Selective Dorsal Rhizotomy for Spasticity due to Upper Motor Neuron Lesions

A SYSTEMATIC REVIEW

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By

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List of Abbreviation

Selective dorsal rhizotomy	(SDR)
Cerebral palsy	(CP)
Gross Motor Function Measure	(GMFM)
Functional Independence Measure for Children	(FIM)
Pediatric Evaluation of Disability Inventory	(PEDI)
Gross Motor Function Classification System	(GMFCS)
Spinal cord injure	(SCI)
Traumatic Brain Injury	(TBI)
Multiple sclerosis	(MS)
Intrathecal baclofen	(ITB)
Dorsal rhizotomy	(DR)
Keyhole interlaminar dorsal rhizotomy	(KIDR)
Range of motion	(ROM)
Vancouver Motor Function Measure	(VMFM)
Barry–Albright Dystonia	(BAD)
Upper motor neuron syndrome	(UMNS)
American Spinal Injury Association	(ASIA)
Microsurgical DREZotomy	(MDT)
Dorsal root entry zone	(DREZ)
Activities of daily living	(ADLs)
International Classification of Functioning Disability and Health	(ICFDH)

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INTRODUCTION

Selective dorsal rhizotomy (SDR) is a neurosurgical 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 **(Aquilina *et al*., 2015).**

SDR involves a surgical section of dorsal nerve roots of the lumbosacral spinal cord. This reduces the sensory input into spinal motor neurone pools, reducing their excitability. It is usually used to treat spasticity associated with cerebral palsy, with good long-term outcomes (**Nordmark *et al*., 2008).**

There is strong evidence that SDR has a positive impact in the functional limitation dimension, with improvements in motor function, and in particular the Gross Motor Function Measure (GMFM). There is a moderate degree of certainty that SDR results in improvements in the disability dimension, as evidenced particularly by improvements in the Functional Independence Measure for Children (FIM) and Pediatric Evaluation of Disability Inventory (PEDI) (**Steinbok, 2001**).

Indications of SDR in CP are severe regional spasticity, ambulant or severely disabled child, age from 3- to 10-year old, and the contraindication is dystonic Cerebral Palsy **(Mahran and Abdel Ghany, 2014)**.

Two different techniques are currently being used for SDR: one that involves a one or two level approach at the level of the conus and the other that involves a multi-level approach at the level of the nerve root exit foramina **(Ou *et al*., 2010).**

SDR yields durable reduction in spasticity after 10 years. Early improvements in motor function are present, but at long-term follow-up, these improvements were attenuated in Gross Motor Function Classification System (GMFCS) II and III and were not sustained in GMFCS IV and V **(Ailon *et al*., 2015)**.

Spinal deformities are significant problems in children with spastic cerebral palsy. The treatment of their spasticity by SDR may worsen or improve these problems **(Steinbok *et al*., 2005)**.

Children with spastic diplegia from CP experience measurable improvement in their spasticity and motor function following SDR. The role of this operation in the treatment of other spasticity causes is less well defined. SDR is a well-studied and effective therapy for lower extremity spasticity resulting from CP and may be beneficial in other types of upper motor neuron disease **(Gump *et al*., 2013).**

Spastic paraparesis in adult patients due to stroke can be treated with Selective Dorsal Rhizotomy (SDR) **(Eppinger *et al.,* 2015).**

The upper motor neuron lesions may be secondary to a cerebral vascular accident, head injury, spinal cord injury, or degenerative diseases such as multiple sclerosis, or perinatal brain injuries such as cerebral palsy **(Foran *et al.*, 2005).**

In United States (US) the of incidence rate of stroke is 183 per 100,000, the incidence rate of spinal cord injure (SCI) is 40 cases per million, the incidence rate of traumatic Brain Injury (TBI) is 538.2 per 100,000, the prevalence of Cerebral palsy (CP) to range from 1.5 to 3.0 cases per 1000 children ,and the prevalence for multiple sclerosis (MS) is 0.9 per 1000 (**McGuire, 2011)**.

Prevalence rate of CP among living children in El-Kharga District, New Valley (Egypt) was 2.04/1000 live births. The order of frequency of different subtypes of CP was as follows; spastic type is the most common type (65.4%), followed by mixed type (26.9%) and then ataxic and dyskinetic types (3.8% for each) **(El-Tallawy *et al.*, 2010)**.

The prevalence of stroke in Egypt among males was higher than females (1174/100,000 vs. 736/100,000) with a ratio 1.7:1. There was a significantly higher prevalence of ischemic (895/100,000) than hemorrhagic (68/100,000) stroke. Stroke prevalence was the same in rural and urban areas and in males and females **(Khedr *et al*., 2013)**.

The onset of spasticity is highly variable and may occur shortly or more than 1 year after stroke **(Ward, 2012).**

Currently available treatment options for treatment of spasticity include oral medications and interventional procedures. Oral medications comprise centrally acting agents, such as baclofen, clonidine, and tizanidine, as well as anticonvulsants such as benzodiazepines and Gabapentin and peripherally acting dantrolene. Interventional procedures include focal injections of Botulinum toxin, phenol or alcohol, and an intrathecal baclofen pump. Surgical treatments include selective dorsal rhizotomy and neurectomy **(Chang *et al*., 2013).**

AIM OF THE WORK

- The aim of this work was to review and justify the available knowledge on SDR for spasticity due to Upper Motor Neuron Lesions regarding selection criteria, outcomes and adverse events.

Pathophysiology of Spasticity

Definitions and characteristic

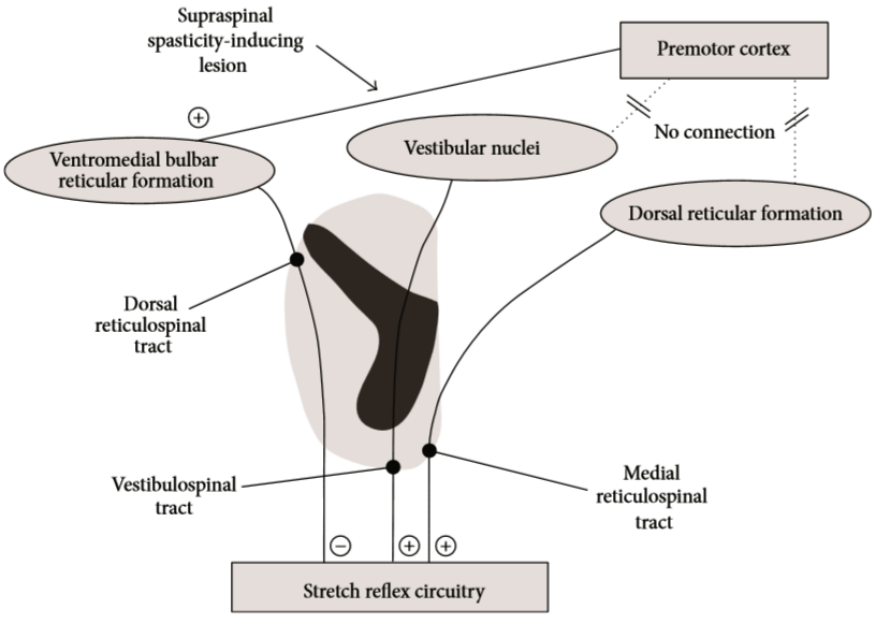
Spasticity is a motor disorder characterised by a velocity dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron syndrome **(Trompetto *et al.,* 2014)**.

Decq has suggested that "spasticity in general is defined as a symptom of the upper motor neuron syndrome (UMNS) characterized by an exaggeration of the stretch reflex secondary to hyperexcitability of spinal reflexes. He follows by separating the various components of spasticity into sub-definitions: (1) intrinsic tonic spasticity: exaggeration of the tonic component of the stretch reflex (manifesting as increased tone), (2) intrinsic phasic spasticity: exaggeration of the phasic component of the stretch reflex (manifesting as tendon hyperreflexia and clonus), and (3) extrinsic spasticity: exaggeration of extrinsic flexion or extension spinal reflexes **(Adams** and **AL Hicks, 2005).**

The upper motor neuron lesions may be secondary to a cerebral vascular accident (stroke), head injury, spinal cord injury, or degenerative diseases such as multiple sclerosis (MS), or perinatal brain injuries such as cerebral palsy (CP) **(Foran *et al.*, 2005).**

Spasticity is a component of the UMNS that is composed of positive and negative symptoms. The positive symptoms include hyperreflexia, clonus, spasms and postural abnormalities, and the negative symptoms include weakness, incoordination, fatigue, and pain **(Kirshblum, 1999)**.

The central lesion causing the UMNS disrupts the balance of supraspinal inhibitory and excitatory inputs directed to the spinal cord, leading to a state of disinhibition of the stretch reflex (Hypertonia) **(Fig-1) (Trompetto *et al*., 2014).**



(Fig-1): Schematic representation of the descending pathways modulating the stretch reflex circuitry **(Trompetto *et al*., 2014).**

Spasticity due to multiple sclerosis (MS)

the prevalence of multiple sclerosis (MS) in Egypt ranged from 0.4% at Assuit to 1.78% at Cairo with the overall prevalence is 1.41% or 14.1 in 1000 neurological patients. Also, the maximum distribution of cases was at Cairo 83.48% of all the cases and the lowest distribution was at Tanta. The female to male ratio was 1.6:1. pyramidal signs were the most frequent signs **(Hashem *et al*., 2010)**.

MS is an inflammatory, autoimmune, demyelinating disease of the central nervous system. It generally strikes at an early age, most often the early adult years. Its most frequent symptoms include numbness, impaired vision, loss of balance, weakness, bladder dysfunction, and psychological changes. MS owes its name to the presence of multiple sclerotic (hardened) lesions in the brain and spinal cord – multiple scars **(Parris, 2001)**.

The prevalence of spasticity in MS can be as high as 80%, and can be present clinically in a variety of ways. Clinically, spasticity can manifest as stiffness of a muscle, muscle cramping, clonus, or periodic muscle spasms (flexor and extensor) **(Hughes** and **Howard, 2013)**.