Selective Dorsal Rhizotomy (SDR) in SCOTLAND

INFORMATION FOR PHYSIOTHERAPISTS

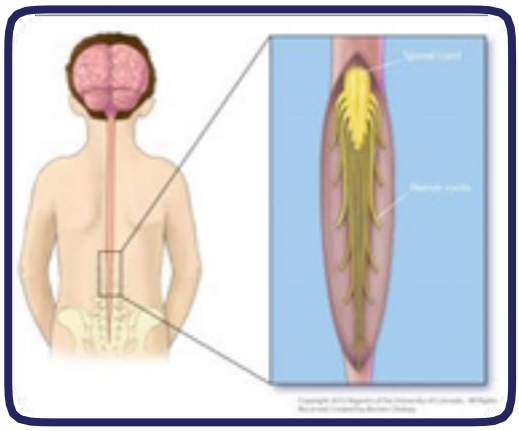
Background

What is Selective Dorsal Rhizotomy (SDR)?

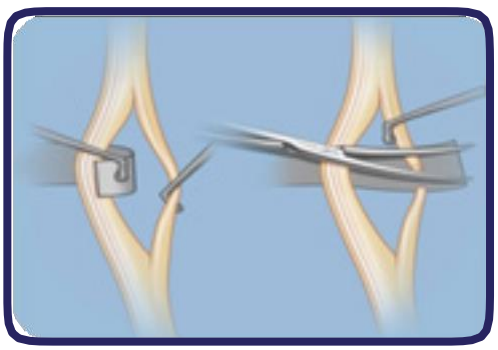
SDR is a neurosurgical procedure (SDR) used to improve spasticity in some children with spastic diplegic cerebral palsy.

What happens during the procedure?

SDR takes around four to five hours. A skin incision is made in the upper lumbar spine. The spinal canal is opened at level L1. An ultrasound probe is used to identify the lower end of the spinal cord. Under the operating microscope, the membrane covering the spinal cord is opened and the lower end of the cord, with the sensory roots entering it, is identified.



Each of the sensory nerve roots is then subdivided into four or five rootlets. Each rootlet is stimulated to identify the ones that contribute most to the spasticity – these rootlets are then divided. The process is repeated for all the other nerve roots, from L1 to S2, on both sides, aiming to divide 50 to 70 per cent of the sensory roots.



At the end of the procedure, the membrane covering the spinal cord is closed again, the back muscles are returned to their original position and the skin is closed with dissolvable stitches.

Which patients are suitable for this procedure?

The following referral selection criteria have been agreed with the Scottish SDR working group, in association with specialist centres throughout the UK.

The child should have a diagnosis of Spastic Diplegic Cerebral Palsy (CP).

History

- Age range 5–10
- Absence of chronic conditions which may contraindicate anaesthesia or adversely affect rehabilitation e.g. chronic lung disease, refractory epilepsy, severe visual impairment, severe learning difficulties, scoliosis
- Able to understand and comply with rehabilitation with good cognitive ability
- Well motivated, emotionally robust with no evidence of non compliance with physio/orthoses
- Good family/social support and agreed commitment to active participation in rehabilitation following surgery.

Examination

- Demonstrable lower limb spasticity—moderate to severe
- Ambulant: established GMFCS II to III (possibly high functioning IV)
- No predominant motor pattern of dystonia or involuntary movements
- Adequate lower limb extensor power >3 on MRC oxford scale, particularly in knee and hip extensors, hip flexors and preferably hip abductors
- Movement control at least moderate- isolate hip flexion (minimum), knee extension (better) and dorsiflexion (best)
- Good control of spinal posture
- MRC grade 3 muscle power in knee extensors, hip flexors and preferable hip abductors
- Balance at least moderate
- Absence of severe fixed joint contractures
- Absence of significant upper limb dysfunction that would impair ability to use walking aids independently
- Absence of significant concerns about weight management and obesity.

Investigation

- No hip dysplasia (<40% Reimers index)
- No scoliosis

- No basal ganglia change on MRI.

Are there alternatives treatments?

SDR is only one option in the management of spastic diplegia. It is an irreversible procedure which permanently reduces spasticity in the legs. Other therapies used to manage spasticity include oral tone-modifying medication, long-term commitment to exercise and activity with physiotherapy advice, botulinum toxin injections into the spastic muscles, intrathecal baclofen and multi-level orthopaedic procedures.

Oral baclofen, trihexphenidyl and other tone modifying medication can result in improvements in spasticity, but high doses can cause drowsiness and interfere with the child's ability to learn and concentrate. Introducing the drug slowly and incrementally can minimize the expected side effects and in some children, night time only dosing is helpful. Intrathecal baclofen therapy is another possible route for administrating baclofen however it is generally reserved for patients with severe whole body involvement.

Not every child with cerebral palsy will show benefit from this intervention. SDR surgery and the best results have been shown in series where a careful patient selection strategy was implemented. Dystonia may be unmasked when spasticity is relieved and may be even more difficult to manage. Children with poor proprioception or a primitive walking reflex pattern of gait may respond poorly after SDR due to further impairment of proprioceptive input.

Optimising the management of children with cerebral palsy requires repeated careful assessment during growth and development and a bespoke individual package of appropriate medication, therapy, orthoses and if needed orthopaedic or SDR surgery.

How can I refer one of my patients into this service?

Each local area will have a form of multidisciplinary team managing complex motor disorders and children with spasticity. These multidisciplinary (MDT) teams should discuss children potentially suitable for SDR and assess if they fit the referral criteria. If the local MDT agrees, the child should be referred via the SDR coordinator using the appropriate referral form (e-form available from SDRService@scottish.onmicrosoft.com).

Realistic outcomes and the limitations of all therapies should be discussed with the family as SDR may not be the "miracle cure" some families expect.

Families also need to be aware of and agree to an increased programme of home exercises following the procedure.

What information do I need to provide/assessments do I need to do?

- Full CPIPS assessment (pre-op and annually post-op)

- GMFM-66 (no more than 6 months prior to procedure) ** contact us for help if required.

Other referral Information required from local MDT

The child should have had:

- Recent gait analysis (< 6 months prior to referral). • Recent hip x-ray (Reimers<40% bilaterally)
- MRI brain and MRI spine.

Approval by the Physiotherapy Manager of the child's Health Board that appropriate community physiotherapy resource is available.

- If SDR is considered by the National MDT team to be the optimal tone management strategy then approval from the Physiotherapy Manager for the child's Health Board will be sought to confirm that appropriate community physiotherapy resources are available
- This will precede arranging an out-patient visit pre-operatively with the neuro- surgical team.

Is there any additional input required in the pre-operative period?

For children/families where you have concerns about compliance and the child's tolerance to an intensive exercise programme it is recommended they increase their home exercise plan to a more strict daily exercise (**pre-habilitation**) programme both to help strengthen and assess whether the child and family will be able to manage in the post-operative period. If they are unable to comply in the pre-operative period, it is unlikely the child will
fulfill criteria for referral for surgery.

Local community physiotherapists will provide the advice and programme of exercises required, based on the child's capability, ideally within the 6 week pre-operative period.

If the child does not have a **wheelchair**, they should have one ordered to be available prior to admission to hospital.

Where will the patient go for their surgery?

The inpatient SDR surgery and immediate post-operative inpatient rehabilitation will take place in either The Royal Hospital for Children, Glasgow or in The Royal Hospital for Children and Young People, Edinburgh.

How long will the child have physiotherapy in the hospital?

At present the children will be seen by the acute hospital based physiotherapy service for the first 3 weeks postoperatively, then a detailed handover will be given to transfer care back to the child's local community physiotherapist.

If convenient, the local physiotherapist will be invited to come into the hospital to have a joint session prior to hospital discharge.

What assessments/follow-up will the child have prior to/ following the SDR procedure?

Prior to surgery

The SDR acute physiotherapy service will complete some additional pre-op assessments with the child to get a baseline of additional outcome measures (see below).

At this point families will again be advised on the expectation required of them and their child following discharge and what to expect during the inpatient stay.

Following Surgery

- Neurosurgery: neurosurgical review at 3 months post-op
- Gait analysis: repeat gait analysis at 2 years post-operatively and at age 16 yrs with additional gait analysis on a problem-solving basis
- Local Physiotherapy Assessments: CPIPS yearly by local therapist, GMFM-66 at 6 months post-operatively then repeated at 1, 2, 5 and 10 years post-operatively
- Acute SDR Physiotherapy assessments: by SDR PT at centre where surgery was done at 6 months, 12 months, some at 24 months, 5 and 10 years post-op:
  - GM-FM 66 (if local physiotherapy service is unable to do this)
  - CPQOL (quality of life)
  - WeeGGI (gait score)
  - SCALE (selective motor control)
  - Muscle Power
  - BMI (height and weight)
  - Sensation, pain and continence
  - 10m walk and Timed up and Go test ○ 2 minute and 6 minute walk test.
- SDR National MDT discussion at 12 months and 24 months post-operatively.

The local physiotherapy team will receive feedback from these assessments and we will inform local physiotherapy services of appointments to allow for 2 way dialogue with regards to patients progress.

Orthotic Service and SDR

- SDR children are likely to need AFOs after surgery and most children already have AFOs which will be suitable for post-op rehab

- As part of the SDR pre-operative assessment an orthotist from the hospital will assess the child's orthoses and a plan will be made regarding the orthotic care required after surgery- they may require new AFOs prior to hospital admission which will be requested via the local orthotist where possible.

- The child may also require resting ankle splints (off-the-shelf heel pressure relieving AFOs) and Knee gaiters based on pre-operative assessment for use in the early post-operative period.

- If new orthoses are required, the orthotist from the operating centre may cast for required AFOs either pre-operatively or they may choose to cast the child in the initial days after surgery. This will be assessed on a case by case basis

- Post-operatively, the child will have a further orthotic assessment and fitting of new AFOs if they are required

- AFO review/adaptation will be arranged if required during the inpatient rehab period

- Ongoing orthotic care following discharge will be by child's local services

Recommended post-operative guidelines for physiotherapy

- Please keep in mind that individual time frames will differ for each patient.
  This is intended to be a general guideline for the progression of the post-operative physiotherapy

- We expect that children will function at different levels and improve at different rates with varying physiotherapy goals. Please use this as a guide only

- Adapt and progress the child's home exercise programme as indicated.

Precautions/Things to expect

For the first 4 to 6 weeks after surgery

- **No passive hip flexion past 90 degrees.**
  - The patient can perform hip flexion actively to his/her tolerance

- **No passive trunk rotation/lateral flexion into extremes of range.**
  - The patient can perform this actively to his/her tolerance

- **Hamstring stretching should be done with care and limited by back pain** (not discomfort caused by the stretching of the hamstring muscles)
- Because of increased weakness in the feet and ankles, any necessary orthoses should be worn during all standing and walking activities
- Expect some **sensory changes** in the lower extremities, this may include some hypersensitivity on the plantar surfaces of the feet. This may be alleviated by handling feet firmly and wearing socks and shoes. This hypersensitivity usually resolves in the first 6–8 weeks. Gabapentin therapy can also be helpful
- As the oedema resolves around the site of the surgery, a bump may appear just above the scar. This is the spinous process of T12 or L1 and should not be a cause for concern
- It is common for the child to **tire more easily** than normal
- The child will have a change in movement patterns and control which they may find frustrating. Changes in behaviour such as irritability and frustration are common as the child learns that movement feels different
- Patients may not have the motor control and/or strength to produce the desired movement
- Hydrotherapy may begin 2–3 weeks after surgery (once wound is healed)
- Swimming may begin 4 weeks after surgery
- **Do not** begin or resume electrical stimulation of any kind until 6 weeks after surgery
- **Do not** begin horse riding or contact sports until 6 weeks after surgery

Please consider antigravity muscle strength before changing the style of the child's orthotics.

Physiotherapy advice during intensive (acute post-op) rehabilitation episode

- Take advice from the neurosurgeon regarding when the child is allowed up to sit/ stand and walk- children are usually allowed up day 3 post op
- When on bed rest (3 days) in the immediate post-op period, ensure the child maintains a clear airway and is taking big breaths- practicing bubbles or blowing games are beneficial
- During the bed rest period, maintain lower limb ranges of movement within the child's pain tolerance, avoiding hamstring stretches and encourage as much active lower limb movement as the child can tolerate (they will find isolating movements very difficult)
- Maintain close observation of pressure areas due to altered sensation
- Ensure the child has adequate analgesia to cover physiotherapy sessions
- Work initially with the family to get their child out of bed and progress to independent transfers
- Introducing a tilt table/standing frame for initial weight bearing may be indicated from day 4–5
- Gradually introduce rehabilitation exercises
- The child should walk as much as possible as soon as they are able and walking causes no discomfort. Close supervision should be provided until child is safe in ambulation with or without an assistive device. Child should be encouraged to walk even if the pattern is not yet ideal
- Liaise with the orthotist regarding orthoses
- Ideally children requiring walkers should have a posterior walker with swivel front wheels that can be locked in a non-swivel position. Other components may be needed e.g. hip guides/folding seat, and assessed on a needs led basis
- Increase range of motion where limited through stretching and use of splinting such as gaiters/pressure relieving AFOs at night while sleeping. Most commonly shortened muscle groups are hamstrings, hip flexors (iliopsoas and rectus femoris) and gastrocnemius
- Strengthening programme should concentrate on the following areas:

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  - Trunk, especially lower abdominals
  - Lower limb muscles, through full range now available to the child
  - Eccentric as well as concentric control of anti- gravity muscles.

- Specific activities may include:
  - Work in four point and half high kneeling
  - Facilitated transfers
  - Trunk control/weight shift in sitting in some children ○ Work on weight transference and side stepping ○ Gait re-education.

- Education of family regarding home exercise programme and what to do at weekends during in patient episode
- Normal movement patterns will be facilitated and encouraged in all activities
- Adjuncts to therapy may also be used such as treadmill training.

Treatment goals during first 3 weeks

- Development or increase of weight bearing through lower limbs
- Development of isolated movements in lower limbs
- Improvement of postural alignment and movement transitions within/between positions,
  i.e. sitting, high kneeling, half kneeling, standing and ambulation
- For children who are not yet walking independently with or without an assistive device, a standing frame/tilt table may be indicated.

Physiotherapy advice/goals of treatment following hospital discharge/transfer back to community physiotherapist teams

- The child and their family will be provided with a home exercise programme
- The hospital physiotherapist will contact the local community physiotherapist to handover any specific advice and discuss the child's engagement with rehab and where they have progressed to with their rehabilitation programme

- A detailed written handover including the recommended home exercise programme will also be given

- Any post-operative specific advice such as the need for serial casting or feedback regarding referral back to local orthotic services will also be given

- The local physiotherapy teams are advised to make contact with their patient as soon as possible post discharge to ensure the family understand the programme they have been given and the physiotherapist can address any concerns or difficulties that have arisen since discharge.

- Following discharge children will need an increased intensity of rehabilitation to progress balance, strength, endurance and control of their movement

- An improvement in gross motor function post SDR surgery is facilitated by adherence to a home exercise programme and “as required” access to post-operative physiotherapy

  Local physiotherapists need to be aware of what is available in their area and make families aware of the frequency of input they are able to offer

- Consider and be aware that the child may have underlying low tone or occasional dyskinesia emerging following reduction of spasticity- ongoing assessment is required.

- **Equipment Needs** Post SDR a child may have a change in function and therefore require access to additional equipment e.g. Kaye walker/tripods/standing frame/ orthotic services.

- **Orthotic Services** Post SDR each child will require additional orthotic provision. As these children progress they will require a combined physiotherapy and orthotic review every 3–4 months.

- **School** Some children may take time to return to their pre-operative levels of endurance and will fatigue more quickly. For those children who may find full days/ weeks at school difficult to start with, a phased return may be indicated.

- **Progress** The child may continue to progress up to 2 years following surgery and some continue to improve up to 5 years post-op.

  Where a child’s abilities plateau but there is an expectation that they have further potential to improve, feel free to contact the SDR PT to discuss if you would like advice.

Physiotherapy Home Exercise Programme should focus on:

Strengthening

- Previously spastic muscles will now present with marked weakness and will require strengthening

- Particular attention should be given to the following muscle groups:
  - Abdominals and trunk extensors
  - Hip extensors, abductors and adductors
  - Knee extensors
  - Ankle dorsiflexors and plantarflexors.

- Gastrocnemius, Soleus and Hamstrings are also typically weak at the mid and end range and especially at the lengthened position of the muscle. Attention should be given to strengthening lower extremity muscles at the end of available passive range of motion

- Particular focus should be given to inner range strengthening in antigravity muscles

- Ensure that both concentric and eccentric strengthening is practiced through full available range

- Closed Kinetic Chain activities are particularly useful and more functional (foot in contact)

- Weakness in calf muscles is almost always a problem for children with cerebral palsy. Weakness in Gastrocnemius and Soleus can cause crouch gait or toe walking and therefore must be addressed in the strengthening programme

- Targeted Strength Training is a useful component of a strengthening programme— recent advice is demonstrating bigger benefits with loading muscle groups— be aware of child's 1 Repitition maximum (RM) (train at 80% × 8 × 3 sets or 75% × 10 × 3 sets)

- Muscles are listed below in usual order of greatest weakness and therefore therapy should be focused on addressing these:

  1. Gastrocnemius and Soleus
  2. Gluteus maximus and medius
  3. Hamstrings
  4. Quadriceps
  5. Tibialis anterior.

Range of Motion/ Flexibility

- In children with a loss of muscle flexibility, an ongoing programme of exercises to maintain ROM is required

- This may include night-time maintenance of joint ranges with night AFO's and knee gaiters and in rare cases a sleep system.

Posture/Proprioception and Balance

- Reduction of sensory feedback after SDR will result in reduced proprioception and balance. The child may also have underlying low tone which also challenges their postural alignment.

- Re-education of balance and postural alignment should be practiced in any/all of the following positions, as appropriate

  - Sitting
  - High kneeling (as a transition)
  - Half kneeling
  - Standing.

- Once static balance in a certain position is achieved, progress to dynamic activities.

- Use of a therapy ball or peanut should be considered for core strengthening/ dynamic balance re-education

- Consider alignment and core stability with mat work (modified Pilates (APPI))

- Lightweight ankle weights may be helpful to increase proprioception during therapy sessions.

Movement re-education and isolation of movement

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- Following reduction of spasticity, re-education of transition movements in normal movement patterns will be required e.g. lying to sitting, rolling, sit to stand, floor to standing through half kneeling

- Some children may now be able to achieve certain positions for the first time such as side sitting, cross leg sitting, half kneeling

Significant reduction in spasticity will enable isolation of joint movements that were previously performed as a mass pattern e.g. dorsiflexion with knee extended, knee extension with hip flexion

- Isolated joint movements will require regular individual practice e.g. ankle dorsiflexion

- FES can be considered > 6 weeks post op as an adjunct to movement re- education.

Gait re-education/ training

- The child should be encouraged to do lots of walking in the rehabilitation period and should be encouraged to rely less on wheelchair use as strength improves

- Following reduction in spasticity and decreased proprioception, significant gait re-education will be required

- Address the individual components of gait (**stride length**, hip extension, terminal knee extension and propulsion) to improve smoothness, coordination, and level of independence in ambulation. Focus should be on improving **alignment and weight shift**

- Successful gait re-education requires ongoing assessment and appropriate progression to less supportive orthoses (where appropriate) and mobility aids, based on clinical need

- Treadmill training is a useful adjunct to gait re-education (when possible/available)
- Lightweight ankle weights may be helpful to increase proprioception during therapy sessions

- Endurance and walking speed can be addressed in later stages of rehabilitation.

Equipment which may be helpful

Consider the use of the following to assist with treatment sessions, depending on child's capability and interests and availability locally:

- Therapy ball/ peanut/ roll
- Therapy bench

- Exercise Step
- Football/ goal
- Parallel bars
- Treadmill
- FES
- Ankle weights
- Resistance bands
- Hula Hoop
- Standing frame
- Agility ladder
- Balance beam

Activities to supplement physiotherapy programme

- The following standard forms of activities are a useful addition to complement the therapy programme, depending on the child's capability:
  - swimming
  - soft play
  - playgrounds and parks
  - walking
  - cycling (static bike/ tricycle)
  - scooter
  - football
  - horse riding (6 weeks post op)/i-joy
  - Wii fit active games/X-box Kinect
  - climbing walls
  - multi-gym/gym programme
  - trampoline (12 weeks post op) ○ frame football
  - race running.

Progression

Continue to develop strength, balance, coordination, speed and endurance with the addition of sports, dance and recreational activities.

Who can I contact for further information/advice?

Edinburgh Paediatric Neurosurgery Physiotherapy Service:

Valerie Kennedy | Highly Specialist Paediatric Physiotherapist

Royal Hospital for Children and Young People
Edinburgh, EH16 4TJ

Email: val.a.kennedy@nhslothian.scot.nhs.uk
Tel: 0131 536 0337

Glasgow Paediatric Neurosurgery Physiotherapy Service:

Magalie MacKay | Highly Specialist Paediatric Physiotherapist

Royal Hospital for Children
Glasgow, G51 4TF

Email: Magalie.mckay@ggc.scot.nhs.uk
Tel: 0141 452 4803

For e-Referral Form/Other information:

Jacqueline Clark | SDR Co-ordinator

Zone 2 Area 2, Office Block
Queen Elizabeth University Hospital Campus
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Email: SDRService@scottish.onmicrosoft.com

Further information for professionals and families/children

Managed Service Network for Neurosurgery:

www.msn-neuro.scot.nhs.uk