Gait disorders in clinical practice

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handout

additional videos and photos will be shown in the presentation
Disorders of gait and balance: basic definitions

Bipedal walking: evolitional human motor skill, parallels the development of the frontal lobe

• **Balance:** the ability to stand up and remain upright against the force of gravity (equilibrium)
• **Locomotion:** rhythmic stepping movements to advance in space (gait)
• **Adaptability** to the environment

Disorders of gait and balance:
• among the most common problems in neurologic patients
• increasing prevalence with age
• limit QoL, most serious consequence: *Falls*
Disorders of gait and balance: clinical examination

History of gait and balance disorders
- quality of gait, activity levels, walking perimeter
- falls (frequency, circumstances, direction)

Associated symptoms and signs
- dizziness, urinary symptoms
- other neurologic or systemic symptoms
- depression, cognitive dysfunction

Testing of balance and gait
- simple observation
- gait/balance tasks
- questionnaires and scales
- laboratory measurement of gait parameters
## Basic patterns of gait disorders

<table>
<thead>
<tr>
<th>Parameter Affected</th>
<th>Abnormal Pattern of Gait</th>
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<tbody>
<tr>
<td>Muscle strength</td>
<td>Weakness: paretic gait</td>
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<tr>
<td>Base width</td>
<td>Broad base: ataxic gait</td>
</tr>
<tr>
<td>Stride length</td>
<td>Stiff gait</td>
</tr>
<tr>
<td>Cadence of stepping</td>
<td>Fluidity of movement</td>
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<tr>
<td>Fluidity of movement</td>
<td>Freezing of gait</td>
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<tr>
<td>Gait initiation and maintenance</td>
<td>„Bizarre“ gaits</td>
</tr>
<tr>
<td>Unclassifiable</td>
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</tbody>
</table>
Classification of gait disorders

phenomenologic (patterns of gait)

- antalgic
- weakness
- ataxic
- stiff
- freezing
- „bizarre“
Classification of gait disorders

phenomenologic (patterns of gait)
- antalgic
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- “bizarre”

anatomic (levels of involvement)
- higher
- middle
- lower

disease (etiology)
- genetic
- autoimmune
- degenerative
- metabolic
- vascular
- trauma

Nutt 1993, Verghese 2006, Snijders 2007, Giladi 2013, ...
## Classification of gait disorders: anatomic levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Anatomic</th>
<th>Functional subsystem</th>
</tr>
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<tbody>
<tr>
<td><strong>Higher</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cortex</td>
<td>cognition, attention, insight (conscious)</td>
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<tr>
<td></td>
<td>subcortical white matter</td>
<td>synergy selection and adaptation to circumstances (unconscious)</td>
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<tr>
<td><strong>Middle</strong></td>
<td>basal ganglia</td>
<td>perception/orientation (body spatial maps)</td>
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<tr>
<td></td>
<td>thalamus</td>
<td></td>
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<tr>
<td></td>
<td>cerebellum</td>
<td>force scaling (modulation of motor patterns)</td>
</tr>
<tr>
<td></td>
<td>brainstem</td>
<td></td>
</tr>
<tr>
<td></td>
<td>spinal cord tracts</td>
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<tr>
<td><strong>Lower</strong></td>
<td>periph. sensory nerve</td>
<td>locomotor synergies</td>
</tr>
<tr>
<td></td>
<td>lower motor neuron</td>
<td>primary afferent input</td>
</tr>
<tr>
<td></td>
<td>muscle and nm junction</td>
<td>force production</td>
</tr>
</tbody>
</table>

Nutt 2001, adapted
Anatomo-clinical classification

Lower level disorders of gait

- myopathies
- neuropathies and radiculopathies
- lower motor neuron disease
- sensory disorders
  - visual
  - vestibular
  - proprioceptive

- bilateral peroneal neuropathy
- distal weakness, foot drop, steppage
Anatomo-clinical classification

Middle level gait disorders

**parkinsonian** (hypokinetic)
- + PIGD phenotype

**dyskinetic**
- chorea
- dystonia
- myoclonus
- tics

**cerebellar** (ataxic)

**corticospinal** (spastic)
- hemiparetic
- paraparetic
Anatomo-clinical classification

Middle level gait disorders

parkinsonian (hypokinetiс)

- short steps
- shuffling
- festination
- slow turning
- flexed posture
- reduced arm swing

Parkinson disease – early onset
Anatomo-clinical classification

Middle level gait disorders

**parkinsonian**
(hypokinetisch)

- PIGD phenotype
- Predominant involvement of posture and gait
- Poor response to treatment
- High risk of dementia
- Frequent falls and injuries

Gait disorders and falls are major problems in late stage PD
- Start hesitation in 90%, freezing in 81% pats.
- Falls in 81% pats. (mean onset at 11.5 years)

*Hely 2005*
Anatomo-clinical classification
Middle level gait disorders

Huntington’s disease

dyskinetic
- chorea
- dystonia
- myoclonus
- tics

dyskinesia interfering with gait
broad base
variable stride length and cadence
Anatomo-clinical classification
Middle level gait disorders

BROAD BASED GAIT

- instability
- freely-flowing unsteady steps
- erratic variance in rhythm and amplitude
- action tremor + titubation

multiple sclerosis

cerebellar
(ataxic)
Anatomo-clinical classification
Middle level gait disorders

cerebral palsy

corticospinal (spastic)
• hemiparetic
• paraparetic

STIFF GAIT
spasticity
circumduction, scissoring
Anatomo-clinical classification
Higher level gait disorders

1) Freezing of gait (FOG)
   - FOG in PD
   - primary progressive freezing of gait

2) Frontal (apraxia of) gait
   - cautious gait, senile gait, lower body parkinsonism, gait apraxia, ...
   - combining signs of ataxia, parkinsonism, FOG
   - bilateral involvement of frontal lobes = cortical-basal ganglia-thalamo-cortical loops
Higher level gait disorders

FOG in Parkinson disease

FOG leads to falls

FOG + STIFF GAIT
start hesitation
sudden stops
motor blocks
sensory tricks

common cause of falls in PD
Higher level gait disorders
FOG in Parkinson disease

effect of sensory tricks

external pacing cues
  (including emotions)
triggering alternative
  motor programs
helpful in rehabilitation
Higher level gait disorders

Primary progressive FOG

FOG more common in APS than in PD: 53% of PSP, 54% MSA, 54% DLB, 25% CBD

50% of vascular parkinsonism cases

FOG is associated with executive dysfunction

Syndromes dominated by FOG: “gait ignition failure, pure akinesia, primary progressive freezing of gait”

Higher level gait disorders

Frontal (apraxia of) gait

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Higher level gait disorders

Frontal gait

- increased variability of gait parameters, greatly influenced by the environment and emotion
- narrow or widened base
- stooped or upright posture with flexed hips or knees
- reduced gait speed and stride length
- often associated with FOG, hypokinesia/rigidity, frontal release signs, cognitive deficits - executive dysfunction
- absent or inappropriate rescue reactions, often falls and/or fear of falling
- various etiologies: arteriosclerotic encephalopathy („vascular parkinsonism“), normal pressure hydrocephalus, etc.
Higher level gait disorders

Frontal gait

FRONTAL GAIT + FOG
• broad base, instability
• fear of falling
• freezing of gait
• hypokinetic gait
• incontinence
• cognitive dysfunction

normal pressure hydrocephalus
Higher level gait disorders

Frontal gait

„VASCULAR PARKINSONISM“

• hypokinetic gait
• FOG
• preserved arm swing
• no hypokinesia of hands and feet
• no effect of L-DOPA

subcortical arteriosclerotic encephalopathy
Falls

• causes and mechanisms (careful history taking!)
  – relative to the primary disease
    • postural instability (e.g. as part of PD symptoms)
    • freezing + (retro)pulsion
    • orthostatic hypotension
  – unspecific causes, comorbidity in the elderly
    • astasia-abasia
    • impairment of vision
    • cardiogenic syncopes

• prevention
  – modifications in the environment and regime
  – physical activity, physiotherapy, mechanical devices
Summary

DISORDERS OF GAIT AND FALLS
• are common in neurologic patients and in the elderly
• substantially limit quality of life

OBSERVATION
• key approach to diagnosis of gait disorders

PHENOMENOLOGIC CLASSIFICATION
• to distinguish basic patterns of abnormal gait
• always consider compensation - fall risk - cognitive dysfunction - continuous vs. episodic disorder

SYSTEM (ANATOMIC) CLASSIFICATION
• lower – middle – higher level gait disorders
• to understand pathophysiology and to recognize etiology
References
Nutt JG, Marsden CD, Thompson PD. Human walking and higher level gait disorders, particularly in the elderly. Neurology 1993;43:268–79.

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