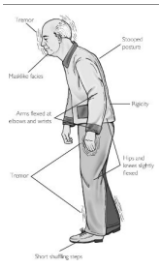
Movement Training For Patients with Parkinson's Disease: An Evidence-Based Approach



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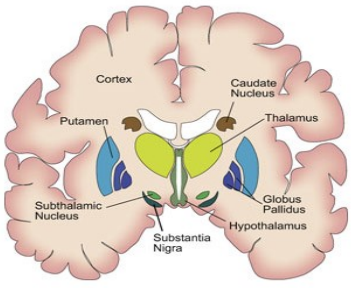
Parkinson's Disease

- ***Progressive neurodegenerative*** disease.
- ***Degeneration of dopaminergic neurons*** leading to malfunctions of basal ganglia
- ***Movement disorders*** with tremor and/or bradykinesia

Basal Ganglia

- Basal ganglia: 5 components.
- ***Caudate nucleus, Putamen, Globus pallidus, Substantia nigra and Subthalamus***
- Substantia nigra: 2 zones
  - ***a) Zona compacta: produces dopamine (DA)***
  - ***b) Zona reticulata: produces GABA.***
- DA is crucial to human movement.
- DA helps in transmitting messages to the striatum to initiate and control movement.

Basal Ganglia



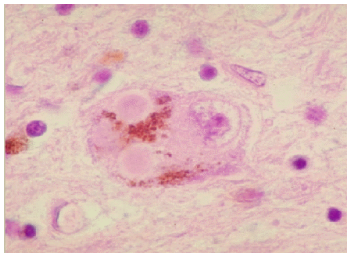
Parkinsonism

- Parkinsonism
  - Idiopathic Parkinson's disease
  - Vascular Parkinsonism
  - Progressive supranuclear palsy
  - Lewy body dementia
  - Drug induced parkinsonism
  - Multiple system atrophy

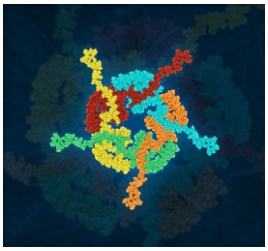
- Causes
  - Mostly idiopathic
  - Genetic
  - Environmental toxins
    - Pesticides
    - Herbicides
    - Manganese
  - Heroin byproducts
  - Free radicals
- Medications
- Stroke and atherosclerosis

Neuropathology of PD
Normal (right) vs. Patient with PD (left)

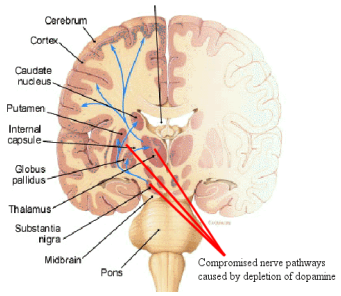
Section of neural tissue, Showing Three Lewy Bodies; Characteristic of PD.



Alpha-Synuclein: Misfolding



Pathways Affected in PD



Clinical Features: Resting Tremor

- **Resting Tremor**
  - Pill rolling at rest
  - Can be any where such as arms, legs, feet, jaw
  - Present at rest
  - Present when distracted
  - Diminished during action

Clinical Features: Bradykinesia

- Bradykinesia
  - Slowness in all movements and can lead to akinesia.
  - Difficulty to initiate movement
  - Difficulty to perform rapid movements especially using fingers
  - Difficulty in changing set during movement (decreased motor plan readiness)
  - Difficulty in maximizing movement speed when motor output is driven by internal control
  - Hypomimia (facial immobility or masked faces)
  - Reduced spontaneous blinking

Clinical Features: Rigidity

- **Rigidity: Increased muscle tone**
  - Cogwheel rigidity, generally in the UE
  - Lead pipe rigidity, generally in the LE
  - Increased muscle tone when opposite arm moves
  - Stooped posture

Clinical Features: Posture

- Posture:
  - Instability
  - Loss of postural reflexes
  - Retropulsion
  - Difficulty making turns
  - Muscle weakness
  - Rigidity

Gait Characteristics

- Slow to initiate
- Stooping
- Festinating
- Shuffling
- Shortened stride
- Reduced arm swing
- Decreased foot clearance

Other Clinical Features

- Micrographia
- Impaired speech
- Difficulty in swallowing and chewing
- Incontinence
- Sleep disturbances
- Autonomic disturbances (sweating, constipation)

Clinical Features: Cognitive Impairments

- I/3rd individual with PD
- Mostly developed later stage of the disease
  - Decreased planning
  - Loss of executive functions
  - Decreased decision making
  - Depression

Non Motor Symptoms

- Depression
- Anxiety
- Stress
- Pain
- Fatigue
- Halucinosis
- Sensory dysfunction with hyposmia
- Disturbances in sleep-wake cycle

Bradykinesia

- Proposed theories for bradykinesia
  - Difficulty in maximizing movement speed when motor output is driven by internal control
  - Unable to generate adequate force
  - Difficulty in changing postural set
- Bradykinesia or akinesia are more pronounced when patients with PD attempt to perform self initiated movements

Akinesia

- Lack of initiation or freezing during activities.
  - During walking especially during weight shift from one extremity to other
- Episodes of freezing are also context dependent
  - Walking through doorway
  - Walking in crowed area
  - Walking through narrow path
  - Turning

Movements for Simultaneous and Sequential Task

- Individuals with PD exhibit difficulty in carrying out two tasks (simultaneously or sequentially).
  - May be the result of bradykinesia.
  - Faces more difficulties when two tasks are carried out in opposing directions [***Johnson et.al. 1998***]
  - Lack of readiness
  - Delayed in motor plan execution

PD: Muscle Strength and Force Production

- Reduced rate of muscle force production (**Corcos et al, 1996; Stelmach and Worringham, 1998**)
- Slow rate of force development (**Fellows and North , 2004; Park and Stelmach, 2007).**
- Lower trunk muscle strength in individuals with PD when compared to control subjects even early in the disease (***Bridgewater and Sharpe, 1998***).
- Reduced strength at the hip which contributes to the difficulties to rise from chair (**Inkster et. al, 2003**)

PD: Sensory Processing

- Difficulty in performing movements that are internally planned as compared to movements that are driven by visual or auditory cues (***Dibble and Nicholson, 1997; Majsak et.al., 1998).***
- Therefore, external sensory cue is effective in promoting movement

PD: Sensory Processing

- **Sensory cueing to improve gait**
  - Improved gait velocity and arm swing with verbal instruction (***Behrman et.al, 1998***).
  - Improvement in gait with rhythmic auditory stimulation with music (***Thaut et.al, 1996, Hausdorff et al, 2007***).
  - Improved stride length in patient with PD with extrinsic stationary visual cue (taped step length) (***Lewis et.al., 2000***).

Postural Instability

- Postural instability is the major cause of fall
- Following five factors have significant impact on postural instability in IPD (Diab et. al, 2014)
  - Dysfunction of sensory organization
  - Bradykinesia
  - Abnormal postural response patterns
  - L-DOPA induced dyskinesia
  - Orthostatic hypotension

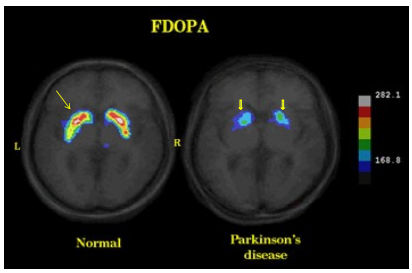
PD: Impaired Motor Processing and Influence on Gait

- Difficulty with the internal regulation of stride length because of difficulties activating the motor control system.
  - Therefore, implementation of visual cueing can improve spatiotemporal variables of gait.
- The initiation of gait is a well known problem for patients with PD secondary to akinesia.
  - Evidences suggest patients with PD can initiate gait with increased force and velocity when a cutaneous cue was used as signal initiation (*Butleigh-Jacobs et.al. 1997, Dibble et.al, 2004*)

Diagnosis of PD

- There is no diagnostic test. Diagnosis is made clinically.
- Parkinsonism diagnostic criteria
  1. Resting tremor
  2. Bradykinesia
  3. Rigidity
  4. Loss of postural reflexes
  5. Flexed posture
- **Definite:** At least two of the above features must be present, one of them being 1 or 2
- **Probable:** Feature 1 or 2 alone is present

PET Scan of Normal Brain and Brain From Patient with PD



Differential Diagnosis

- Multiple systems atrophy
- Progressive supranuclear palsy
- Lewy body dementia
- Drug-induced parkinsonism
- Vascular parkinsonism

Rationale For Therapy in Patients With PD

- Interventions vary depending on the presentation of symptoms by individual with PD.
- The patient may be thought to present in three broad categories.
  a. Tremor predominant
  b. Bradykinesia/akinesia
  c. Rigidity/postural instability/gait difficulty
- Therefore, goals depend on the type of presentation, of course there will be a considerable overlapping of signs and symptoms.

Rationale For Therapeutic Interventions

- Early intervention should always be the focus.
- The rationale for therapy:
  - ***To increase ROM***
  - ***To decrease rigidity***.
  - ***To improve co-ordination of movement***.
  - ***To maintain posture and functional abilities***.
  - ***To maintain ADL***
  - ***To improve balance, and gait***.
  - ***To prevent secondary sequelae*** (eg. Deconditioning, contracture, loss of extension and trunk rotation)

Key Elements to Consider During Physical Therapy

- Movement disorders
- Cognitive impairment
- Task analysis and task specific training
- Environment
- Medication
- Concurrent pathologies
- Secondary adaptive changes
- Needs of patient and caregivers

PD: Intervention Strategies

- Goal of rehabilitation is to reduce functional losses due to change of motor functions in individuals with PD
- Evidences support that exercise can improve both motor functions (Morris, 2000; Keus etal, 2007) and cognitive functions (Petzinger et al, 2013) in individual with PD
- <u>As patients develop high risk of fall over time, therapists should focus on balance training from the beginning.</u>

Stages of the Parkinson's Disease and Intervention

- Intervention strategies range from highly corrective to highly compensatory depending on the stages of the disease.
- H&Y stages 1 and 2: To improve or correct impairments to prevent patient's functional loss later in the disease.
  - Spinal ROM exercise
  - Functional training
  - Bed mobility
  - Transfer
  - Balance
  - Gait

Stages of the Parkinson's Disease and Intervention

- H&Y stage 3: falls prevention is the primary concern and preventive strategies should be incorporated.
- The causes of fall may be due to:
  a. Movement disorders and cognitive impairments
  b. The way the task is performed (e.g. uni- or multi-task)
  c. Environmental factors
  d. Adverse effects of medications
  e. Other factors such as age-related impairments of strength and postural control.
- Combination of corrective and compensatory strategies to reduce and prevent falls.

Stages of the Parkinson's Disease and Intervention

- H & Y stages 4 and 5: Intervention should aim in preventing further pathology (falls with fracture, skin breakdown, pneumonia etc.) and improving quality of life.
  a. Educate family members and caregivers so that they can assist patient effectively.
  b. ROM should be continued
  c. Implement strategies for pain management.
  d. Breathing exercises need to be continued
  e. Maintain pulmonary hygiene.

ROM Exercises

- Early in the disease process, movement throughout the full ROM is crucial
- Contractile elements of flexor muscles become shortened and those of extensors become lengthened, causing flexed posture.
- The movement should be large and through the entire range especially in the extremities as well as in the trunk.
- Distal motion first and gradually increase the movement, bringing in proximal and trunk muscles.
- Exercise should be given during the "on" phase of medication (45-60 min after medication is the best time)

Exercise to Increase Flexibility: Stretching

- Stretching of hip flexor muscles:
  - In prone position
  - Supine position with weight cuff on both legs
  - Prone on elbow
- Prone-extension can be used to improve thoracic and neck extension
- Trunk extension can be promoted by asking patients to stand with elbows extended and hands weight bearing on a wall.
- Hamstring stretching: Long sitting

Rotational Movements in Supine Position

- Rotational movement is typically lost early in PD.
- Therefore in early stages of PD, slow, rhythmic, rotational movements through small ranges of motion are effective.
- Slow side-to-side head rotation

Rotational Movements in Sidelying Position

- Trunk rotational movement can be incorporated in sidelying position:
  1. Upper and lower trunk rotation exercises on both sides.
  2. Trunk rotations with shoulder protraction and elevation and shoulder retraction and depression.

Exercises to Increase Flexibility: PNF

- Bilateral symmetrical D2 flexion pattern to promote upper trunk extension.
- In the LE, D1 extension pattern (hip extension, abduction, internal rotation) needs to incorporated to counteract LE flexion and adducted position.
- Active muscle inhibition techniques (through hold-relax or contract-relax) can be used to specific muscle rigidity and contractures.

Exercise to Reduce Rigidity

- Relaxation techniques: Better in sitting position than supine as supine position may increase rigidity.
- As proximal muscles are more rigid than distal muscles in patient with PD, relaxation may be easier to start from distal first and progressed to the proximal direction.
- Example:
  a. Gentle slow rocking
  b. Rotation of extremities and then trunk
  c. Yoga and meditation
  d. Deep breathing exercise

Rigidity: Rocking Exercise

- ***Swiss ball:*** Patient is on mat and asked to use Swiss ball to help in rocking forward and backward.
- ***Rocking chair exercise:*** A rhythmic whole body movements using rocking chair can be effective in reducing rigidity in patients with PD.

Deep Breathing Exercise

- Diaphragmatic breathing exercises
- Deep breathing exercise can be done in supine, sitting or standing position to promote relaxation.
- The patient is to be taught to take slow deep breaths through nose and exhale through mouth.
- Complete chest wall expansion will be difficult as patient's trunk is often rigid.
- Therefore, chest wall stiffness and postural malalignment needs to be addressed using stretching, visual feedback and strengthening exercise.

Deep Breathing Exercise with PNF

- PNF: Alternative bilateral symmetrical D2F and D2E patterns can be combined with slow and deep inspiration and expiration respectively.

Muscle Relaxation and Diaphramatic Breathing in PD

- One group of researchers developed a program which emphasized exercises for axial mobility associated with muscle relaxation and diaphragmatic breathing to increase range of motion of the neck and trunk.
- They have found that 10 weeks of exercise improved in axial mobility and postural control of individuals with PD (Schenkman et al. 1998).

Strengthening Exercise in Patients With PD

- Because of the rigidity of flexor group of muscles, the antagonistic muscles (extensors) become weak.
- Therefore, strengthening exercises are to be incorporated to extensor muscles.
- Initially, patient may not have full range because of rigidity of flexor muscles.
- Once the full range is achieved (following stretching as described before), progressive resistive exercises are to be incorporated.

PD: Strength Training

- Sit to stand and walk can be compromised due to muscle weakness in the lower limbs of individuals with PD.
- Strength training program may be beneficial
  - Squat
  - Lunge
  - Sit to stand and stand to sit slowly
  - Stand marching

PD: Strength Training

- Strength training programs are effective to improve muscular strength that in turn improve the mobility of individuals with PD (Hass et al. 2007).
- Some researchers observed that promoting eccentric contraction through high intensity protocol can improve muscular strength and functional gains (Dibble et al. 2009).
- They have also observed that high intensity strength training was better for motor and functional performance in individuals with PD than training based on flexibility exercises, balance and concentric strength training of limbs

Strength Training Videos

PD: Endurance Training

- Individuals with PD show decreased in cardiorespiratory function.
  - Low metabolic efficiency
  - Higher energy cost for the movement
- Following endurance training will be effective in improving gait and QOL (Herman et al, 2007)
  - Aerobic exercise programs on a treadmill,
  - walking training,
  - stepping activities

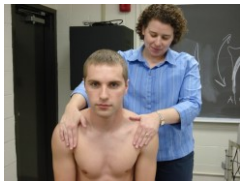
PD: Endurance Training

- A group of researchers suggested that aerobic exercise can improve the effectiveness of levodopa, and therefore patients' motor response (Muhlack et al.)
- It is also possible that regular and intense aerobic exercises can produce a neuroprotective effect and may contribute to the restoration of neuronal pathways impaired by the PD (Fisher et al. 2004, Pothakos et al. 2009).

Interventions for Postural Corrections

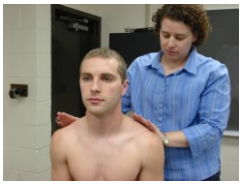
- Using PNF
- Stabilization
- Using mirror as a visual cue
- Using backpack with weight

Alternating Isometrics to Promote Trunk Stability in Sitting



- Patient is sitting
- Resistance needs to be provided to trunk flexion through symmetrical manual contacts on the ant. Shoulder.
- The verbal cue "don't let me push you backward"

Alternating Isometrics to Promote Trunk Stability in Sitting



- Patient is sitting
- Place hands bilaterally on the superior aspects of patient's scapulae
- The verbal cue will be "don't let me push you forward"

Exercises For Mobility in Sitting

- Reaching activities (forward, sideways) along with trunk rotation are important to challenge dynamic sitting balance and promote movement initiation.

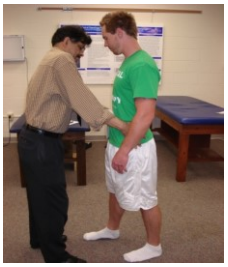
Exercise in Sitting Position

- Arm biking with or without metronome
- Initially unilateral arm swing
- Bilateral symmetrical swinging the arms in increasing amplitude is easier than reciprocal pattern.
- Then reciprocal arm swing in increasing amplitude.
- Diagonal patterns of bilateral symmetrical arm swing.
- Trunk rotation activities (as trunk rotation will reduce proximal rigidity)
- Diagonal PNF pattern on UE (both D1 and D2)

Exercises For Mobility in Standing

- In standing, marching exercise is also helpful to:
  - Improve balance
  - Promote initiation of movement (metronome or music enhances the effect).
  - Promote endurance if the movement is large

Exercises For Mobility in Standing



- Arm swing with pendulum exercise
- Weight shifting and stepping movements in standing are beneficial to promote pelvic rotation.
- Lateral side steps will enhance standing balance and improve abductor functions.

Functional Training

- Moving weight forward during sit-to-stand is difficult for patient with PD.
- Rocking forward and backward with cuing (counting) can be used to enhance patient's ability to move weight forward.
- Wall squats exercise (to strengthen hip and knee extensors) is a good exercise to prepare for sit-to-stand activity.

Demonstration of BIG Movement

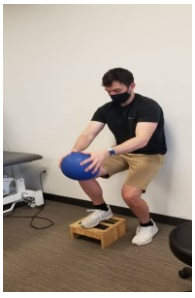
Balance Training

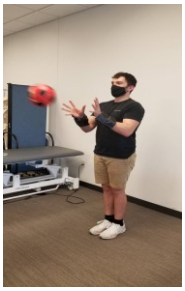
- Individuals with PD fall frequently with devastating consequences
- Approximately 66% of individuals with PD will suffer falls and 46% will experience recurrent falls
- Factors contribute to falls
  - Gait freezing
  - Muscular weakness
  - Compromised balance

Balance Training

- Before gait training, balance training in both sitting and standing needs to be incorporated.
- Sitting balance:
  1. Reaching activities with functional tasks.
  2. Catch and throw balls
  3. Pick up objects from floor
- Standing balance:
  1. Standing with looking at the ceiling and then to the floor.
  2. Reaching activities with functional tasks.
  3. Catch and throw balls
  4. Bouncing ball on the wall
  5. Bouncing ball on the floor while walking
  6. Kick ball in standing
  7. Tai-Chi

Balance Training





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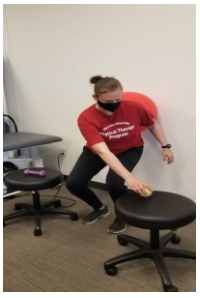
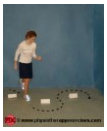


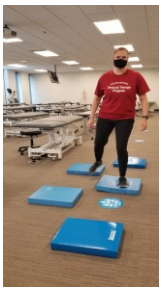
Balance Training

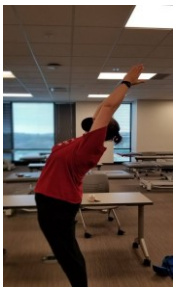
Balance Training



- Standing with feet apart of shoulder distance
- Standing with feet close together with eyes open and then close
- Unilateral stance
- Standing on pillows
- Walking and stepping over cones

Balance Training





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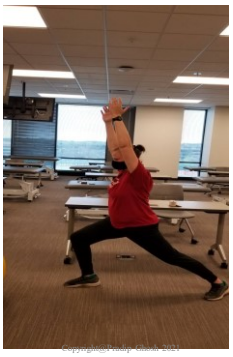


Audio-Biofeedback Training for Posture and Balance in PD

Mirelman et al, 2011 J NeuroEngineering and Rehabil

- Recruited 7 patients with PD
- 6 weeks of individualized intervention using audio-biofeedback (ABF) system with headphone
  - Training was focused on improving posture, sit-to-stand abilities, dynamic balance
  - Assessed BBS, Times up and go test (TUG), PD QOL-39
- Observed significant improvement in BBS and a trend of improvement in TUG and have positive influence on psychological aspects of the disease

Augmented Visual Feedback During Balance Training in Individual with PD

Van den Heuvel et al, 2014

- Recruited 33 patients with idiopathic PD and divided to 2 groups
  - 17 pt in experimental
  - 16 in control group
  - 5 weeks training (2 group treatment sessions of 60 min each /wk)
  - Experimental group trained on workstations consisting of interactive balance games with augmented visual feedback (VFT)
  - Control group received conventional training
  - Standing balance, gait, and health status were assessed at entry, 6 wk and at 12 wk follow-up
- Observation
  - Change scores for all balance measures favored VFT
  - Suggested that balance training based on visual feedback will show greater improvements on standing balance performance than conventional balance training

PD and Balance: Hydrotherapy vs Land-based Therapy

(Volpe et al, Clinical Rehab, 2014)

- Compared the effects of hydrotherapy and land based therapy in individual with PD
- Recruited 34 individual with PD (H&Y 2.5-3) and divided into 2 groups
  - Gr I: Hydrotherapy for 60 min 5X/wk for 2 months
  - Gr II: Land based rehab for 60 min 5x/wk for 2 mo
- Measured COP sway area with open and closed eyes, UPDRS II and III, TUG, BBS, Activity specific Balnce Confidence Scale, Falls Efficacy Scale
- Both group showed significant improvement in all outcomes buth hydrotherapy group showed more improvements than land-based therapy

Gait Training in Patients With PD

- Patients with PD exhibit some gait deficits such as
  - slowed speed,
  - shuffling gait pattern,
  - diminished trunk movement,
  - decreased arm swing, and
  - decreased base of support.
  - Sometimes, patients with PD exhibit freezing episodes.

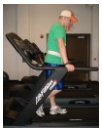
Gait Training in Patients With PD

- The following exercises are helpful in promoting normal gait pattern in patient with PD.
  - Stand marching exercise with reciprocal arm swing if patient exhibits good standing dynamic balance.
  - Stepping forward and backward
  - Stepping up and down

Gait Training in Patients With PD

- Patient with PD should also practice
  - stopping,
  - starting,
  - turning
- Turns of 180 or 360 degrees should be practiced with small steps and wide base of support.
- Treadmill training: Several researchers found that treadmill training can promote a more stable and dynamic gait pattern in individuals with PD (Herman et al, 2009; Miyai et al, 2002) [20-30 min, 3x/week]

Gait: If Movement Initiation is a Problem



- Patients with PD get benefit from stationary arm and leg bicycling as this exercise will help in improving initiation.
- Backward walking on treadmill will also improve initiation from LE muscles and reduces episodes of bradykinesia during walking.

Cueing Strategies

- The performance of automatic and repetitive movements is disturbed as a result of problems of internal control in individual with PD
- For this, cues are effective to replace this reduced or absent internal control.
- Cues are external stimuli of different types:
  - Instructional
  - Auditory
  - Visual Sensory

Cuing Strategies

1. Auditory: Provide external rhythm that bypasses internal rhythm deficits (McIntosh et al, 1997)
   a. Stepping out on the third count to initiate movement
   b. Metronome
   c. Singing or counting
2. Visual: Engage the visual cerebellar motor pathway to facilitate the generation of better gait pattern (Azulay et al 1999)
   a. Using a mirror to correct posture
   b. Laser light focused on floor
3. Sensory: Enable the activation of the dorsolateral premotor control system
4. Attention: Thinking about movement

External Auditory Cueing

- External cueing such as rhythmic auditory cueing (RAC) can be used as adjunct with traditional gait training intervention to facilitate movement, gait initiation and continuation of walking.
- Treadmills and RAC can influence stepping rhythm for individuals with Parkinson disease (PD).

Gait Training with Auditory Cues

- Studies have shown use of RAC during gait training in patients with PD showed
  - improved gait velocity,
  - Improved cadence,
  - Increased stride length (*Ford et al, 2010; McIntosh et.al, 1997*)

Gait Training with External Auditory Cue

Ford MP et. al, Arch Phys Med Rehabil. 2010 Aug;91(8):1255-61

- Recruited 12 individuals with PD who walked independently.
- Adjusted external auditory cues (frequency of beats) based on a participant's comfortable walking pace. Increased external auditory cues rates if patients were able to maintain or increase stride length.
- Participants were trained for 30min/session, 3 sessions/wk, for 8 weeks.
- RESULTS: A significant (P<.01) increase in walking velocity, stride length, and cadence after 8 weeks of training.

Rhythmic Auditory Cue and Functional Gait Performance

Akre M, Dave J, and Deo M. Ind J Physio Occup Ther. 2019; 13: 75-81

- These group of researchers studied the effects of rhythmic auditory cueing on functional gait performance in individuals PD
- Recruited patients with stage 2-3 as per H&Y staging
- Interventions were during on-phase of medication
- Divided into 2 groups:
  - Traditional treatment for 45 min along with 5 min warm-up and 10-min cool down
  - Traditional treatment (25 min), walking (20 min) using metronome along with 5 min warm-up and 10-min cool down
- Assessed functional gait performance using Modified Gait Efficacy Scale (MGES), Freezing of Gait Questionnaire (FOGQ), and Figure of 8 Walk Test (FO8WT) before and after 5 wk of interventions.

Rhythmic Auditory Cue and Functional Gait Performance

Akre M, Dave J, and Deo M. Ind J Physio Occup Ther. 2019; 13: 75-81

- Findings:
  - FOG scores decreased significantly in both control and experimental group.
  - MGES scores improved significantly in experimental group
  - Times in FO8WT decreased significantly in experimental group while no changes in the control group
- Conclusion:
  - Rhythmic auditory cueing has beneficial effects on the functional gait performance primarily on freezing of gait, MGES and the time component of FO8WT in Parkinson's disease patients

Gait Training Using Rhythmic Auditory Cue with Different Frequencies in Treadmill and over the ground

Hoppe M, Chawla G, Browner N, and Lewek MD Gait Posture. 2020; 79: 41-45

- Assessed the effects of different metronome cue frequencies on spatiotemporal gait parameters of patients with PD when walking overground compared to walking on a treadmill
- Recruited 21 individual with PD (stage 1-3 according to H&Y)
- All participants walked overground and on a treadmill with and without metronome cues of 85 %, 100 %, and 115 % of their baseline cadence frequency for one minute each.
- Assessed step length, and cadence during all conditions.
- Assessed gait speed during overground walking

Gait Training Using Rhythmic Auditory Cue with Different Frequencies in Treadmill and over the ground

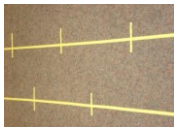
Hoppe M, Chawla G, Browner N, and Lewek MD Gait Posture. 2020; 79: 41-45

- Participants took longer steps during treadmill walking with 85 % of baseline cadence.
- When walked overground, metronome cues of 85% of baseline cadence decreases both cadence and gait speed but cues with 115% of baseline cadence increased the cadence and gait speed without changing step length
- Conclusion: Slow frequency metronome can improve the step length when train in treadmill but the fast frequency cues can improve gait velocity when walk over the ground.

Gait Training with Visual Cues in Patients With PD

- Visual cues have been effective in some patients with PD.
- The problems of shuffling gait can sometimes be minimized by using small blocks of 2-3 inches to provide a target for the patient to step over.
- Use of brightly colored transverse lines on floor (at stepping distance) can be effective in initiating and controlling movement and can minimize freezing episodes.

Gait Training using Visual Cues



Visual cues:

a. Stepping over an object on the floor to initiate walking.
b. Stripes on the floor
c. Walking with an inverted cane by which patient has to step over the grip constantly to continue walking.

Demonstration Using Cues

Acute and Chronic Effects of Acoustic and Visual Cues

De Icco R, Tassorelli C, Berra E, Bolla M, Pacchetti C, and Sandrini G. Parkinsons Disease 2015; 1-9

- Researchers analyzed and compared the acute and chronic effects of visual and acoustic cues on gait performance in individuals with PD
- Recruited 46 patients with idiopathic PD (Stages II-IV as per H &Y) and divided into 3 groups:
- Acoustic cue (metronome), visual cue (colored stripes on floor) and training without cues
- All patients received 40 min of traditional treatment and 20 mins of gait training
- All patients were tested with kinematic analysis of gait at baseline, at the end of the 4-week rehabilitation program , and 3 months later.

Acute and Chronic Effects of Acoustic and Visual Cues

De Icco R, Tassorelli C, Berra E, Bolla M, Pacchetti C, and Sandrini G. Parkinsons Disease 2015; 1-9

- Results:
- Acoustic cues increased stride length and stride duration.
- Visual cues reduced the number of strides and normalized stride/stance distribution but reduced the gait speed.
- As per chronic effects, all 3 types of training improved gait speed, acoustic cues increased the stride length while visual cues normalized the stance/swing ratio.
- Changes were not retained in all 3 groups after 3 months.

Short and Long term Efficacy of Intensive Rehabilitation on Balance and Gait in PD

Frazzitta et al, 2013

- Recruited 20 individual with PD
  - Received 4 weeks of multidisciplinary intensive rehabilitation treatment (MIRT)
  - Evaluated at admission, at the end of 4 wk treatment, and at a 1-yr follow up
  - Assessed UPDRS, BBS, 6-min walk test, TUG, comfortable-Fast gait speed
- Observations
  - All outcome measures improved significantly at the end of treatment
  - At 1-yr follow-up, UPDRS walk and comfortable fast gait speeds still maintained at better values than admission values

Treadmill Training, Stretching, Resistance Exercise on Gait in Patients with PD

(Shulman et al, 2013)

- To compare the efficacy of treadmill training, stretching and resistance exercise on gait speed, strength and fitness in individual with PD
- Recruited 67 patients with PD and divided into 3 groups
  - Higher intensity treadmill (30 min 70-80% of HR reserve)
  - Lower intensity treadmill (50 min at 40-50% of HR reserve)
  - Stretching + resistance exercise (2 sets of 10 rep on each leg on leg press, leg extension, leg curl)
  - Frequency: 3x/wk for 3 months
  - Measured gait speed (6 min walk), cardiovascular fitness (peak O2 consumption/unit time, and muscle strength (1 RM)
- Observation:
  - All 3 group showed improvement in gait speed
  - Lower intensity treadmill group showed greatest improvement in gait speed
  - Both higher and lower intensity treadmill exercises improved cardio vascular fitness

Robot-assisted Gait Training versus Equal Intensity Treadmill Training in Patients with PD

(Picelli et al, 2013)

- Recruited 60 patients with mild to moderate PD and divided into 3 groups
  - Robot assisted gait training
  - Equal intensity treadmill training
  - Conventional gait therapy
- Each patient received 45 min treatment sessions, 3 days/wk for 4 wks
- Patients were evaluated before, after and 3 months post treatment.
- Observations: No significant difference between Robotic gait training group and treadmill training group.
- Conclusion: Robotic gait training is not superior to equal intensity treadmill training for improving walking ability in patients with mild to mod PD

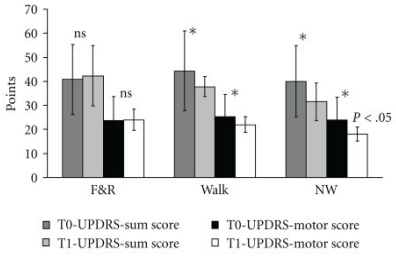
Influence of Flexibility, Relaxation, and Walking on Gait

Reuter I, Mehnert S, Leone P, Kaps M, Oechsner M, Engelhardt M J Ageing Res 2011; 2011: 232473

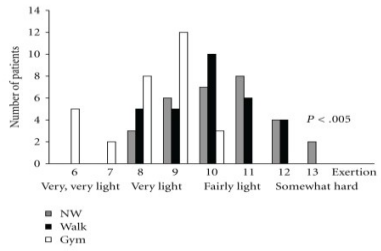
- Recruited 90 individuals with PD and divided into 3 groups
- One group practiced Nordic walking training along with warm-up, cool down and endurance training for 70 min 3x/wk for 6 months
- Second group walked with warm up, cool down and endurance training for 70 min, 3x/wk for 6 months
- Third group went through flexibility and relaxation training for 70 min along with warm up and cool down

Influence of Nordic Walking on UPDRS

Reuter I, Mehnert S, Leone P, Kaps M, Oechsner M, Engelhardt M J Ageing Res 2011; 2011: 232473

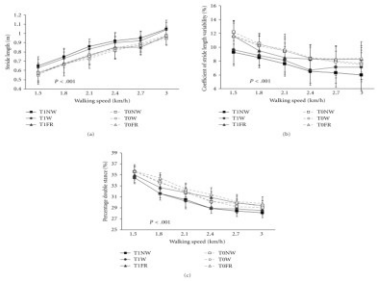


Borg scale: Patients of the Nordic walking group and walking group perceived more exertion than the flexibility and relaxation group suggesting that the training of both groups was more demanding.



Influence of Nordic Walking on Stride Length and Double Stance in Individual with PD

Reuter I, Mehnert S, Leone P, Kaps M, Oechsner M, Engelhardt M J Ageing Res 2011; 2011: 232473



Influence of Flexibility and Relaxation, Nordic Walking on Gait

- Results from Reuter etal research:
  - Walking, and Nordic walking improved stride length, gait variability, maximal walking speed, exercise capacity at submaximal level, and PD disease-specific disability on the UPDRS in addition.
  - Nordic walking was superior to the flexibility and relaxation programme

Gait Training with Theraband and Weighted Strap Demonstration

Patients with PD: Role of Dance

- Dance is a form of expressive art and its use is gaining popularity among individuals with PD.
- Several researchers have documented improvement in balance and walking speed through use of Tango (Hackney & Earhart, 2010), classical Ballet (Houston & McGill, 2012), and modern dance (Batson).
- Researchers have also reported the psychophysical and social benefits of dance exceed those from comparable exercises (Hackney &Earhart, 2009)

How Does Dance Work?

- Dance promotes whole body movements by stimulating sensorimotor systems (visual, auditory, somatosensory as well as vestibular).
- Patients with PD often discover new abilities during dance because they can easily follow the teachers' demonstration (visual and verbal cueing) or can entrain to rhythmic music (auditory cueing).
- These cues successfully regulate steady-state locomotor movements (Lohnes & Earhart, 2011)
- Dance also challenges cognitive faculties such as perceptual awareness, attention, decision-making, judgment, problem solving, and memory (Stevens & McKechnie, 2005)

Demonstration Dance and Music

Irish Set Dancing and Exercise for Patients with PD

Volpe etal, 2013 BMC Geriatrics

- Recruited 24 people with idiopathic PD is randomized into 2 groups
  - Standard physiotherapy group once a week + weekly home program for 6 months
  - Irish set dancing once a week + weekly home program for 6 months
  - Assessed motor component of UPDRS, BBS, TUG, PDQ-39
- Observation:
  - Both the Irish set dancing and physiotherapy exercise program were shown to be feasible and safe
  - Compliance and adherence to both physiotherapy and dance program were very high
  - Dance group showed superior improvement than standard physiotherapy group

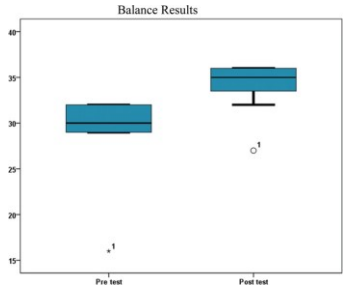
Patients with PD: Role of Dance

(Batson G, Migliarese SJ, Soriano C, Burdette JH, & Laurienti PJ, 2014)

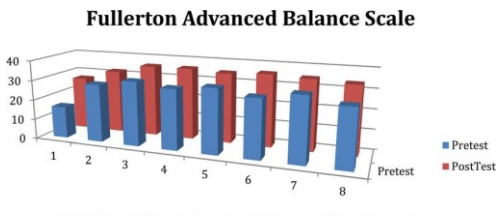
- Two phases (phase I and II) and pre and post-test design
- In phase I, researchers looked at the effects of 7 weeks (3 x each week for an hour) improvisational dance on balance in individual with PD (n=7)
- In phase 1 participant for phase 1 had brain scanning following a 5-day trial of dance.
- In phase I, they have shown significant improvement in balance from measurement using Fullerton Advanced Balance Scale.
- In phase II, brain scanning results showed increased network connectivity between the basal ganglia and premotor cortices.
- Conclusion: Improvisational dance improved balance in individual with PD.

Fullerton advanced balance scale results from Phase I ($N = 7$, $p < 0.017$)

(Batson G, Migliarese SJ, Soriano C, Burdette JH, & Laurienti PJ, 2014)



Batson G, Migliarese SJ, Soriano C, Burdette JH, & Laurienti PJ, 2014)



	1	2	3	4	5	6	7	8
Pretest	16	29	32	30	32	29	32	28.57
PostTest	27	32	36	36	35	36	35	33.86

Patients with PD: Role of Dance

(dos Santos DM, Komeroski IG, Monteiro EP, Costa RR, Haas AN. Aging Clin Exp Res, 2018; 30: 727-735)

- This is a systematic review with meta-analysis to analyze the effects of dance classes on functional mobility and QOL in patients with PD.
- Included 5 RCT and total of 159 patients.
- Looked at motor symptoms using UPDRSIII, functional mobility with Timed Up and Go Test (TUG), endurance with 6 min walk test (6MWT), freezing of gait (FOG) using FOG questionnaire, walking velocity with GAITRite and QOL with PD Questionnaire (PDQ39).
- They documented that dance improved UPDRSIII scores and decreased TUG time when compared to other form of exercise.

PD: Virtual Reality Dance Activity

(Lee, Nam-Yong etal, J Phys. Ther. Sci, 2015)

- Examined the effects of virtual reality dance activity on balance, ADL and depression
- Recruited 20 individual with PD and divided into 2 groups
  - Experimental (10) : 30 min NDT + 15 min FES + 30 min dance activities (5xwk for 6 wk)
  - Control (10): 30 min NDT + 15 min FES
  - Measured balance using BBS; ADL using Barthel Index; and depression using Beck Depression Inventory
- Significant improvement in balance, ADL and depression between before and after treatment as well as in experimental group when compared to control group

Virtual Game and Quality of Life in PD

(Pedeira et al, 2013)

- To evaluate the efficacy of Nintendo Wii training on quality of life in individual with PD
- Recruited forty-four individual with PD and divided into two groups
  - 22 individual received traditional physical therapy (trunk and limb mobilization, balance, muscle strengthening, rhythmic movement, double task execution etc)
  - 22 individual performed movement using Wii
  - Both group were trained for 40 min per session/3 x wk/4 wk
  - Assessed PDQ-39 before and after intervention in the "on" period
- Observed significant improvement in ADL, stigma, social support and communication domain of PDQ-39 in Nintendo WII group compared to traditional physical therapy group

PD: What Sorts of Gait Difficulties are Experienced?

- ***The length of steps becomes smaller***.
- ***The rhythm of walking is affected.***
- ***Starting and maintaining the walking*** pattern is a problem.
- ***Concentrating on other things while walking is difficult.***
- ***Falling is more frequent***.

PD: Taking First Step is Difficult

- **When might this happen most?**
  - After ***rising from a chair or bed***.
  - When ***first step is a turn***.
  - In ***crowded or cluttered places***.
  - When medication is not working,
  - ***Early in the morning*** or at night.

PD: Taking First Step is Difficult

- **What can be done to overcome?**
  - Ask patient to rock slowly ***by moving weight from left to right*** and ***count when rocking and stepping***.
  - Ask patient to ***step backwards or to the side to unlock the freezing*** if stepping forwards is difficult.
  - Place stripes on floor and ask patient to step over.
  - Ask patient to use ***metronome rhythm to rock and step to***. The rhythm should be slow and steady to allow you to make your first step large.

Shuffling Gait: Use of Cue

- Ask patients to concentrate and keep steps long and even during walking. Patients may ***use a prompt such as counting.***
- ***Visual cues:***
  - ***Using stripes in floor patterns and step over***
  - ***Zip tie in the cane and step over .***
- ***Auditory cues***: use a rhythm from a metronome or a piece of music with a definite beat.
- Take fewer and large steps.

Gait Akinesia: Use of Cues

- Ask patients to think about standing tall with feet apart and shift weight from side to side to unlock.
- Ask patients to take a back step and then take step forward
- Ask patients to count or use of metronome beat during walking specially during turn or walking in crowed place
- Ask patients to keep stepping during turn or when opening door

Conclusion

- It is well known that **aerobic** and **learning-based** exercises could be neuroprotective in individuals with neurodegenerative disease.
- Facilitating exercise programs that challenge heart and lungs as well as promote good biomechanics, good posture, trunk rotation and normal rhythmic, symmetric movements are the best.

Conclusion

- Exercises that require balance and preparatory adjustment of the body are also important along with rhythmic activities such as marching, cycling, and dancing can maintain the ability to perform reciprocal movements.
- Other types
  - Marching to music with big arm swings
  - Stepping over obstacles
  - Yoga class
  - Tai-Chi class
  - Swimming

Conclusion

- Weight lifting is not the best choice for strength training in individuals with PD.
- Strengthening exercises may increase rigidity in patients with PD
- **When performed properly**, following strengthening exercises do have **some value**.
  - Pushing up to rise on the toes
  - Modified squats
  - Repetitively rising and sitting from a chair
  - Wearing ankle and wrist weights around the house or out on a walk
  - Push-ups or wall push-ups for arms

Conclusion

- Exercises to decrease rigidity and stiffness
  - Large, rhythmical movements
  - Rotating the trunk
  - Vibration, rocking and swinging
  - Cooling or warming the tense extremity can sometimes be helpful.
  - Carrying out socially engaging and learning based activities
- **Exercise frequency**: **4-5 times a week for at least 30-40 minutes** at 70 to 80% of age predicted maximum HR (220 – your age times 70 or 80%).

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- Following students assisted in creating videos and volunteered to demonstrate different exercises and activities under the supervision of Dr. Pradip Ghosh
  - **Amanda Gapsch, SPT**
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  - **Kaley Ruff, SPT**
  - **Stephanie Sherwood, SPT**
  - **Allison Verville, SPT**

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