The influence of walking aids on balance and gait recovery following stroke

Maastricht Feb 2017

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Content

Motor learning and neuroplasticity
Why walking aids?
Basic science & clinical relevance
Experimental results
Take home messages?
What factors are important for motor learning?

In groups of 2 or 3 discuss the factors which need to be considered when trying to increase motor learning

- High dosage practice (amount and/or intensity)
- Task-specific (but varied) training
- Meaningful or motivating tasks
Neuroplasticity

Neuroplasticity is the substrate for motor learning

Learning or re-learning motor skills causes and is a result of neuroplasticity
Dose? Practice makes perfect

Pellet retrieval - approx **300** repetitions per session with **2 sessions** per day are necessary to generate neuroplasticity

(Nudo 1996)

Rats reaching 400 times a day increase synapse numbers in the motor cortex.

Rats that practice 60 times a day do not.

(Luke et al., 2004)

Typical therapy session average number of functional upper extremity repetitions **32**

(Birkenmeier et al. 2010)
Practice over time increases the chance the gains will be enduring. Changes in rats are seen over weeks not days. Changes can slowly disappear if not practised.

(Luke et al., 2004)
Motivation, challenge and task relevance influence plasticity

No cortical map changes through repetition only – rather through meaningful task and challenging learning: Monkeys required to extract food from small wells versus extracting food from large wells

(Nudo 1996)
Which new developments in neurorehabilitation are based on these concepts?

...very valuable and we can learn from this research.

...but we also need to continue to research more common and cheaper treatments.
Why are these points relevant for walking aids?
Prevalence of prescription

Which ones do you use in your practice and how commonly are they prescribed following stroke?

It has been estimated that two thirds of people with stroke use a cane (J Safety Res 2015)

A Global Burden of Stroke Study (2014) estimated that stroke survivors worldwide number 33 million. (Feigin VL et al. Lancet)

A “Medicare Current Beneficiary Survey” (2005) indicated that of chronic neurological patients 20.9% used a cane and 23.2% used a rollator (Wolff JL et al. Health Aff)
Therefore lots of research?

22 studies look at the immediate effects of walking aids in cross-sectional designs on biomechanical aspects of gait. Generally have positive conclusions.

**Guidelines**

“in the opinion of the guideline development team, the use of walking-aids is beneficial to patients with a stroke in terms of safety, independence, and efficiency of walking, as well as confidence.”
Prospective research: 3 *observational* studies

Stroke patients using canes long-term have **lower balance scores and less social participation** than those without (Hamzat et al. 2008)

**Balance and falls efficacy are reduced** in stroke patients who regularly use walking aids (Kim et al. 2015)

**Significantly reduced sensorimotor function of the cane holding hand** compared to non-cane hand (Son et al. 2012)
Why an immediate improvement but long term deterioration?
Cortical plasticity

- Factors effecting

Central Pattern Generators & spinal plasticity

- Afferent input
- Influence of walking aids
More activity on the hemiplegic side increases ipsilesional plasticity and improves function.

Enziger C et al. 2008 Stroke fMRI Study
Movement-dependent stroke recovery: a systematic review and metaanalysis of TMS and fMRI evidence.

ORIGINAL RESEARCH

Walking with a four wheeled walker (rollator) significantly reduces EMG lower-limb muscle activity in healthy subjects

Zorica Suica, PT, MSc a,c,d,e, Jacqueline Romkes, PhD b, Amir Tal, PT, PhD c, Clare Maguire, PT, MSc, cand. PhD d,e

Clinical Rehabilitation 2010; 24: 37-45

Hip abductor control in walking following stroke – the immediate effect of canes, taping and TheraTogs on gait

Clare Maguire Bildungszentrum Gesundheit Basel Stadt, Studiengang Physiotherapie, Munchenstein, Switzerland, Judith M Sieben Department of Anatomy, Faculty of Health, Medicine and Life Sciences, Maastricht University, The Netherlands, Matthias Frank Department of Neurological Rehabilitation, Felix Platter Hospital, Basel and Jacqueline Romkes Laboratory for Movement Analysis, University Children’s Hospital, Basel, Switzerland

Received 2nd March 2003; returned for revisions 25th May 2009; revised manuscript accepted 16th June 2009.
Important afferent input in healthy gait for normal CPG activity

1. Four limb CPG coupling to reduce cognitive demands

2. Normal hip joint loading

3. Hip movement particularly hip extension to trigger transition to swing phase

4. Normal muscle activity levels and loading

5. Cutaneous inputs particularly to signal when adaptations are necessary for obstacle avoidance or on uneven surfaces
Alterations in afferent information when using a cane which may influence motor output:

1. Arms decoupled from four-limb CPG control requiring increased cognitive resources.

2. Hip joint loading reduced on opposite side to cane use (hemiplegic hip).

3. N.A.

4. Muscle activity reduced on opposite side to cane use (hemiplegic muscles).

5. Collisions between cane and foot may give confusing cutaneous inputs.

Alterations in afferent information when a rollator which may influence motor output:

1. Arms decoupled from four-limb CPG control requiring increased cognitive resources.

2. Increased loading at the arms reduces loading at the hips.

3. Hip extension range of motion reduced, potentially influencing transition to swing phase.

4. Muscle activation levels reduced.

5. Collisions between wheels and feet may give confusing cutaneous inputs.
Consider:

What influence may these walking aids have on balance reactions?
-discuss in plenum

If you could design an optimal „dream“ walking aid what would it be?
What characteristics should it have?
What characteristics would you avoid?
Hypotheses

**Impact on motor learning:**

Walking aids have a specific and potentially significant impact on balance and gait recovery in chronic stroke patients.

- Dosage
- Varied practice
- Motivation

**Impact on balance**

Canes and rollators:

- Require the use of hands (increased cognitive resources)
- Inhibit the normal use of ankle, hip and “change of support” balance strategies

**Impact on spinal and cortical plasticity**

Canes and rollators:

- Provide abnormal afferent input to spinal circuits – affecting motor output and spinal circuitry
- Reduce hemiplegic muscle activity thus supporting contralesional cortical plasticity (associated with reduced function)
Therefore:

Walking aids which provide:

- normal afferent input
- do not reduce activity
- do not require the use of hands

may be more effective than canes in post-stroke rehabilitation
TheraTogs
The effect of Thera Togs on walking ability and balance in cane using chronic stroke patients (minimum 6 months post stroke) 
A multiple single-subject ABC experiment

- 4 chronic stroke patients (minimum 6 months post-stroke) 
- Cane users 
- No cognitive impairments (MMS 22 or above) 
- Low risk of falling (Berg Balance Scale 14 or above)
## Methods

A replicated single case experimental study

<table>
<thead>
<tr>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C Follow-up</th>
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<tbody>
<tr>
<td>cane walking as usual 9-12 weeks</td>
<td>TheraTogs walking &amp; reduced cane walking 9-16 weeks</td>
<td>Patient defined either: cane walking, TheraTogs, no aids 9-11 weeks</td>
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### Time in weeks

- Weekly measurements of Functional Gait Assessment and Trunk Sway when walking
OK but what about....

.....levels of activity?

...aims of rehabilitation – restoration or compensation?
Take home messages

- Walking aids which provide normal afferent feedback and do not reduce muscle activity are more effective than canes in gait and balance rehabilitation (for chronic stroke patients)

- Prescribe with care and with clear treatment aims! (restoration or compensation?)

- Need for further prospective studies (observational and experimental) to enable evidence based prescription of walking aids

- It may be necessary to revise the guidelines


