Surgical Aspects of Selective Dorsal Rhizotomy

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Rhizotomy

- History
- Science
- Procedures
- Provocations
- Movietime
From theory to practice

- In 1898 Sherrington described relief of muscle spasticity by posterior root section in decerebrate cats
Basis for motor control and muscle tone is balance of two opposing forces

- One is facilitation of muscle contraction via the afferent fibres from the muscle spindle.
- The other is inhibition of the muscle contraction via the descending tracts from the brain.
- Spastic paralysis is the result of central neuron damage that reduces the higher level of inhibition.
• The application of the theory is to cut the posterior roots of the spinal cord

• The result is reduction of the spasticity of the muscles.
The pioneer

• In 1913 Foerster used this theoretical basis in performing dorsal rhizotomy for the relief of spasticity in 150 cases

• Using electrical stimulation he identified and cut the posterior roots from L2 to S2.

• Emphasised rehabilitation and orthopaedic procedures in the post-op period.

• Otfried Foerster, German neurosurgeon and neurologist
Oblivion and Resurrection

• Postoperative sensory loss was frequent or the spasticity returned.

• In 1967 Gros and colleagues of Montpelier, France did posterior rhizotomies by cutting only 80% of the rootlets from L1 to S1.
DR to SDR

- Fasano in 1978 introduced 'selective' dorsal rhizotomy at conus level using intraoperative EMG to select which rootlets should be cut.
- Drawback - urinary dysfunction (S2)

- 1982 Peacock modified the technique by exposing the cauda equina rather than at the conus level.
- 1993 Park advocates conus level – single level
Science

- PubMed search: SDR 273 results

- Pub Med search: SDR and controlled trials 16 including five anesthesia/analgesia studies and one meta-analysis
Meta analysis: Steinbook 2001

• SDR results in improvements in lower limb spasticity (level I)
• Increase in range of movements (level I)
• Avoidance of orthopedic surgery in 35%
Long-term outcomes five years after selective dorsal rhizotomy.
Nordmark E, BMC Ped 2008

- This study group consisted of 35 children, consecutively operated, with spastic diplegia
- Muscle tone was immediately reduced in adductors, hamstrings and dorsiflexors \((p < 0.001)\) with no recurrence of spasticity over the 5 years
- SDR is a safe and effective method for reducing spasticity permanently without major negative side effects.
- In combination with physiotherapy, it provides lasting functional benefits over a period of at least five years postoperatively.
Does selective dorsal rhizotomy improve bladder function in children with cerebral palsy?

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Methods  Selective dorsal rhizotomy was performed in 56 children with spastic cerebral palsy. Intraspinal nerve root divisions over the cauda equina from L1/2 to S1/2 levels were performed. Urinary symptoms and urodynamic study (UDS) parameters before and after SDR were analyzed.

Conclusions  Selective dorsal rhizotomy significantly improved urgency, frequency, incontinence, and urodynamic bladder capacity at first incontinence in a significant proportion of spastic cerebral palsy children.
Selection criteria for selective dorsal rhizotomy in children with spastic cerebral palsy: a systematic review of the literature

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METHOD A systematic review was carried out.

RESULTS Fifty-two studies were included.

INTERPRETATION Selection criteria for SDR vary considerably.

Despite the fact that SDR has been performed worldwide over the past three decades and has been studied by many research groups, the lack of randomized clinical trials hinders the development of evidence-based guidelines. Of the
That was the science

• The rest of this talk is art
Competing techniques

• Cauda Equina
  Large opening
  Laminectomy/Laminotomy L1-L5
  Instability?
  Longer time in OR?
  Blood loss?
  More pain?
  Longer recovery time?

  – Selectivity - Divide into
    4 – 6 – 8 -10 -12 rootlets?

• Conus
  Smaller opening
  Laminectomy /Laminotomy L1-L2
  Less selective?
  More urologic complications?
  Less blood loss?
  Less pain
  Shorter recovery?
Multi-level (modified Peacock)
Pre op

• EMG recording in relevant muscles and sphincter
Local anaesthetic before Incision L1-L5
Laminotomy L1-L5 using craniotome
Opening the dura and identification of ventral roots L5 S1
The Procedure

- Stimulation of dorsal roots L2-S2
- Each root divided into 6-12 rootlets
- Stimulation of each rootlet
- Cutting relevant rootlets
Selectivity

- The criteria for division of a rootlet are the duration, location, and electromyographic pattern of response and the observed muscle contraction."
End of procedure

- Intrathecal catheter with morphine and marcaine
- Watertight closure of dura
- Suture the laminae
Postoperative care

• Intrathecal morphine /marcaine for 3-4 days
• 48 hours in the Neurointensive Care (watching videos and eating icecream...)
• Mobilization and physiotherapy from day 5
• Two weeks at pediatric habilitation centre
• Intense physiotherapy 6 months
Single level laminectomy SDR

SDR begins with a 1- to 2-inch incision along the center of the lower back just above the waist. The spinous processes and a portion of the lamina are removed to expose the spinal cord and spinal nerves. Ultrasound and an x-ray locate the tip of the spinal cord, where there is a natural separation between sensory and motor nerves.

Dr T.S. Park  
St Louis Children’s Hospital
Selective dorsal rhizotomy in children: Comparison of outcomes after single-level versus multi-level laminectomy technique

By Christine Ou, RN, BN, MSN(c), Sarah Kent, RN, BScN, CNN(C), Stacey Miller, PT, BSc, and Paul Steinbok, MBBS, FRCSC

A smaller incision and involves less muscle dissection. Functional outcomes at one-year follow-up are similar for the two methods of surgery. It was hypothesized that post-operative pain would be less, mobilization faster and hospital stay shorter using the single-level technique. Using a retrospective case series analysis, we compared nine patients who had had single-level SDR to 18 matched controls who had undergone SDR using the multi-level technique. There were no significant differences in post-operative pain, duration of opioid infusion, or time to mobilization. Length of hospital stay was significantly decreased after the single level procedure: 3.4 versus 5.2 days (p=0.01).
Complications

- Urinary incontinence
- Transient or permanent dysesthesias
- Hip subluxation
- Back pain-spinal deformity
- Motor/sens nerve damage due to hematoma
- Infection
- CSF leakage

- If dystonia worse spasticity???
Selection

• The ideal candidate is a child who has spastic diplegia, good intelligence, good balance, voluntary muscular control, and minimal or no muscle or joint contractures or skeletal deformities.

• Excluded are patients who have athetosis, dystonia, scoliosis, poor trunk balance, and spastic hemiplegia.

• The criteria for selection of the patient with total body involvement (spastic quadriplegia), spasticity from other origin and adults have not been defined and follow up reports are limited.
Critique and controversy

• In a stinging editorial (J Child neurol 1990) Landau and Hunt questioned not only the unproved efficacy of the procedure, but its neurophysiological rationale as well.

• Spasticity was not solely responsible for the functional impairments in cerebral palsy.

• Patient selection (that is, the 'ideal' child who has spastic diplegia might do just as well without treatment)

• Scientific basis of the electromyographic response in selecting which rootlet to cut,

• Need for physical treatment for several years postoperatively,

• Possible long term effects on sex function,

• Possible evolution of neuropathic joints,

• Cost per case,

• Unbiased longterm studies needed
SDR Pros and Cons

- Permanent problem - Single procedure
- No implant
- Safe
- Good long term results
- Cheap

- Surgical risk
- Ablative procedure
- Long term problems?
Present situation

- Private websites on SDR
- Parents discuss “best” therapy / surgeon
- St Louis very popular...(3500 procedures...)
- Increased demand
- How many centers should perform SDR?
Present situation
From St Louis Children´s hospital´s homepage

• In The News
  • Meet A, a 9 year old from Sweden who is hoping to fulfill his dream to walk on his own two feet.

  • Shortly before his 1st birthday got A diagnosed with cerebral palsy. Ever since then he has struggled to be able to walk by himself, which is impossible according to the doctors. But in the U.S. there is a doctor who would be able to realize his dream to be able to walk on his own feet. But the operation is very expensive.

  • A is now 9 years old and gets unexpected help from his classmates. The reputation of the school's fundraising campaign is spreading all over Sweden when it becomes a novelty in SVT Rapport. Money flows in, but will they manage to get up to half a million in time? And A will be able to throw the crutches?
Do we need six centers for SDR surgery in Sweden?
Multidisciplinary team

Diagnosis /problems
- What’s the cause?
- Spastic diplegia?
- Quadriplegia?
- Dystonia?
- Need for spasticity?
- Cooperable?

Treatment
- Physiotherapy
- Botox?
- Bracing?
- Orthopedic surgery?
- SDR?
- Oral Baclofen?
- PEG?
- ITB?
Selection

Goals

• Improved motor function
• Increased mobility
• Increased Independence
• Increased ease of care

• Relief of hypertonia or improved range of movement are means to achieve the goals
Conclusion

• SDR is a safe operation
• No proven benefit of single level procedure
• SDR is a safe and effective method for reducing spasticity permanently without major negative side effects but
• More studies needed
• Multidiciplinary teams – selection
• Six centers??