Clinical tool for assessment of selective voluntary motor control in patients with spastic cerebral palsy

American Academy of Cerebral Palsy and Developmental Medicine
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Disclosure Information
AACPDM 71st Annual Meeting | September 13-16, 2017

Speaker Names: Marcia Greenberg, Kristin Krosschell, Loretta Staudt, Theresa Moulton

Disclosure of Relevant Financial Relationships
I have no financial relationships to disclose.

Disclosure of Off-Label and/or investigative uses:
I will not discuss off label use and/or investigational use in my presentation
Clinical Tools For Assessment of Selective Voluntary Motor Control In Patients with Spastic Cerebral Palsy

SCALE: Selective Control Assessment of the Lower Extremity
&TASC: Test of Arm Selective Control

Presenters

SCALE
Marcia B. Greenberg MS, PT, KEMG
Loretta A. Staudt MS, PT
Center for Cerebral Palsy at UCLA

TASC
Kristin J. Krosschell, PT, DPT, MA, PCS
Theresa Sukal-Moulton, PT, DPT, PhD
Northwestern University

Spastic Cerebral Palsy Multiple Impairments
Selective Voluntary Motor Control (SVMC)

The ability to perform isolated joint movements upon request, without using mass flexor/extensor patterns and without undesired movement at other joints, such as mirroring.

Overview of SVMC

- Results from damage to the corticospinal tracts – pathways for voluntary movement responsible for fine control
- Important for treatment planning and surgical decision making
- While only assessed in patient’s with spastic CP, it has a separate mechanism from spasticity
- Used as screening for selective posterior rhizotomy

Corticospinal Tracts

- Commonly injured in CP
- White matter damage of prematurity (e.g. PVL)
- Responsible for voluntary movement
  - Force
  - Speed
  - Timing
  - Pattern
Tools

- Lower extremity – SCALE
  - Developed at UCLA (Fowler et al 2009)
  - Hip, knee, ankle, subtalar joint, toes
- Upper extremity – TASC
  - Developed at Northwestern University
  - Shoulder, elbow, forearm, wrist, fingers, thumb
- Both ask patient to perform selective movement task
- Similar administration and scoring

Scoring

- SVMC at each joint is graded as:
  - Normal = 2 points
  - Unable/Absent = 0 points
  - Impaired = anything else = 1 point
- SCALE
  - 5 joints for a maximum of 10 points per limb
- TASC
  - 8 movement patterns for a maximum of 16 points per limb

SCALE Validity and Reliability

- Content validity
  - 14 expert clinicians
  - Rated content, administration and grading
  - Mean agreement 91.9%
  - Recommendations incorporated into final tool
- Construct validity
- Interrater reliability
SCALE: Construct Validity

- $n=51$
- $rs=-0.83$
- $p<0.001$

SCALE Interrater Reliability

<table>
<thead>
<tr>
<th>Group</th>
<th>Limb</th>
<th>ICC</th>
<th>95% CIs</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Left</td>
<td>0.88</td>
<td>0.69, 0.97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>A</td>
<td>Right</td>
<td>0.89</td>
<td>0.72, 0.97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>B</td>
<td>Left</td>
<td>0.90</td>
<td>0.77, 0.97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>B</td>
<td>Right</td>
<td>0.91</td>
<td>0.79, 0.97</td>
<td>&lt;0.001</td>
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</tbody>
</table>

SCALE Validity and Reliability

- Balzer et al (Dev Med Child Neurol 2016)
- German translation of SCALE
- 38 participants
  - Validity
    - Similar results to UCLA using GMFCS
  - Inter-rater reliability
    - ICC >.9; p <.001
  - Intra-rater reliability (video)
    - ICC >.9; p <.001
Overview of SCALE

- Patient is able to follow directions
  - Minimum age typically 4 years
- Hip, knee, ankle, subtalar and toe motion
- Non-synergistic movement task
- Check available passive ROM
- Move within 3 second verbal count
- Move ONLY the joint being tested
- Grade best performance

Scoring System

<table>
<thead>
<tr>
<th>Grade</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>✔ ✔ ✔</td>
<td>✔ ✔ ✔</td>
</tr>
<tr>
<td>Impaired</td>
<td>✔ ✔ ✔</td>
<td>✔ ✔ ✔</td>
</tr>
</tbody>
</table>

Example of scores for a child with spastic diplegic CP

Maximum score per each lower limb = 10

Grading

- Normal
  - Completes isolated movement within 3 seconds
- Unable
  - Does not move requested joint or
  - Cannot perform movement out of synergy
- Impaired
  - Less than 50% available motion
  - Slower than 3 second verbal count
  - Mirror movements of contralateral limb
  - Motion at other joints
  - Movement occurs only in one direction
Grading Guidelines

- Only grade what you observe – no assumptions
- If contracture is present
  - Grade movement that you see, not palpate
  - Note contracture in descriptor section
  - Area for comments

Hip

Starting position

“flex”  “extend”  “flex”

Knee

Starting position

“extend”  “flex”  “extend”
Ankle

“Starting position”

“move foot up” “down” “up”

Subtalar Joint

“in” “out” “in”

Starting position

Toes

“flex” “extend” “flex”

Starting position
**Administration and Grading Guidelines**

- **Hip**
  - Tight hamstrings restricted ROM
  - Can use hip extension with knee flexed
- **Knee**
  - Allowed to lean back on hands
  - Watch for trunk movement
- **Ankle**
  - Can flex knee to 20°
  - Must observe at least 15° arc of motion
- **Subtalar**
  - Need active eversion
- **Toes**
  - Motion at all five toes

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**Resisted Extensor Synergy**

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**Resisted Flexor Synergy**

("Confusion Test")
Descriptors for Impaired Grade

- Mirrors motion on opposite limb
- Motion slower than 3 sec verbal count
- Moves one direction only

Movement of other joints
- Motion less than 50% of range
- Contractures/spasticity interfere, knee, ankle
- Ankle: inverts/everts, not pure dorsiflexion
- Ankle: primarily moves toes

Clinical Examples: Videos

- Each joint
- Each grade
- Patient example
• Research
  - Proximal to distal impairment
  - SVMC and gait
  - Force production
  - Mirror movements

• Clinical decision making
  - Selective posterior rhizotomy
  - Hamstring lengthening
  - Exercise design
Test of Arm Selective Control (TASC)

Clinical tool for assessment of selective voluntary motor control in patients with spastic cerebral palsy

Clinical use of the TASC

Kristin J. Krosschell, PT, DPT, MA, PCS
American Academy of Cerebral Palsy and Developmental Medicine
Montreal, September 2017

Test of Arm Selective Control

- Designed to differentiate and describe selective voluntary movement control in the upper limb of those with cerebral palsy
- Background
  » NIH Task Force on Childhood Motor Disorders
  » No scales to specifically examine UE selective control
  » Modeled after Selective Control Assessment of Lower Extremity (SCALE)

TASC
**TASC General Directions**

**Location:** Minimize distractions, document setting (location, others present, time of day, etc).

**Seating:** Choose appropriately (90/90, no arms).

Must be able to follow simple motor commands.

1. Proximal to distal, less impaired side 1st
2. Check PROM
3. Demonstrate the task
4. Ask the patient to perform
   a. Within 3 sec cadence
   b. Without moving other joints/limbs
5. Up to 3 attempts allowed.
6. Instructions/verbal cues may be modified to maximize performance

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**TASC test items**

1. Shoulder abd/add
2. Shoulder flex/ext
3. Elbow flex/ext (concentric/eccentric)
4. Forearm supination/pronation
5. Wrist ext/flex
6. Finger/thumb ext/flex
7. Thumb opposition ('neat' or tip to tip pincer)
8. Thumb ext/flex (key grip)

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**Scoring**

<table>
<thead>
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<tbody>
<tr>
<td>2</td>
<td>Performs completely (&gt;50% of available range) without movement at other joints</td>
</tr>
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<td></td>
<td>Within a 3 second cadence</td>
</tr>
<tr>
<td></td>
<td>Without mirror movement</td>
</tr>
<tr>
<td>1</td>
<td>Completes ≤ 50% of available ROM</td>
</tr>
<tr>
<td></td>
<td>Performs slower than 3 second cadence</td>
</tr>
<tr>
<td></td>
<td>Movement occurs only in 1 direction, or motion at another joint (including mirror movements) occurs.</td>
</tr>
<tr>
<td>0</td>
<td>Does not complete the task, or only does so with other joint movement</td>
</tr>
</tbody>
</table>
Reduced ROM

• Consider:
  » Contractures
  » Non-standard start positions
  » Available ROM

Movement properties and descriptors

• Spastic catch
• Muscle tightness
• ↓ ROM
• Motion slow
• Extra movement
• Mirror movements
• No palpable contraction
• Movement in only one direction

• Flexion and/or extension synergy influence
Starting position 1
(Items 1-3)

Correct alignment

shoulder neutral

elbow extended

wrist neutral

Poor alignment

Fingers extended as required by task

Starting position 2
(Items 4-8)

shoulder neutral

elbow 90°

wrist neutral

Fingers flexed or extended as required by task

Examiner may lightly support elbow if needed

Meet our patient

• 7 year old
• R hemi

What might you hypothesize as primary issues based on the next few videos?
**Shoulder ABD/ADD**

Start position 1

"UP, DOWN, UP"

"Raise your arm to the side as high as you can (with the palm of your hand facing down), bring it down, and then raise it again. Try to keep your elbow, wrist and fingers straight while you do this."

---

**Left Shoulder Abduction/Adduction**

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|       | - slower than 3 second count  
|       | - movement occurs only in one direction  
|       | - motion at another joint  
|       | - mirror movements  |
| 0     | - No AROM  
|       | - Immediate or obligatory motion at another joint  |

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| 0     | - No AROM  
|       | - Immediate or obligatory motion at another joint  |
Shoulder flexion/extension

Start position 1

"UP, DOWN, UP"

"Raise your arm to the front as high as you can, with your thumb pointing to the ceiling, bring it down, and then raise it again. Try to keep your elbow, wrist and fingers straight while you do this."

Left Shoulder flexion/extension

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Elbow flexion/extension

Start position 1

“UP, DOWN, UP”

*Bend your elbow up as far as you can while your thumb points towards the ceiling, straighten your elbow and then bend it again.*

Left Elbow flexion/extension

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Score Table:

- Muscle properties: muscle tightness, muscle weakness, extra movement, mirror movement, no joint contract, random direction
- Descriptors: muscle tightness, muscle weakness, extra movement, mirror movement, no joint contract, random direction

Right Elbow flexion/extension

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- Descriptors: muscle tightness, muscle weakness, extra movement, mirror movement, no joint contract, random direction
Forearm supination/pronation

Start position 2

“UP, DOWN, UP”

“Turn your hand so that I can see the inside of your hand, the back of your hand and then the inside of your hand again.”

Left Forearm supination/pronation

<table>
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|       | slower than 3 second count  
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|       | motion at another joint  
|       | mirror movements |
| 0     | No AROM  
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Right Forearm supination/pronation

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|       | motion at another joint  
|       | mirror movements |
| 0     | No AROM  
|       | Immediate or obligatory motion at another joint |
Wrist extension/flexion

Start position 2

"OUT, IN, OUT"

"Move your wrist so you hand comes out, in, and then out again."

Left Wrist extension/flexion

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Right Wrist extension/flexion

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motion at another joint  
motion at another joint  
mirror movements |
| 0     | No AROM  
Immediate or obligatory motion at another joint |
Finger and thumb flexion/extension

Start position 2

“Open your hand wide, make your hand into a fist, and then open it wide again.”

Left Finger-thumb extension/flexion

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Right Finger-thumb extension/flexion

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</table>
Thumb opposition (thumb to 1st finger tip to tip)

Start position 2

"Move your thumb and index finger together to make a circle like this (demo). Straighten your thumb and finger out. Make a circle again."

Left Thumb opposition (pincer)

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</table>
Thumb extension (key grip)

Start position 2

“Keep your fingers flexed and your thumb straight. Lift your thumb up, down and up.”

Left Thumb extension (key grip)

Score | Criteria
--- | ---
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  | within a 3 second count
  | without mirror movement
1 | ≤ 50% available ROM
  | slower than 3 second count
  | movement occurs only in one direction
  | motion at another joint
  | mirror movements
0 | No AROM
  | Immediate or obligatory motion at another joint

| Score | Muscle properties
--- | ---
2 | Passive reach
  | Muscle tightness
  | AROM ≤ 50%
  | Slow
  | Extra amount
  | Mirror movement
  | No pain
  | Contract
  | Equal direction

Left Thumb extension (key grip)

Score | Criteria
--- | ---
2 | > 50% available ROM
  | within a 3 second count
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1 | ≤ 50% available ROM
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| Score | Muscle properties
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2 | Passive reach
  | Muscle tightness
  | AROM ≤ 50%
  | Slow
  | Extra amount
  | Mirror movement
  | No pain
  | Contract
  | Equal direction
TASC Scoresheet

TASC team members

**NIH Task Force members**
- Kristin J Krosschell, PT, DPT, MA, PCS
- Theresa Sukal Moulton, PT, DPT, PhD
- Deborah Gaebler Spira, MD
- Darcy Fehlings, MD
- Eileen Fowler, PT, PhD

**Acknowledgements:**
- NIH Task Force on Childhood Movement Disorders
- Sanger Funds
- Local clinics for hosting and recruiting

**PTHMS Synthesis students**
- Kat Block, PT, DPT
- Alexi Block, PT, DPT
- Erin Salzman, PT, DPT
- Jessica Barnum, PT, DPT
- Katie Warner, SPT
- Elizabeth Byrne, SPT
- Andrew Robertson, SPT
- Erin Cameron, SPT
- Shannon Murphy, SPT
Clinical tools for assessment of selective voluntary motor control in patients with spastic cerebral palsy

Research in UE SVMC and Relationship to TASC

American Academy of Cerebral Palsy and Developmental Medicine
Annual Meeting, September 2016
Theresa Sukal-Moulton, PT, DPT, PhD
Bibliography


Sukal-Moulton T, Clancy T, Zhang, L, Gaebler-Spira D. Clinical application of a robotic ankle training program for cerebral palsy compared to the research laboratory application: Does it translate to practice? *Arch Phys Med Rehabil*


