Selective dorsal rhizotomy for spastic cerebral palsy

- A prospective gait follow-up study 30 years after selective dorsal rhizotomy
- Beyond Spasticity: The Dual Impact of Selective Dorsal Rhizotomy in Spastic Quadriplegic Patients With Generalized Dystonia and the Need for Intrathecal Baclofen
- Impact of Unilateral Selective Dorsal Rhizotomy (SDR) on Spasticity and Motor Function Improvement in Children With Hemiparetic Cerebral Palsy Caused by Intraventricular Hemorrhage
- Role of Dorsal Rhizotomy in the Comprehensive Management of Childhood Spasticity
- Creating a Selective Dorsal Rhizotomy Team
- Selection of Children with Spasticity Other Than Cerebral Palsy: Indications, Long-Term Outcome, and Exclusion Criteria
- Preoperative Assessments for Selective Dorsal Rhizotomy
- Rootlet Selection by Crescendo Single-Pulse Evoked Compound Muscle Action Potential Interpretation During Selective Dorsal Rhizotomy

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Indications

Ideal Candidates

Children with CP: SDR is often performed on children, typically between 3-8 years old, with moderate to severe spasticity that affects their ability to walk or perform other motor activities. Stable Health: Candidates should be in good overall health and have the mental and emotional maturity to undergo rehabilitation after the surgery.

Choosing the correct patient for rhizotomy requires considerable effort and a comprehensive evaluation. Instrumented three-dimensional gait analysis provides supporting evidence in the selection of the ideal child for SDR as well as enabling quantitative monitoring of outcome and post-operative management up to skeletal maturity [1)].

SDR has been performed mostly on children with cerebral palsy and less often in adults with spasticity from cerebral palsy or other etiologies. Studies have shown that most children with cerebral palsy experience a reduction in spasticity and an increase in range of motion that occurs immediately after SDR and persists for at least a year.

Cole et al emphasized the importance of applying strict selection criteria when considering children for SDR, as this is more likely to result in encouraging results. Of 53 children referred for SDR, only 19 (35%) fulfilled their selection criteria. These children showed improvement in cosmesis of gait, clinical examination, and temporal, kinetic, and kinematic parameters of gait analysis. [42]

Physical and occupational therapy are important postsurgical interventions to achieve the best outcome in patients who have undergone SDR. Most often, therapy is recommended 5 times per week for 6 months after the operation.

The relatively few longer-term follow-up studies that have been done on SDR indicate that tone reduction may last for a number of years. Reduction of spasticity can in some instances improve function, with most studies showing some benefit in mobility for subjects with spastic diplegia but less for those with spastic quadriplegia.

see Selective dorsal rhizotomy for spastic diplegia.

The extent of functional improvement after SDR therefore varies. Positive prognostic factors include the extent of mobility before the operation, underlying strength and balance, availability of regular physical therapy after SDR, and the patient's motivation and ability to undertake the rehabilitation process.

The possible complications from the surgery include those involving general anesthesia. Pain, altered sensation, and fatigue may continue for a number of weeks after the operation, as may changes in sleep and bladder or bowel function. Rare, long-term complications include low back pain, scoliosis or kyphosis (ie, spinal curves), and hip displacement.

Selective dorsal rhizotomy (SDR) is a technique developed to reduce spasticity and improve mobility in children with cerebral palsy (CP) and lower extremity spasticity.

First described in 1908, early procedures were effective at reducing spasticity but were associated with significant morbidity. Technical advancements over the last two decades have reduced the invasiveness of the procedure, typically from a five-level laminoplasty to a single-level laminotomy at the conus.

Technique

The selective dorsal rhizotomy (SDR) for spastic cerebral palsy has been the main use of rhizotomy for neurosurgeons specialising in spastic CP since the 1980s; in this surgery, the spasticity-causing nerves are isolated and then targeted and destroyed. The sensory nerve roots, where spasticity is located, are first separated from the motor ones, and the nerve fibres to be cut are then identified via electromyographic stimulation. The ones producing spasticity are then selectively lesioned with tiny electrical pulses.

It involves the selective division of lumbosacral afferent (sensory) rootlets at the conus or at the intervertebral foramina under intraoperative neurophysiological guidance.

Efficiency and safety

The efficiency and safety of dorsal rhizotomies for cerebral palsy lie in the accuracy of radicular identification together with selectivity of root sectioning.

Two different exposures are currently in use. The first is extended laminotomy/laminectomy from the upper lumbar level to the sacrum, which allows accurate identification of all L2-S2 roots/rootlets. The second is limited laminotomy exposing the conus/cauda equina at the thoracolumbar junction; this less invasive method limits accessibility to the roots.

Keyhole interlaminar dorsal rhizotomy (KIDr) offers direct intradural access to each of the ventral/dorsal roots, thus maximizing the reliability of anatomical mapping and allowing individual physiological testing of all targeted roots. The interlaminar approach minimizes invasiveness by respecting the posterior spine structures [2)].

Complications

Risk Factors for Dystonia after Selective Dorsal Rhizotomy in Nonwalking Children and Adolescents with Bilateral Spasticity [3)].

3 patients with bilateral spastic paresis, aged 12, 6, and 7 years at the time of surgery. The percentage of transected dorsal rootlets was around 40% at the L2-S1 levels. Sudden falls were reported with a frequency of several a day, continuing for years after SDR. The falls were often triggered by performing dual tasks as well as occurring in the transition from sitting to standing, during running, after strenuous exercise, or following a fright. Patients also had residual hyperesthesia and dysesthesia of the foot sole. The authors hypothesize that the sudden falls are caused by a muscle inhibition reflex of the muscles in the legs, as an abnormal reaction to a sensory stimulus that is perceived with increased intensity by a patient with hyperesthesia. A favorable effect of gabapentin medication supports this hypothesis [4)].

Prospective cohort studies

A study investigated the prevalence and severity of lower urinary tract symptoms (LUTS) in children with spastic cerebral palsy (SCP). It evaluated the effect of selective dorsal rhizotomy (SDR) in alleviating these symptoms. The study also explored the correlation between postoperative LUTS improvement and intraoperative electrophysiological findings. Prospective data were collected from a consecutive cohort of 247 children with SCP who underwent SDR and were retrospectively analyzed. Pre- and post-operative assessments, including muscle tone, motor function, LUTS, and intraoperative electrophysiology data, were analyzed. Preoperatively, 94 patients (38.1%) had LUTS, and the severity of LUTS negatively correlated with motor function ($R=-0.32$, $P < 0.0001$). After SDR, muscle tone decreased, motor function improved ($P < 0.0001$), and LUTS resolved in 49/94 patients (52.1%). LUTS improvement correlated with a higher proportion of sensory nerves evoking anal sphincter EMG > 20μV. SDR effectively reduces spasticity, improves motor function, and alleviates LUTS in most children with SCP. Intraoperative neurophysiology may predict improvements, warranting further research [5)]

This study offers important preliminary evidence supporting the use of SDR to alleviate LUTS in children with SCP, with interesting insights into the potential role of intraoperative electrophysiology

in predicting outcomes. However, the retrospective nature of the study, the lack of a control group, and the limited exploration of long-term effects mean that the findings should be interpreted with caution. Future research, particularly prospective studies with control groups and long-term follow-up, is needed to further validate these findings and refine the criteria for patient selection and outcome prediction.

1)

Roberts A, Stewart C, Freeman R. Gait analysis to guide a selective dorsal rhizotomy program. Gait Posture. 2015 Apr 20. pii: S0966-6362(15)00445-2. doi: 10.1016/j.gaitpost.2015.04.004. [Epub ahead of print] Review. PubMed PMID: 25979183.

2)

Sindou M, Georgoulis G. Keyhole interlaminar dorsal rhizotomy for spastic diplegia in cerebral palsy. Acta Neurochir (Wien). 2015 May 24. [Epub ahead of print] PubMed PMID: 26002713.

3)

van de Pol LA, Vermeulen JR, van 't Westende C, van Schie PEM, Bolster EAM, van Ouwerkerk PWJR, Strijers RL, Becher JG, Stadhouder A, de Graaf P, Buizer AI. Risk Factors for Dystonia after Selective Dorsal Rhizotomy in Nonwalking Children and Adolescents with Bilateral Spasticity. Neuropediatrics. 2017 Nov 7. doi: 10.1055/s-0037-1607395. [Epub ahead of print] PubMed PMID: 29112992.

4)

Grootveld LR, van Schie PE, Buizer AI, Jeroen Vermeulen R, van Ouwerkerk WJ, Strijers RL, Becher JJ. Sudden falls as a persistent complication of selective dorsal rhizotomy surgery in children with bilateral spasticity: report of 3 cases. J Neurosurg Pediatr. 2016 Aug;18(2):192-5. doi: 10.3171/2016.2.PEDS15527. Epub 2016 Apr 22. PubMed PMID: 27104630.

5)

Jiang W, Wang J, Robe PA, Wei M, Li S, Wang R, Zhan Q, Xiao B. Effect of selective dorsal rhizotomy on bladder dysfunction in children with spastic cerebral palsy. Sci Rep. 2024 Dec 30;14(1):31687. doi: 10.1038/s41598-024-81512-w. PMID: 39738149.