Treadmill walking with body weight support

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Mobilisation should be repetitive, specific to everyday tasks, and aim for high intensity (Langhorne et al, 2009)

Early mobilisation important (Cumming et al, 2011)

A main goal during rehabilitation is to recover walking ability (Tilson et al, 2008)

Majority of time during physiotherapy is spent practicing walking (Jette et al, 2005; Latham et al, 2005)
Correction and compensation
Neurophysiologic focus
Learning and task specificity
Physical activity
Fitness
Technical developments

ECLECTIC WAY OF THINKING ADAPTED TO THE INDIVIDUAL

Walking
Walking to cross a road
Walking in a rehabilitation setting
Walking with support
Walking to exercise

Why is walking so important?
To get from A to B
ADL
Enables a person to be independent
Giving new experiences
Enables a person to be social
Reduce sedentary behavior
Enable physical activity

ECLECTIC WAY OF THINKING ADAPTED TO THE INDIVIDUAL

Based on Pollock et al, 2007
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Indirect effects prior to stroke

Old age
Physical inactivity
Chronic disease
Smoking

Stroke

Direct effects of stroke

Limitations due to physical fitness
Activity limitations

Other limitations

Physical inactivity

Limited participation

Overground walking vs. treadmill training

Overground walking
- Involves walking over a regular floor surface (States et al., 2009)
- Training overground walking is the most common form of gait rehabilitation (States et al., 2009)
- Reflects a basic element of physiotherapy
- Often challenging to do with low risk, and at the same time, sufficient duration and speed
**Treadmill training**

- Enables practice of complete gait cycle
- Improves walking
- Improves strength and fitness
- Workload input and output is measurable
- Provides opportunities for speed and endurance training
- Minimizes manual handling risk

**Rationale for treadmill training**

- Task specific practice
- Soft training may start early
- Enables practice of complete gait cycle
- Provides opportunities for speed and endurance training
- Improves walking
- Provides opportunities for speed and endurance training
- Minimizes manual handling risk

**Effect of treadmill training**

- Inconclusive results about the effectiveness of treadmill training in stroke rehabilitation (Moseley et al., 2005)
  - Some studies favor treadmill training (Hess et al., 1995; Mamo et al., 1998; Patel et al., 2004; Eich et al., 2004; Honda et al., 2005; Tang et al., 2005)
  - Others have not found treadmill training superior (Kosak and Reding, 1999; Fluck et al., 2001; Franceschini et al., 2003; Aller et al., 2003; Dennis et al., 2004)
- More effective with body weight support, and most effective for independent walkers and if the goal is to increase walking speed (Moseley, 2005; Manning and Pomeroy, 2003)
Rationale for treadmill training

Enables practice of complete gait cycle
Improves walking
Improves strength and fitness
Workload input and output is measurable
Provides opportunities for speed and endurance training
Minimises manual handling risk
Gait training may start early

Based on Stokes and Stack, 2011, pg. 357

Task-specificity

- Small adaptations of tasks may result in different movement strategies (Majsak, 1996)
- Evidence that task-specific training is required to improve functional recovery (Stokes and Stack, 2011)
- Task-specific training: training or intervention which uses ordinary everyday activities which are intrinsically and/or extrinsically meaningful to the patient (Hubbard et al, 2009)

Treadmill training vs. overground walking

- New and challenging task
- Feet in contact with a moving surface
- Not moving in relation to an external frame of reference
- No variation in the surface
- Less demands on antigravity muscles when body weight support is being used
- Walking speed is more stable
Treadmill walking vs. overground walking

**Non-impaired**
- Decreased step length
- Altered gait cycle (increased swing phase)
- Altered motion of pelvis, hip, knee and ankle joints
- Altered muscle activation patterns
- Higher metabolic cost


**Patients post-stroke**
- Improved symmetry
- Altered muscle activation patterns
- Altered cadence and step length
- Higher metabolic cost


Treadmill walking with BWS vs. overground walking

- **Non-impaired:**
  - Decreased metabolic cost
    (Danielsson and Sunnerhagen, 2000)

- **Patients post-stroke:**
  - Decreased metabolic cost
    (Danielsson and Sunnerhagen, 2000)

Our research

**Non-impaired**
- Aaslund and Moe-Nilssen, 2008
  - Treadmill vs. overground:
    - Increased cadence
    - Altered acceleration over the trunk
    - Altered regularity between strides

**Patients post-stroke**
- Aaslund, Moe-Nilssen and Helbostad, 2012
  - Treadmill walking with BWS vs. overground walking
    - Tended to take longer steps and decrease cadence
    - Altered acceleration over the trunk
    - Altered regularity between strides
    - Altered symmetry between steps
Pros and cons of overground walking

**PROS**
- Always available
- No equipment necessary
- Task-specific as overground walking is part of everyday walking

**CONS**
- Difficult or impossible to manage for many patients
- May be a safety risk for patient and therapist
- Quality may be dependent on the therapists abilities to give support
- Often difficult or unpractical to walk long distances and in fast speeds

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Pros and cons of treadmill walking

**PROS**
- Facilitate taking steps and give repetitive practice
- Allows for long distances on a flat surface and with adjustable speed, and allows quantification of training and progress
- The treadmill may affect walking characteristics positively
- Easily available

**CONS**
- Difficult to secure the patient
- Walking on a moving surface without support may be too challenging
- The treadmill may affect walking characteristics negatively
- Unknown transfer to everyday walking

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Pros and cons of treadmill training with BWS

**PROS**
- Allows early start of gait rehabilitation
- Facilitate taking steps and give repetitive practice
- Allows relatively hard exercise in safe surroundings, and allows quantification of training and progress
- Affect some walking characteristics positively

**CONS**
- Expensive equipment
- Often unavailable
- Take away some of the balance aspects of walking
- Affect some walking characteristics negatively
- Unknown transfer to everyday walking
Conclusions

- There are differences in tasks between treadmill training and overground walking.
- People walk differently during treadmill training compared to overground walking.
- Effect of treadmill training and training with overground walking have not been found different in stroke rehabilitation.
- There is a need for more knowledge on how to optimise gait training.

TREADMILL WALKING WITH BODY WEIGHT SUPPORT

PhD
Background

Research questions

- How are kinematic walking characteristics affected by treadmill walking with BWS?
- Do kinematic walking characteristics familiarise during treadmill walking with BWS?
- What are the consequences of modulating walking speed and percentage of BWS during treadmill walking with BWS?

Method

- Design: Cross-sectional repeated measures design
- Instrumentation: kinematic sensor to measure acceleration
Outcome: walking characteristics

- Cadence (number of steps per minute)
- Step length (length of one step in meter or cm)
- Walk ratio (cadence divided by step length)
- Average trunk acceleration (root mean square)
- Trunk regularity (autocorrelation coefficient between strides)
- Trunk asymmetry (autocorrelation of stride minus autocorrelation of step)

Trunk regularity

Regularity

Asymmetry

Step

Procedure

Paper 1

Overground walking

Overground walking with harness

Familiarisation

Treadmill walking

Treadmill walking with harness

Treadmill walking with dynamic BWS

Treadmill walking with static BWS

Paper 2 and 3

Overground walking

Familiarisation

Treadmill walking with 40 N BWS

Treadmill walking with 40 N BWS

Findings

The treadmill, the harness and the 30 percent body weight support influenced the walking characteristics significantly.

- The influence of the treadmill
  - Increased cadence, more forward lean of the trunk, more vertical (V) trunk acceleration, and less regular steps in the anteroposterior (AP) direction.

- The influence of the harness
  - Decreased V trunk acceleration.

- The influence of the 30 % body weight support
  - Less trunk acceleration in all directions, less regular steps in the AP and the V direction, and more regular steps in the mediolateral (ML) direction.

Findings

- The patients obtained a relatively stable gait pattern within the first 5 minutes, and the majority of the familiarisation happened during the first 3 minutes.

- In particular cadence, step length and trunk acceleration stabilised fast.

Paper 2

Familiarisation to body weight supported treadmill training for patients post-stroke


Findings

- The patients obtained a relatively stable gait pattern within the first 5 minutes, and the majority of the familiarisation happened during the first 3 minutes.

- In particular cadence, step length and trunk acceleration stabilised fast.
Findings

- Treadmill with body weight support vs. overground
  - Step length and walk ratio tended to be more normalized
  - Decreased trunk acceleration in all directions
  - ML asymmetry decreased, but V asymmetry increased
  - Increased ML regularity, but decreased regularity in the AP and V direction

- 20% vs. 40% body weight support
  - Less AP and V trunk acceleration
  - Increased ML regularity
  - Increased AP and ML asymmetry

- Increasing walking speed
  - Cadence, step length, trunk acceleration, and V regularity increased
  - ML regularity and ML asymmetry decreased
  - Walk ratio, and AP and V asymmetry were not different

Conclusions

- Walking on a treadmill with body weight support and walking overground is different both for non-impaired and for patients post-stroke

- For patients post-stroke, the gait pattern during body weight supported treadmill walking did not aggravate, but tended to be more normalized

- Modulating walking speed influenced walking characteristics more than modulating proportion of body weight support

- Increasing walking speed had a tendency to influence the walking characteristics positively
Clinical implications

- Clinical choices during body weight supported treadmill training influences the gait pattern during training
- Body weight supported treadmill training can be a good alternative for ambulatory patients post-stroke
- BUT, we do not know how transferable the gait pattern during body weight supported treadmill training is to overground "normal" walking

A new interest...

Walking speed necessary to cross a pedestrian-crossing on green light is in Norway is 1.2 m/s (Statens vegvesen)

Walking speed for the patients in the PhD study

<table>
<thead>
<tr>
<th>Speed</th>
<th>m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td>0.50</td>
</tr>
<tr>
<td>Preferred</td>
<td>0.68</td>
</tr>
<tr>
<td>Fast</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Only 11 of our 56 patients had a maximal walking speed that were 1.2 m/s or more
Relevance walking speed

- A vital sign similar to temperature, respiration rate and blood pressure (Fritz og Lusardi, 2009; Studenski, 2009)
- Represents general health (Fritz og Lusardi, 2009; Studenski, 2009)
- Good predictor - for example for survival, disability, admission to hospital, discharge destination, dementia and falls (Studenski, 2009)
- Simple, quick and cheap to use as a measure!!

Red flag: Walking speed < 0.6 m/s

Yellow flag: Walking speed between 0.6 – 1 m/s

Fritz and Lusardi (2009), Abellan van Kan et al (2009), Studenski (2009)
THANK YOU...

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