory
  – Beck et al found step length and gait velocity were significantly reduced in freezers compared to non-freezers when vision of lower limbs was removed
  – Use of sensory cues at times increase episodes of FOG possibly due to sensory overload
    • Stepping over imaginary line or line from laser pointer
Causes of FOG

- Motor
  - “Sequence Effect” - gradual step to step reduction that eventually leads to freezing
  - Threshold model - induced by accumulation of motor impairments
    - Reduced step, coordination and symmetry (Schlick et al)
  - Deficits in Bilateral coordination: initiation of locomotion and during turns because these require efficient coordination of leg movements
- Not related to abnormal tone of muscles or weakness (Sarbaz et al)
Causes of FOG

• Cognitive
  • Associations between FOG and executive functioning decline
    - Frontal lobe is impacted with difficulty with initiation or switching motor plans
    - Arousal and attention factors
      • Suggested due to increased attention required for gait
      • Tasks that divert attention away from walking increase FOG episodes indicating cognition is a factor
      • Beck et al found increased number of FOG episodes and percentage of time spent frozen when performing dual task compared to baseline
      • Freezers found to gaze at pathway vs. doorway with addition of dual task possibly decreasing attentional resource
Causes of FOG

• Emotional/Limbic system (Martens et al)
  – Anxiety = most common non-motor symptom of PD
    • 69% of individuals with PD
    • Greater in freezers than non-freezers
  – Freezing precede anxiety or does anxiety lead to FOG?
  – Increased heart rate seen prior to and during FOG episode
  – Martens et al found freezers spent a greater percentage of trial frozen when walking in an anxiety provoking situation and had a greater number of freezing episodes in anxiety provoking setting
    • Reduced velocity and step length
  – Thought to contribute to overload
Evaluation (Nonnekes et al)

• HPI
  – “Feet glued or pasted to the floor”
  – FOG episodes
    • Frequency, where, intensity, and duration of freezing episodes
  – Medication
    • Timing, episodes “ON” or “OFF”
  – Presence of falls
    • During turns OR “spontaneous falls”
  – Cognitive difficulties
  – Visual changes
Evaluation: Tests and Measures

• Visual assessment is vital *(Ekker et al)*
  – Dependent upon vision to compensate for defects in automatic motor behavior
  – Visual deficits are very common in PD and usually worse in Freezers increasing risk for falls
  – Common deficits include:
    • Dry eyes (reduced blinking)
      – Blurry vision, pain
    • Ocular motor
      – Convergence insufficiency
    • Impaired color discrimination and contrast sensitivity
      – Difficulty with low light environments
    • Impaired visuospatial ability
      – Interferes with movement planning
    • Visual hallucinations
Evaluation

• Cognition
  – Executive functioning skills
    • Indications for treatment and potential for success with use of cueing strategies

• Eliciting FOG
  – Using a series of turns, narrow pathways, starts, and dual task situations
  – Make full or rapid turns in both directions, walk with short steps as rapidly as possible
Outcome Measures

• Freezing of gait questionnaire (Bloem et al)
  – Subjective severity of freezing of gait and how it impacts daily life
  – 6 item scale ranging from 0-24 (higher score = greater severity)
  – Question 3 found to be a good single question for FOG frequency
  – Rate gait difficulties (2 items) and frequency/duration of most typical FOG episodes on 5 point scale (0 = absent to 4 = most severe)
    • High internal consistency and good inter-intrarater reliability
    • Criterion validity is supported by ability to distinguish freezers from non-freezers
    • High correlations with other gait and balance measures
    • MDC, MCID not established
Outcome Measure

• Question 14 of UPDRS
  – Freezing when walking and rate 0-4 scale (0 = none; 4 = frequent falls)

• Modified Parkinson’s Activity Scale (MPAS) (Keus et al)
  – 14 items assessing general mobility with 6 items assessing FOG
  – Observe quality of movements rating from 0 (dependent) to 4 (normal)
  – Range from 0 - 56 (higher = more impaired)
  – Includes dual tasking items
  – MDC = 7.2
  – No reliability or validity data to date
Outcome Measures

- **Short freezing of gait assessment** (Zeigler et al)
  - 4 situational maneuvers rated on 4 level interval scale
    - Start to walk, turning CW, CCW, and passing through doorway
    - Range from 0 - 36
    - Items scored from 0- 3 (severity of FOG)
    - 3 conditions: Walking, addition of motor task, and addition of cognitive task
Interventions
Intervention: Visual Cues (Beck et al)

• Assessed dual tasking with addition of visual cues
  – Auditory list of random numbers in which individual was asked to count number of times a specific number was stated

• Results
  – Visual cues improved step length and step time in freezers regardless of dual task
  – Reduced number of FOG episodes
    • Visual cues unable to ameliorate FOG during dual task
  – Visual cues assisted to focus attention on walking or provided information to form a feed forward plan reducing reliance on proprioceptive feedback
Intervention: Auditory Cues

• Plotnik et al assessed if auditory cueing provided in environment likely to induce FOG affected the number and duration of FOG episodes
  – Narrow passageway, doorways, turns, slalom with progressive task conditions including dual tasking and busier environments
  – Set to 80% of the cadence and then adjusted as learning occurred
  – **Results:**
    • Lower frequency of FOG episodes and shorter duration of FOG episode during all gait trials
    • FOG episodes remained significantly reduced in the 4 week follow up testing compared to pre-testing
    • Increased gait speed but only statistically significant for dual tasking conditions; decreased TUG and improved ABC
Intervention: Gait Initiation

- Lu et al: Determine effects of external cue timing on the timing, magnitude, and incidence of anticipatory postural adjustments during gait initiation
  - **Setup**: Provided auditory, visual, or somatosensory cueing during 3 timing protocols including countdown, fixed delay, and random delay
  - **Results**:
    - Auditory and visual cues significantly decreased the incidence of incomplete postural adjustments compared with self initiation across all cue timings
      - Increased amplitude of initial loading and unloading forces
    - Tactile had no significant effect on APA timing
    - Predictable cue timings were most effective at improving the timing of APA and propulsive phase of gait initiation
Intervention: Turns

- Spildooren et al examined if turns could be improved with use of auditory cue or attentional cue
  - **Setup:** Baseline trial at beginning and end, auditory cue during entire trial, attentional cue with focus on initiating turn with their head
  - Assessed head, trunk, and pelvic rotation, head/pelvis separation, FOC occurrence, Medial COM deviation during turning, turn velocity, and knee flexion amplitude
  - **Results:**
    - FOG occurred in 52.8% of baseline and 34.6% of trials using attention strategy and 3.8% of trials with unilateral cue
    - Cueing increased the en-bloc movement and decreased the knee flexion suggesting compensatory mechanism for reduced postural control
    - Cueing did not affect COM suggesting mediolateral weight shift may not be of critical importance in the etiology of FOG and that en block might actually reduce FOG
Interventions: Turns

- Yang et al examined whether use of a clock turn strategy is effective on the pattern of turning steps, turning performance, and FOG during narrow turning
  - Imagine a virtual clock: If turning R = 12, 3, 6 and if turning L = 12, 9, 6 using 3 step to cycles
  - **Results:**
    - Clock turn group had greater foot clearance than usual - turn group and clock turn group had lower step time variability
    - Both groups had higher step time variability with addition of dual task however clock turn strategy group was no longer able to maintain foot clearance however FOG number and duration did not increase
    - Clock turn group took less time to turn than usual - turn group
    - Clock turn group had lower FOG severity
Intervention: Combination Cues

• Frazzitta et al assessed effect of treadmill training with auditory and visual cues vs. auditory and visual cueing only
  – Group 1 (Treadmill)
    • Visual cue displayed on screen with patient matching to stride
    • Auditory cue of musical beats synchronized with the visual cues
  – Group 2 (No Treadmill)
    • Visual cue consisted of lines spaced according to individual stride length (increased every 3 days by 0.05m)
    • Auditory cue same as group 1
  – Results: 6MWT, gait speed, stride cycle improved in both groups however treadmill significantly better than cueing only
    • Treadmill may impose another external cue
Intervention: Combination Cues

- Schlick et al examined the effects of treadmill training with visual cues vs. treadmill training alone
  - Treadmill training: 20 minutes up to 45 minutes with progressive speed
  - Treadmill training with visual cues projected onto the treadmill belt
    - Increased 10% of their step length initially
  - Results:
    - Gait speed and stride length improved in both, TUG only reduced in treadmill with visual cues group
    - 2 month follow up: Both groups had reduced gait speed and stride length but treadmill only group was significantly lower; no change in TUG
LSVT BIG for FOG

• Use of large amplitude movements with cue of “BIG”
• Provide functional practice under circumstances that increase freezing episodes
• During freezing episode: Use of 4 S’s
  – Stop BIG
  – Stand BIG
  – Shift BIG
  – Step BIG
Emerging Technology (Ekker et al)

• Walking sticks and rolling walkers that project laser line on the floor
  – Effective in overcoming FOG and reducing falls in some patients
• Auditory device incorporated into glasses
  – Effective in improving gait parameters in lab settings
  – cost?
• Smart glasses
  – Provide contrast enhancing functions
  – Magnification of view
Medication improved your freezing a bit.
Research Limitations

- Excludes those in later stages of PD (Hoehn and Yahr 4)
- Exclusions of those with visual impairment
- Exclusions of those with greater cognitive deficits
- Many without a long term follow up
- Retention of training effects is limited even in short periods of time
Cognitive Barriers to Cueing Interventions
(Heremans et al)

• Successful use of cues requires an ability to retrieve them
  – May have difficulty with using strategies

• Provided cues requires individuals to shift their motor control from automatic to attention demanding control
  – Providing cue may use greater attentional resources

• Can create cue dependency and reduced flexibility
  – Decreased transfer of learning
Special Considerations

• Cognition and progression of the disease
• Consider referrals for OT
  – Household adaptations, lighting, safety rails, planning schedules to minimize stress (Nonnekes et al)
• Consider referral to Ophthalmologist
• Patient preference (Rahman et al)
  – Prefer cognitive strategies over other forms of cueing
• Carryover is limited
  – Require significant social support
  – Consideration for maintenance programs
Take Home Points

• FOG is one of the most debilitating symptoms of PD, is resistant to medical management, is challenging to assess, and is a main source of falls and reduced quality of life in those with PD.

• Therapeutic strategies using external cues can improve FOG however the effects are patient dependent and impacted by an individual’s cognitive and visual impairments.

• Effects can be short term therefore a multidisciplinary approach including caregiver support is necessary to assist with carryover of treatment strategies into the home setting.
Questions?
References


References


