IC 20 - A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, AND OUTCOMES

**Selective Dorsal Rhizotomy:**

A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, SHORT-TERM OUTCOMES AND LONG-TERM OUTCOMES

AACPDM 72nd Annual Meeting
Cincinnati, Ohio, USA 2018

**Objectives**

Describe characteristics of patients that are consistent with a predictable positive result following SDR.

Learn the benefits of a multidisciplinary collaborative evaluation in these patients.

Explore the techniques of rhizotomy and the benefits of utilizing a selective approach in the procedure.

Review the post SDR short and long term outcomes data.

**Why SDR?**

SDR is safe
SDR rarely worsens gait function when candidates are chosen following careful selection parameters
SDR is effective at reducing spasticity of cerebral origin
SDR is permanent
SDR almost always improves efficiency of gait
SDR helps reduce the number of orthopedic procedures that need to be performed in order to keep these patients walking

**Definitions of abnormal tone**

Hypertonia
Abnormally increased resistance to externally imposed movement about a joint. It may be caused by spasticity, dystonia, rigidity, or a combination of features. By definition excludes resistance to movement imposed by joint, ligament, or skeletal properties

Spasticity
A velocity dependent resistance to muscle stretch

Dystonia
Involuntary alteration in the pattern of muscle activation during voluntary movement or maintenance of posture

Rigidity
Common in adults (parkinsonism), rare in children; resistance to passive movement is not dependent on velocity

Spasticity
Dystonia, Rigidity, Athetosis, Chorea

**Mechanisms of abnormal tone**

Pyramidal or Extrapyramidal

Pyramidal
Upper motor neurons
Primary motor area
Internal capsule
Corpus striatum

Extrapyramidal

Primarily Spasticity
Dystonia, Rigidity, Athetosis, Chorea

**Pyramidal**

Periventricular Leukomalacia

**Extrapyramidal**

Global or watershed injuries

Spasticity
Dystonia, Rigidity, Athetosis, Chorea

Task Force on Childhood Motor Disorders 2003
Multidisciplinary Approach

Physical Therapy Evaluation including video
Gait Lab Evaluation
(Social Work Consult)
(Psychology Consult)
Spasticity Clinic Evaluation
  Pediatric Neurosurgery
  Pediatric Orthopedics
  Pediatric Physiatry
“Checks and Balances”

Multidisciplinary Approach

Physical Therapy Evaluation including video
Gait Lab Evaluation
(Social Work Consult)
(Psychology Consult)
Spasticity Clinic Evaluation
  Pediatric Neurosurgery
  Pediatric Orthopedics
  Pediatric Physiatry

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Physical Therapy Evaluation

GMFCS
Equipment
ROM
Strength/Selectivity
Contracture/Deformity
Tone
Ashworth scores
Dystonia
Interference w/ function
GMFM
Subjective Behavior Evaluation

Physical Therapy Video

• Rolling
• Prone on Elbows
• Supine to Sit
• Crawling forward and backward
• Quadraped to side-sit -- both sides

Accredited Motion Labs by The Commission of Motion Laboratory Accreditation

• A I duPont Hospital for Children, Wilmington, DE
• Children’s Hospital of Colorado, Aurora
• Children’s Hospital of Los Angeles, CA
• Connecticut Children’s Medical Center, Farmington
• Gillette Children’s Specialty Healthcare, St. Paul, MN
• Hospital for Special Surgery, New York, NY
• Mayo Clinic, Rochester, MN
• MossRehab and Albert Einstein Healthcare Network, Elkins Park, PA
• Shriners’ Hospital for Children, Philadelphia, PA
• Shriners’ Hospital for Children, Salt Lake City, UT
• Shriners’ Hospital for Children, Spokane, WA

www.cmliinc.org/AccreditedLabs.html
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**Gait and Motion Analysis**

- Helps quantify and localize areas of spasticity
- Can help identify non-spastic tone patterns (dystonia, athetosis, etc.)
- Evaluates for evidence of primitive (steppage) patterns in gait that truly represent mass flexion-extension patterns
- Quantifies energy expenditure in gait
- Kinematics of typical gait patterns responsive to SDR can be seen – flat knee curves and plantar flexed ankles at IC.

**Multidisciplinary Approach**

- Physical Therapy Evaluation including video
- Gait Lab Evaluation
- (Social Work Consult)
- (Psychology Consult)
- Spasticity Clinic Evaluation
  - Pediatric Neurosurgery
  - Pediatric Orthopedics
  - Pediatric Physiatry
- “Checks and Balances”

**Gait Analysis Resources**

- www.cmlainc.org/AccreditedLabs.html
- www.gcmas.org/

**Clinic Appointment**

- 60 – 120 minutes
  - Nurse evaluation
    - review the medical record with family
    - review current medications
    - review interim history
    - Review of MRIs, radiography, gait analysis results, PT eval and video
  - Multidisciplinary Clinic Evaluation
    - Pediatric Neurosurgery
    - Pediatric Orthopedics
    - Pediatric Physiatry
  - History Review
    - identify family expectations of visit
  - Focused Physical Exam
    - ROM
    - Spine exam
    - Torsional measurements/joint health
    - Spasticity (Other abnormal tone)
    - Selectivity
    - Strength

**Selection**

Team convenes outside of the patient’s clinic room to collaborate on findings and to develop an agreed upon plan.
What crucial information does gait analysis provide regarding spasticity management decision-making?

Tom F Novacheck, MD
Director, Center for Gait and Motion Analysis
Gillette Children’s Specialty Healthcare
Associate Professor, Dept of Orthopaedics
University of Minnesota

Candidacy for SDR

- Prematurity with periventricular leukomalacia
- Hypertonia 2° spasticity
- Energy inefficiency
- Antigravity muscle strength
- “Adequate” motor control and selectivity
- Severe contractures not present (4 - 7 yoa)
- Psychosocial factors -- adequate cognitive function and motivation

The Challenge with SDR

- Destructive/irreversible
- CP is not uniform.
- Bad results d/t
  - Poor patient selection
  - Excessive rhizotomy
  - Incorrect selection of nerve root levels
  - Unmanaged lever arm dysfunction/contracture/weakness

Selection process

- Gait analysis
- Multidisciplinary spasticity clinic

Overall Factor Tree

- Birth History
- Tone
- Selectivity
- Strength
- Energy

Birth/Imaging History Factor Tree

- Born premature
  - Yes
  - No
- Periventricular Leukomalacia
  - Yes
  - No
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**Tone Factor Tree (Average Ashworth score)**

- Pure spastic tone dictated in SPEV clinic notes and gait interpretation consistently
  - Yes
  - No

- Plantarflexor
  - n=2
  - 2≤<5
  - 5

- Rectus/hamstring
  - n=2
  - 2≤<5
  - 5

- Hipflexor/adductor
  - n≤2
  - 2≤<5
  - 5

**Average Selectivity Factor Tree**

- Hip
  - 0
  - 1
  - 2

- Knee
  - ≤1
  - 1≤<2
  - 2≤<5
  - 5

- Plantarflexors
  - ≤1
  - 1≤<2
  - 2≤<5
  - 5

**Average Strength Factor Tree**

- Hip Flexor
  - ≤3
  - >3

**Energy Factor Tree**

- Net
  - ≤200%
  - >200%

**Physical examination**

**Hypertonia Assessment Tool (HAT)**

- Increased involuntary movements or postures of the designated limb with tactile stimulus of a distant body part: Dystonia
- Increased involuntary movements or postures with purposeful movement of a distant body part: Spasticity
- Presence of a spastic catch: Rigidity
- Equal resistance to passive stretch during bi-directional movement of a joint: Spasticity
- Increased tone with movement of a distant body part: Dystonia
- Maintenance of limb position after passive movement: Rigidity

**Selectivity, Strength**

<table>
<thead>
<tr>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>2.5/5</td>
</tr>
<tr>
<td>Extension</td>
<td>2.5/5</td>
</tr>
<tr>
<td>Knee 0</td>
<td>2.5/5</td>
</tr>
<tr>
<td>Knee 90</td>
<td>2.5/5</td>
</tr>
<tr>
<td>Abduction</td>
<td>2.5/5</td>
</tr>
<tr>
<td>Hips extended</td>
<td>1.5/5</td>
</tr>
<tr>
<td>Addition</td>
<td>1.5/5</td>
</tr>
</tbody>
</table>

Selectivity Grade Key:
- 0 - Only patterned movement observed
- 1 - Partially isolated movement observed
- 2 - Completely isolated movement observed
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**Physical examination**

- **Spasticity (Ashworth Scale)**
  - Hip flexors
    - Left: 2
    - Right: 2
  - Adductors
    - Left: 3
    - Right: 4
  - Hamstrings
    - Left: 3
    - Right: 3
  - Rectus femoris
    - Left: 3
    - Right: 3
  - Plantarflexors
    - Left: 1
    - Right: 1
  - Ankle clonus
    - Left: ++
    - Right: ++

**Poor selective motor control**

- **Kinematics**
  - Primitive movement pattern
  - "mass flexion/mass extension"

**Good selective motor control**

- **Kinematics**
  - Stiffness
  - Diminished ROM
  - Typical spastic movement pattern
  - Could be contractures

**Sagittal plane kinematics**

**Hamstring muscle lengths**

**EMG "patterned"**

*Not ideal*
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EMG cospasticity

Energy Efficiency

GMFCS I

Selective Dorsal Rhizotomy

Procedure

History:
Charles Scott Sherrington
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**History**

1898 Sherrington showed relief of muscle spasticity in decerebrate cats by section of the dorsal root. Won Noble prize in 1932 in medicine and physiology for “discoveries involving the function of neurons”

Inhibition of function

C coined the term **synapse**

1913 Otfrid Foerster 150 cases of dorsal rhizotomy from L2-S2 (Foerster operation)

Emphasized rehabilitation and orthopedic procedures in the post-op period.

Was Lenin’s personal physician and performed his autopsy

1967 Gros in Montpelier France modified the operation to cut 4/5 of dorsal roots from L1-S1.

Gros reported 62 cases with 18 year follow up.

(25 cases of CP)

Noted improved speech and upper limb function in the CP sub-category

1978 Fasano et al in Italy reported using intra-operative EMG to select which dorsal rootlets should be cut.

109 cases done starting in 1971 (CP population)
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**History**

Peacock 1982

**Science**

PubMed search: Selective dorsal rhizotomy 340 results

PubMed search: Selective dorsal rhizotomy and controlled trial 12

5 are anesthesia and analgesia papers and to are a meta-analyses

**That was the science**

The rest of this talk is art

**Technique**

- Cauda Equina
  - Larger opening
  - Anatomic Localization
  - Most used
  - Long term spinal instability
  - Longer operative time
  - More blood loss
  - Longer recover time

- Conus
  - Smaller opening
  - Venous drainage
  - Less Bone Removal
  - Localization less precise
  - More urologic complications
  - Less blood loss
  - Less painful

**Cauda Equina**

Prone under general anesthesia

EMG

L1-L5 Laminotomy

**Technique: Cauda Equina**
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**Technique: Cauda Equina**

- Anatomic and EMG identification of each rootlet L1-S1
- (S2 included if < 50% of S1 sectioned)
- Dura closed

**Technique: Conus method**

- Prone under general anesthesia
- EMG
- Laminectomy/Laminotomy guided by pre-op MRI and intra-operative ultrasound
- Laminectomy one or two segments (L1, L2)
- L2 root can be anatomically identified
- L3-S2 are isolated base on appearance and EMG recordings

**Spinal deformity**

- Several studies have been done to answer this question in this population
- Answer still unclear

**Spinal deformity: the work of JC Peter**

- 2009 “Incidence of spinal abnormalities in patients with spastic diplegia 17 to 26 years after selective dorsal rhizotomy.”
- 1990 “Incidence of spinal deformity in children after multiple level laminectomy for selective posterior rhizotomy.”
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**Spinal deformity: the work of JC Peter**

“Except for spondylolisthesis, spinal deformities did appear to progress with time. However, this increase was not marked, and the development of relatively mild scoliosis was the only statistically significant increase.” 2009

“Spondylolysis/spondylolisthesis is the only abnormality that appeared to be more common in this group than in children with CP” (9%) 1990

Spondylolisthesis rates for general population is 4-6%.

**Conclusion**

Both methods are acceptable

No good evidence exists at this time to suggest one should be done over the other.

---

**Varying Rehabilitation Approaches**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Inpatient Stay</th>
<th>Outpatient Episode (~12 months)</th>
<th>Post op Orthotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gillette, St. Paul, MN</td>
<td>6 weeks</td>
<td>3x/wk → 2x/wk → 1x/wk</td>
<td>pediATR AFOs</td>
</tr>
<tr>
<td>RIC, Chicago, IL</td>
<td>4 weeks</td>
<td>3x/wk → 2x/wk → 1x/wk</td>
<td>semirigid TLS AFOs</td>
</tr>
<tr>
<td>Cincinnati Children’s, OH</td>
<td>none</td>
<td>3x/wk → 2x/wk → 1x/wk</td>
<td></td>
</tr>
<tr>
<td>Children’s Mercy, Kansas City</td>
<td>2 weeks</td>
<td>3x/wk → 2.5x/wk → 2x/wk → 1x/wk</td>
<td></td>
</tr>
<tr>
<td>Mayo Clinic, Rochester, MN</td>
<td>none</td>
<td>3x/wk → 2.5x/wk → 2x/wk → 1x/wk</td>
<td></td>
</tr>
<tr>
<td>Seattle Children’s, WA</td>
<td>3-4 weeks: 3-5x/wk</td>
<td>3x/wk → 2-3x/wk → 1x/wk</td>
<td></td>
</tr>
<tr>
<td>UT Southwestern, Dallas</td>
<td>2 weeks</td>
<td>3-4x/wk → 2-3x/wk → 1x/wk</td>
<td></td>
</tr>
</tbody>
</table>

**Rehabilitation following SDR**

Some centers do no inpatient work

Some centers do six weeks of inpatient therapy

Many centers do somewhere in between

**Goals of Rehabilitation**

- Range of Motion
- Strengthening
- Sitting posture
- Mobility/weight shifting
- Reciprocal Movement
- Balance
- Motor control
- Ankle/Feet preparation for stance phase of gait
- Pre-ambulation
- AFO selection
- Transition work
- Endurance
- Speed
- Hip extension
- Prone lying time
- Prone stander/mobile stander
- Knee extension
- Prone lying time
- Prone stander/mobile stander
- K's
- Dorsiflexion
- Prone stander/mobile stander
- AFO's

**Range Of Motion**

- Hip extension
- Prone lying time
- Prone stander/mobile stander
- Knee extension
- Prone lying time
- Prone stander/mobile stander
- K’s
- Dorsiflexion
- Prone stander/mobile stander
- AFO’s
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AFO Selection
Solid AFO to rigid PLS
Support the patient in stance
Maintain ROM
Reduce crouch

Institution | Post-op Orthotics
---|---
Gillette, St. Paul, MN | semirigid PLS AFOs
RIC, Chicago, IL | solid AFOs primarily
Mayo Clinic, Rochester, MN | articulated w/tether
Seattle Children’s, WA | solid AFOs primarily

Strengthening
- Certainly leg strengthening
- Don’t forget the arms!
- OT daily
- Core muscle strengthening

Sitting
- Side sitting
- Long sitting
- Tailor sitting
- Transitions

Endurance
Many centers employ various modalities to continue endurance and gait work:

Institution | Additional Modalities
---|---
Gillette, St. Paul, MN | lokomat, Litegait, aqua therapy
RIC, Chicago, IL | lokomat, Aqua; ultrasound, AFOs
Cincinnati Children’s, OH | lokomat, Litegait, aqua therapy
Mayo Clinic, Rochester, MN | lokomat, Litegait
Seattle Children’s, WA | safe gait
UT Southwestern, Dallas | lokomat, Litegait, aqua therapy

Mobility and Weight shifting

Outpatient Therapy
- At discharge, outpatient therapy remains imperative:
  - 5 days/week X ~1 month—accomplished typically between the school team and the outpatient therapy team
  - Decreased dosing of PT is approved as the child demonstrates solid and retained improvement in ambulation goals
  - Many children continue with 2-3 days/week at 6 months
- The child returns for PT evaluations at Gillette approximately 6 and 12 months postoperatively
Outcomes of Spasticity Reduction for Children with Cerebral Palsy

Maximizing Efficacy
Minimizing Risk
Tom F Novacheck, MD
Gillette Children’s Specialty Healthcare
Director, Center for Gait and Motion Analysis

Study Design

- Retrospective Analysis

- Subjects
  - Gait analysis 0-18 months prior to SDR
  - Gait analysis 8-36 months subsequent to SDR
  - SDR performed at 1994 - 2003
    - Gillette Children’s Specialty Healthcare, or
    - Shriners Hospital for Children – Twin Cities Unit

Outcome Measures

- Gillette Gait Index
  - Overall measure of gait pathology
- Gillette Functional Assessment Questionnaire
  - 10 level walking scale
- Oxygen Cost
  - Net nondimensional cost
- Ashworth Score
  - Sum of specific muscles

Subjects

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Age</th>
<th>Follow-Up Time</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>76</td>
<td>2.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Male</td>
<td>69</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>145</td>
<td>2.1</td>
<td>1.1</td>
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</table>

Age and Follow-Up Time in Years

Table 2. Patient Characteristics

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Age</th>
<th>Follow-Up Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>55</td>
<td>7.6</td>
<td>2.1</td>
</tr>
<tr>
<td>Male</td>
<td>81</td>
<td>6.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>136</td>
<td>7.2</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Age and Follow-Up Time in Years

Outcome

Trost JP, Schwartz MH, Krach LE, Dunn MB, Novacheck TF:
Comprehensive short-term outcome assessment of selective dorsal rhizotomy.
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Outcome Categories

**Poor**
- Lost: Pre: within typical range, Post: outside typical range
- Worsened: Pre: outside typical range, Post: further outside typical range

**Neutral**
- Unchanged: Pre: outside typical range, Post: outside typical range, no further/closer to typical (within exp. Error)
- Maintained: Pre: within typical range, Post: within typical range

**Good**
- Improved: Pre: outside typical range, Post: outside typical range, but closer to typical
- Corrected: Pre: outside typical range, Post: within typical range

Gait Changes: Pelvis

Gait Changes: Hip

Gait Changes: Knee

Gait Changes: Ankle

What do we know about gait outcome?

We know what is currently working.
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Gait Pathology: GGI

- Mean pre = 243
- Mean pst = 172
- Decrease of 29%

Spasticity: Ashworth

- Mean pre = 343% control
- Mean pst = 291% control

Efficiency: Oxygen Cost

- Mean pre = 343% control
- Mean pst = 291% control
A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, AND OUTCOMES

**Function: Gillette FAQ**

- **Mean pre** = 7.3
- **Mean post** = 8.2
- **Increase of 0.9 levels**

**Dependent vs Independent Ambulation**

- **Walks more than 15-50 feet outside the home but usually uses wheelchair or stroller for community distances or in congested areas**
- **Walks outside for community distances, but only on level surfaces (cannot perform curb, uneven terrain, or stairs without assistance of another person)**
- **Walks outside the home for community distances, is able to get around on curb and uneven terrain in addition to level surfaces, but usually requires minimal assistance or supervision for safety**
- **Walks outside the home for community distances, usually gains around on level, ground, curbs, and uneven terrain, but has difficulty or requires minimal assistance or supervision with running, climbing and stairs**

**Purpose**

Test whether assistive device use (GMFCS level) was predictive of SDR outcome

- Motor control
- Stand alone indicator of risk

**Gross Motor Function Classification System (GMFCS)**

- **Pre-op score**
  - 1 or 2
  - 3 or 4
- **assistive device**
  - Independent
  - Dependent
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**GMFCS II**

5+6 diplegic CP

**GMFCS III**

5+3 diplegic CP

**Results**

- GMFCS 1/2 independent N = 70
- GMFCS 3/4 dependent N = 66

The groups closely matched:

- age
- % of rootlets cut

**Gillette Gait Index**

No difference

**FAQ - 10**

No difference

**Oxygen Cost**

Dependent greater chance of poor outcome (significant)

**Walking Speed**

Dependent more likely to improve (significant)
Discussion

- Energy cost (O2) was more likely to be poor for dependent ambulators.
- That same group of children was more likely to walk faster.
- Ceiling effect -- independent ambulators walked at typical speed pre-operatively.
- No relationship between GGI or FAQ and O2.

Take Home

- Following SDR, children who use assistive devices have
  - equal likelihood of a good outcome
  - gait (GGI, speed)
  - ambulatory function (FAQ)
  - 32% no longer use devices post-operatively
  - more likely to have poor energy outcome

Complications

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowel and bladder</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Skin related</td>
<td>9</td>
<td>7</td>
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<tr>
<td>Wound healing</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Headache</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Paresthesia</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Weakness</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Miscellaneous related</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Miscellaneous not related</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

All resolved by time of discharge

Conclusions

- SDR outcomes are good & complication rates are low
  - strict patient selection criteria
  - strict rootlet sectioning criteria
- Risk associated with deviation from the protocol described has not been assessed
  - High adherence to defined criteria
  - Other criteria or operative techniques may work as well, better, or worse

We know that the current methods provide us with a high rate of good outcomes & a low risk of bad outcomes.

Gait status 17–26 years after selective dorsal rhizotomy

| Nettlak 31, Legerst 131, Nicholas 31, Christopher 31, Vaughan 31, Graham 31, Michael 31, Schwartz 31 |

31 adults with diplegia post SDR

- mean age= 26.8 years
- mean time since SDR= 21.2±2.9 years
- 43 typically developing controls

Results:

- 58% showed improved GMFCS levels
- Similar gait results compared with published short-term outcomes
- Appropriate orthopedic intervention was required in 61% of the cohort
IC 20 - A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, AND OUTCOMES

Comprehensive Long-Term Outcomes Following Selective Dorsal Rhizotomy

Tom F. Novacheck, MD1, Meghan E. Munger, MPH1, Nanette Aldahondo, MD1, Linda Krach, MD2, Michael H. Schwartz, PhD1

1 Gillette Children’s Specialty Healthcare, St. Paul, MN, USA
2 Courage Kenny Rehabilitation Institute, Minneapolis, MN, USA

Goals

• Evaluate comprehensive outcomes 10-17 years after SDR
  – Spasticity
  – Gait
  – Function
  – Pain
  – Quality of Life
  – Subsequent Treatment

• Test benefit of SDR compared to alternative treatments

HYPOTHESIS

SDR will lead to better outcomes and fewer subsequent treatments compared to a control group

Inclusion Criteria

SDR group
  – spastic diplegic CP
  – SDR between 1995 and 2005
  – pre-SDR three-dimensional (3-D) computerized gait analysis
  – follow-up ≥ 8 years
  – 16-25 years old at follow-up

Strength: Retrospectively Identified Control Group

• Propensity Model (Random Forest Algorithm):
  – age
  – gait
  – stature
  – function
  – CP subtype
  – treatment history
  – plantarflexor spasticity

95% ACCURATE

• Sensitivity: 80%
• Specificity: 98%
• Pos. Pred. Value: 89%
• Neg. Pred. Value: 97%

Timeline
A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, AND OUTCOMES

Survey Measures

- Surveys at follow-up
  - Diener Satisfaction with Life Scale
  - World Health Organization’s Quality of Life-BREF
  - Modified Brief Pain Inventory
  - Frequency of Participation Questionnaire
  - Functional Assessment Questionnaire
  - Functional Mobility Scale

RESULTS

Reduced Spasticity: SDR>>Control

<table>
<thead>
<tr>
<th></th>
<th>SDR (17+8 yoa) n = 13</th>
<th>Control (19+7 yoa) n = 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adductors</td>
<td>3.1* → 1.1</td>
<td>2.1* → 1.8</td>
</tr>
<tr>
<td>Hip Flexors</td>
<td>1.9 → 1.0</td>
<td>1.4 → 1.3</td>
</tr>
<tr>
<td>Hamstrings</td>
<td>1.9 → 1.0</td>
<td>High QOL</td>
</tr>
<tr>
<td>Rectus Femoris</td>
<td>2.9* → 1.2</td>
<td>Rectus Femoris</td>
</tr>
<tr>
<td>Plantarflexors</td>
<td>3.2 → 1.0</td>
<td>Plantarflexors</td>
</tr>
</tbody>
</table>

Improved Gait

Surveys and Energy

- Surveys: no difference
  - Low pain interference: SDR: 0.9 ±1.1 Control: 1.7 ± 2.3 p = .27
  - High QOL: SDR: 78.1 ± 9.5 Control: 79.5 ± 9.8 p > .46
  - Similar FAQ: SDR: 9.0 Control: 8.0 p = .82

- Energy
  - Δ SDR 312 → 242% p=.01
  - Δ Control 267 → 206% p=.31

Subsequent Treatment: Big Difference (Control >> SDR)

<table>
<thead>
<tr>
<th></th>
<th>SDR Group (n=24)</th>
<th>Treatment</th>
<th>Control Group (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean bones/muscles</td>
<td>mean bones/muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>Soft Tissue Surgery</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Bony Surgery</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>Botulinum Toxin A</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>Phenol</td>
<td>2.7</td>
<td></td>
</tr>
</tbody>
</table>

All differences significant
IC 20 - A MULTIDISCIPLINARY APPROACH TO IMPROVING GAIT IN CHILDREN WITH CEREBRAL PALSY WITH RHIZOTOMY: PATIENT SELECTION, AND OUTCOMES

Change in GMFCS

<table>
<thead>
<tr>
<th></th>
<th>Control (N=6)</th>
<th>SDR (N=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-up</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Green is Better, Red is Worse. 1 of 6, 5 of 9.

DISCUSSION

- Unique study design – with control group
- Similar good outcomes
- Better GDI (control) vs. Better ∆GMFCS/spasticity (SDR)
- Control group received more treatment

**Remember…**

SDR only addresses part of the problem (tone)
Orthopaedic problems typically need to be assessed and corrected at a later time

**My level of understanding regarding candidate selection for Selective Dorsal Rhizotomy is…**

A. Poor
B. Fair
C. Good
D. Excellent

A. 67%  B. 0%  C. 0%  D. 33%

**My overall opinion of SDR is..**

A. Positive
B. Neutral
C. Cautious
D. Negative

A. 67%  B. 0%  C. 0%  D. 33%