A Review of Bilateral Arm Movement Approach for Upper Extremities Treatments in Stroke

雙側上肢動作對於中風病患的上肢康復治療之探討

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Introduction

Hemiparetic upper extremity recovery in stroke

• 60% of the chronic stroke patients have motor dysfunction in their upper extremity (上肢的動作功能缺失)
• 5% of them demonstrate complete functional recovery (完全的功能恢復) (Dobkin, 2005)
• The impairment of upper extremity affects
  – Gross motor (大動作)
  – Fine motor (細動作)
• Bilateral upper limbs movement (雙側上肢動作) is essential to finish the tasks in daily living.
  – Grooming task (盥洗), bilateral movements are needed to dry the towel.

Hemiparetic upper extremity recovery in stroke

• Normal subjects
  – coordinate the movements of the upper limbs (協調) very well
• Stroke patients
  – Appear obvious bilateral motor dysfunction (雙側動作缺失) caused by imbalanced cortical excitation and inhibition (大腦皮質的刺激和抑制之間的不平衡) (Mudie & Matyas, 2000)

An overview of upper extremities treatment approaches in stroke

• Constraint induced movement therapy (局限誘發療法)
  – Forced to use their affected upper extremity (強迫使用患肢) to perform different kind of tasks, in order to facilitate motor recovery of the affected arm (Sterr, Szarek, Shen, & Freivogel, 2006; Taub & Uswatte, 2003).
  – only apply to the patients who have mild impairment in upper extremity (輕微缺失)
• Using therapeutic device such as robotics
  – train independently
  – mass repetitive movement practice

A comparison between the Conventional Bilateral Treatment (傳統雙側治療) and the Bilateral Arm Movement Approaches (雙側上肢動作訓練)
Conventional bilateral treatment

- Brunnstrom’s movement therapy (Sawner & LaVigne, 1992)
  - no voluntary + spasticity
  - associated reaction (聯合反應) → flexor & extensor tone → voluntary movement (自主動作)
- Neurodevelopmental Treatment (NDT) (Davies, 1993)
  - clasped hands → inhibit the spastic pattern + experience the normal sensations of the functional movements (體驗正常動作的感覺)

Bilateral Arm Movement Approach

- New prospective on bilateral movement training.
  - inter-limb coupling (肢體間的聯結) in stroke patients
  - applying bilateral arm movement training could promote the function of upper extremity.

What bilateral arm movement emphasizes?

- Two upper extremities
- Simultaneously (同時)
  - initiate and perform the bilateral task at the same time
- symmetrical movements (對稱性動作)
  - similar spatiotemporal trajectories
- separate from each other (雙側上肢分開動作)
- assisted / non-assisted
  - Device: Robotic arms (機械手)
  - Sensory feedbacks: auditory curing (聲音提示)
  - and neuromuscular stimulations

Rationale behind the Bilateral Arm Movement Approach (雙側上肢動作訓練原理)

Interhemispheric inhibition (大腦間的抑制)

- minimize interferences in each limb and prevent mirror movement of the contralateral arm

Interhemispheric disinhibition

- During bilateral movement
  - motor organization occurs in both hemispheres
  - allocate less attention or energy
    - couple the limbs → as one functional unit (連結兩側肢體成一功能單位) (Mudie & Matyas, 2000)
  - undamaged hemisphere → damaged hemisphere and prompt the neural plasticity (誘發神經重塑) (Carson, 2005)
**Interhemispheric disinhibition**

- Brain region related to Bilateral arm movt.
  (Carson, 2005)
  - primary motor cortex (主要運動皮質區)
  - supplementary motor area (補充運動區)
  - non-primary motor areas (非主要運動皮質區)
  - basal ganglia (基底核)
  - Cerebellum (小腦)

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**Review of literature related to bilateral arm movement approach**

(雙側上肢動作法的文獻回顧)

**Aim of review**

- Past review
  - 2006 (articles were published until the year 2005)
  - bilateral arm movement training is effective for sub-acute and chronic stroke patients
- bilateral arm movement training has been used increasingly in these recent years
  - especially for the bilateral robotic therapy

**Method of search strategy**

- MEDLINE & PubMed
  - keywords: stroke or CVA, bilateral, hemiplegic, arm or upper limb or upper extremity training and robotic therapy
- 29 articles
  - Excluded 13 articles
  - Included 16 articles

**Effectiveness of different Bilateral Arm Movement Approaches**

- Up to present
  - miscellaneous trainings for bilateral arm movement approach → different training protocols.
- Based on the level of assistance (協助的程度) or auxiliary sensory feedback (輔助性感覺刺激)
  - categorized in to training without facilitation and with facilitation.

**Pure bilateral tasks with no facilitations**

<table>
<thead>
<tr>
<th>Study</th>
<th>N. groups</th>
<th>Training protocol</th>
<th>Length of training period</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mudie &amp; Matyas, 2000</td>
<td>1x1</td>
<td>Block placement and simulated drinking</td>
<td>N/A</td>
<td>Kinematic analysis</td>
<td>All participants demonstrated highly significant improvement in movement pattern.</td>
</tr>
<tr>
<td>Lewis &amp; Byblow, 2004</td>
<td>1x1</td>
<td>3 upper extremities tasks (eg. Block placement, peg activity, simulated drinking)</td>
<td>33 trials 4 weeks (20 sessions)</td>
<td>FMA</td>
<td>No FMA score difference between unilateral and bilateral training</td>
</tr>
<tr>
<td>Summers et al., 2007</td>
<td>1x2</td>
<td>Dowel placement task</td>
<td>50 trials 6 days</td>
<td>MAS, Kinematic analysis</td>
<td>5 out of 12 participants in bilateral training group improved in MAS score. The difference between unilateral and bilateral group reached significant level.</td>
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</table>
Discussion

A comparison of different types of treatment approaches

<table>
<thead>
<tr>
<th>Without facilitation</th>
<th>With facilitation</th>
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<tbody>
<tr>
<td>Pure bilateral tasks training</td>
<td>BATRAC Bilateral tasks with ANS</td>
</tr>
<tr>
<td>Bilateral tasks with Robot</td>
<td>Bilateral tasks with Robot</td>
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<tr>
<td>Target patients</td>
<td>Chronic (mild motor impairment)</td>
</tr>
<tr>
<td>Subacute to Chronic (voluntary movement in paretic arm)</td>
<td></td>
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<tr>
<td>Total Training duration</td>
<td>Varied 15–18hr 6 hr 3.75–24 hr</td>
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<tr>
<td>Pure bilateral tasks training</td>
<td>BATRAC</td>
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**Advantages**
- Generalization
- Provide feedback, constant frequency
- Provide feedback
- High intensity of therapy
- Saving manpower, Flexible protocol

**Disadvantages**
- Limited target group
- Limited target group
- Limited target group
- Apparent gains occur only at the early phase of training
- Expensive

**Implications in future rehabilitation for upper extremity in stroke**

- Bilateral arm movement
  - lower motor function
  - assistance is provided
- Coordination movement
  - voluntary movement (自主動作) achieved
  - enhance the functional use in daily life.

**References**


**Conclusion**

- A systemic review and several studies showed improvement on motor performance, muscle strength and spasticity in affected upper extremity.
- There are still some studies could not find any additional improvement after bilateral arm training.
- Prolonged treatment effect is not clear.
- Further study with RCT is required to assess its effectiveness and find out the most effective protocol.

**References**


