PARKINSON DISEASE
DANCE FOR PD WORKSHOP

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Normal Motor Control

• Central Nervous System
  • Premotor, Supplementary Motor and Primary Motor Cortex
  • Sensory Cortex
  • Limbic System Structures
  • Basal ganglia
  • Thalamus
  • Cerebellum
  • Brainstem
  • Spinal Cord

• Lower motor and sensory neurons

• Muscle fibers
Multiple Segregated Parallel Loops

(MOTOR LOOP)
- Cortex
  - Motor cortex
- Striatum
  - Putamen
- Pallidum
  - Lateral GPi
- Thalamus
  - Ventral lateral nucleus

(EXECUTIVE LOOP)
- Dorsolateral prefrontal cortex
- Dorsolateral caudate
- Medial GPi
- Medial dorsal and ventral anterior nuclei

(LIMBIC LOOP)
- Anterior cingulate cortex
- Ventral striatum
- Ventral pallidum
- Medial dorsal nucleus

Basal Ganglia

- Caudate
- Putamen
- Globus Pallidus
- Subthalamic Nucleus
- Substantia Nigra
Role of the Basal Ganglia

- Selection and accentuation of certain motor patterns, to the exclusion of others
  - Center-surround concept
- Preparation for movement
- Scaling of speed and amplitude of movement
- Motor learning
- Sequencing of motor patterns
- Termination of an ongoing motor program
- Behavioral learning based upon reward
  - Part of the development of habits/motor learning
- Sensory processing
Concept of Parkinson Disease

• Widespread neuro-degenerative disorder
  • Central and peripheral nervous systems involved
  • Multiple neurotransmitter systems affected

• Different presenting symptoms & progression
  • Tremor predominant form
  • Postural instability gait disorder form

• Multiple genetic associations
ETIOLOGY OF PD

- Genes
- Environmental toxins?
- Endogenous factors

Pathogenesis

- Protein accumulation
- Oxidative stress
- Mitochondria
- Inflammation
- Apoptosis cascade

Parkinson disease
Pathology of PD

• Cumulative loss of dopaminergic neurons in the substantia nigra compacta (SNc) is responsible for key motor features of the PD, particularly bradykinesia.

• Lewy bodies accumulate in multiple brain regions, starting in the brainstem, and affecting multiple neurotransmitter systems (Braak 2003)
  • May explain some of the “non-motor” features
Physiology of PD Motor Symptoms*

- Conceptualized as an imbalance between excitatory and inhibitory input from the BG via the thalamus to the cortex.

- The result is excessive inhibition of the cortex.

- *particularly bradykinesia
Early Symptoms

• Decreased sense of smell

• Sleep disorders
  • REM d/o
  • Excessive daytime sleepiness
  • Insomnia

• Shoulder pain

• Restless leg syndrome

• Autonomic dysfunction
  • Constipation
  • Urinary frequency and urgency
  • Sexual dysfunction

• Mood disorders
  • Depression, anxiety
Cardinal Motor Features

• 4-6 Hz rest tremor
  – Similar frequency “re-emergent” postural tremor

• Bradykinesia/hypokinesia
  – Slowness of initiation of voluntary movement with progressive reduction in speed and amplitude of repetitive actions

• Rigidity

• Loss of postural reflexes
  – Generally occurs later in disease
Clinical Diagnosis

• Presence of cardinal motor features.
  • Early symptoms are often unrecognized as early PD until the motor symptoms develop.

• Characteristics of symptom onset and progression.

• Response to levodopa (dopamine replacement).

• Lack of features suggesting an alternative diagnosis.
  • There are many Parkinson disease mimics.
<table>
<thead>
<tr>
<th>Motor Symptoms</th>
<th>Non-motor Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tremor, bradykinesia, rigidity, postural instability</td>
<td>Cognitive symptoms: executive dysfunction, bradyphrenia, tip-of-the-tongue (word finding) phenomenon, hallucinations</td>
</tr>
<tr>
<td>Hypomimia, dysarthria, dysphagia, sialorrhoea</td>
<td>Psychiatric symptoms: depression, anxiety, apathy, anhedonia, fatigue, impulse control disorder</td>
</tr>
<tr>
<td>Decreased arm swing, shuffling gait, festination, difficulty arising from chair and turning in bed</td>
<td>Sensory symptoms: anosmia, ageusia, pain, paresthesias, abnormal eye movements – difficulty reading, defective eye-hand coordination, visual spatial dysfunction, impaired color discrimination</td>
</tr>
<tr>
<td>Micrographia, cutting food, feeding, hygiene, slow activities of daily living</td>
<td>Dysautonomia: orthostatic hypotension, constipation, urinary and sexual dysfunction, abnormal sweating, seborrhoea</td>
</tr>
<tr>
<td>Glabellar reflex, blepharospasm, dystonia, striatal deformity, scoliosis, camptocormia</td>
<td>Sleep disorders: REM behavior disorder, vivid dreams, daytime drowsiness, sleep fragmentation, restless legs syndrome</td>
</tr>
</tbody>
</table>

Adapted from Jankovic 2007
Frequent Concerns

- Poorly controlled tremor
- Wearing off of medications before next dose
- Dyskinesias
- Falls/near falls
- Orthostatic hypotension (leading to falls)
- Cognitive impairment
- Anxiety
- Pain (often present, but not often mentioned)
Medication Choices

• Degree of disability
• Age of the patient
• Most bothersome symptoms
• Other medical conditions
• Side effect profile
• Risk of medication induced motor fluctuations
• Cost
Pharmacological Treatment
Motor Symptoms

• Dopamine replacement
  • Levodopa/Carbidopa (Sinemet)
• Dopamine agonists
  • Pramipexole (Mirapex)
  • Ropirinole (Requip)
  • Rotigotine (Neupro)*
  • Bromocriptine (Parlodel)
  • Apomorphine (Apokyn)

• COMT Inhibitors
  • Entacapone (Comtan)
  • Tolcapone (Tasmar)

• MAO B Inhibitors
  • Selegiline (Eldepryl and Zelapar)
  • Rasagiline (Azilect)

• Anticholinergics
  • Trihexyphenidyl (Artane)
  • Benztropine (Cogentin)

• Increased dopamine release and decreased reuptake + NMDA receptor blockade
  • Amantadine (Symmetrel)
Pharmacological Treatment

COMT = catechol O-methyltransferase, MAO = monoamine oxidase
Deep Brain Stimulation (DBS)

• Electrodes implanted in the subthalamic nucleus (STN) or globus pallidus internus (GPi)

• Leads are tunneled under the skin and connected to a neurostimulator placed under the clavicle.

• Hand held programmer used to adjust stimulation parameters.

• Patients have limited control.

• High-frequency stimulation used for “neuromodulation”
  • Mechanism of action poorly understood.
  • Probably decreases the excessive output of the basal ganglia upon the thalamus and allows the thalamus to excite the cortex.
DBS Indications

- Advanced PD (?)
- Severe medically “refractory” tremor
- Medication-induced complications impacting quality of life
- Levodopa responsive impairments
  - Except tremor
- Cognitively intact
- Absence of significant or uncontrolled psychiatric problems
- Realistic expectations
DBS Outcomes

• Increased “on time”

• Decreased rigidity, bradykinesia, akinesia and tremor

• Decreased medication use and medication-induced dyskinesia

• Improved quality of sleep and total sleep time

• Decreased pain???
DBS Outcomes

• Variable effect upon postural instability and speech impairment – can be worse!!!!!

• Possible cognitive decline - temporary or permanent

• Depression and anxiety may increase if dopaminergic medications are significantly reduced

• Impulse control problems

• Significant weight gain
Restorative Surgery

- Experimental
- Gene transfer
- Stem cell transplantation
Exercise

• Possible neuroprotective effects - particularly high intensity aerobic activity.
  • Possible pro-degenerative effects of inactivity

• Management of PD motor symptoms.
  • Ex. Tremor, rigidity, bradykinesia

• Management of PD nonmotor symptoms.
  • Ex. Depression, anxiety, sleep dysregulation, pain
Skilled Therapies

• Improve strength and activity tolerance

• Teach “tricks” for overcoming or adapting to motor limitations

• Provide education patient and family on strategies to accomplish activities of daily living (ADLs)

• Access appropriate adaptive equipment and orthotics
Aerobic Training for PD

- Treadmill training is associated with:
  - Improved overall aerobic conditioning

- Decreased energy expenditure during walking

- Improved overground gait measures, including increased speed and stride length
Aerobic Training for PD

- Body Weight Supported Treadmill:
  - Increased speed
  - High repetition
  - Active engagement
  - Sensory experience of more normal gait mechanics
  - Multisensory cues
  - Task-specific training
Aerobic Training for PD

- Cycling:
  - Improved aerobic conditioning
  - Forced-cycling at a high pedaling rate is associated with:
    - Off medications improvements in tremor, rigidity and bradykinesia
    - Improved upper extremity function
Resistance Training

- Evidence for primary weakness, in addition to deconditioning.
- The weakness may contribute to postural instability.
- Weakness + slowness may also contribute to difficulties with sit-stand transfers, gait and stair climbing.
Resistance Training

• Progressive resistance exercises are safe, well tolerated and are associated with:
  • Increased strength in target muscles
  • Improved sit-stand transfers
  • Improved balance
  • Improved gait velocity and stride length
Spinal Flexibility Programs

- Spinal range of motion is decreased even in early PD.

- Poor spinal flexibility is associated with decreased balance.

- Spinal flexibility can be improved with targeted exercise.

- Interventions include:
  - Schenkman’s Axial Mobility Program, NPF Fitness Counts Program, PD yoga classes, Tai Chi, Quigong, Dance
Rhythmic Cueing

• Use of external auditory stimuli to facilitate movement initiation and continuation.

• Rhythmic pacing alone (metronomic) or embedded.

• Postulated to “circumvent disordered circuitry and entrain rhythmic motor responses”, perhaps via cerebellar connections to premotor cortex.
Rhythmical Cueing

• Associated with rapid improvements:
  • Increased gait velocity and stride length
  • Increased step cadence (number of steps/time)
  • Improved lower extremity muscle activation patterns
  • Improved postural instability and gait scores on UPDRS
  • Modest decrease in freezing of gait (FOG) severity
Visual Cueing

- Use of lines drawn \( \perp \) to direction of gait to increase gait speed and step length.

- U-Step laser cane or laser walker for FOG.
Dance

- Combination of rhythmic, visual and tactile cueing
- Social contact
- Emotional response

Mark Morris Dance Group
Dance

• Hackney 2007:
  • Twenty 1 hour sessions of Argentine Tango over 13 weeks (n=9) v. structured strength and flexibility program (n=10).
  
• Both groups showed significant improvements in UPDRS III, a trend toward decreased FOG, and slight improvement in gait velocity.

• Tango group showed additional improvements in Berg Balance Test and a trend toward improvement in the Timed Up and Go Test.
Dance

• Hackney 2009
  • Twenty 1 hour sessions of Argentine Tango (n=14) v. twenty 1 hour sessions of Fox Trot over 13 weeks (n=17) v. no intervention (n=17).

• Both dance groups showed significant improvements in the Berg Balance Scale, 6-minute walk distance, and backward stride length.
  • No improvement seen in controls

• Tango group showed improvement in FOG
  • No improvement in Fox Trot group and worsening in controls

• Controls showed sign worsening on UPDRSIII
Amplitude-Specific Training

- Bradykinesia and hypokinesia are cardinal features of PD.

- Faulty sensorimotor processing leads to reduced gain in the motor command for selecting and reinforcing movement amplitude.
  - Part of the problem may be related to abnormal perception of the energy cost of the movement
Amplitude-Specific Training

• LVST/LOUD (Lee Silverman Voice Treatment)
  • Consciously increasing volume

• Modification of speech patterns
  • Ex. use of shorter sentences

• Breathing exercises

• Range-of-motion exercises for the muscles of speech

• Significant long-term (2 years) improvements in vocal loudness and speech intelligibility

• Transfer of improvements from LVST to swallow and facial expression
Amplitude-Specific Training

• Training BIG
  • Based upon observation that speed increases with increased movement amplitude.
  
  • Use of repetitive large amplitude full body movements, with directed attention to the feeling of “moving big”.
  
• May be most effective for earlier stage of PD.
  • Possibly due to increasing impairment of directed attention in later stages.
  
• Transfer of cued repetitive movement to un-cued functional tasks (reaching and gait) observed.
References


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