Selective dorsal rhizotomy for spastic diplegia

Exceptional healthcare, personally delivered
Cerebral palsy and spasticity

Cerebral palsy occurs when a child sustains a brain injury very early on in life. Although the brain injury is static, its effects change continuously in the growing child. The commonest cause is premature birth. This causes damage to some of the bundles of nerve fibres in the brain, particularly the motor nerves that control leg movement. These nerve fibres run down from the brain to the spinal cord and control contraction of the limb muscles. If these fibres are damaged, the limb muscles contract too much and become stiff. This stiffness, or spasticity, interferes with children’s ability to move and to learn to walk. Spasticity also causes pain, and, over time, shortening of muscles and tendons, joint contractures and severe deformities.

One of the patterns of muscle stiffness in cerebral palsy is spastic diplegia. This predominantly involves the muscles of the thighs, legs and feet. Nerve fibres running from the muscles back to the spinal cord play a major role in maintaining this excessive muscle stiffness. This is why dividing some of these fibres tends to reduce stiffness and spasticity. This is the basis of selective dorsal rhizotomy (SDR).

What is selective dorsal rhizotomy?

SDR was first performed in the early 1900’s, when complete division of all the nerve roots to the lower limbs was performed. Although this did lead to improvement in spasticity, it also caused severe muscle weakness, as well as loss of skin sensation and joint-position sense. The current technique, in which only those nerve rootlets that contribute most to the spasticity are divided, was introduced in 1978.

The current technique involves surgery in the lower back. The procedure is performed under general anaesthesia and takes around four to five hours. The technique we use is the same as that developed in St Louis in the USA. A skin incision is made in the upper lumbar spine. The spinal canal is opened at only one level. An ultrasound probe is used to identify the lower end of the spinal cord. The tough tissue covering the spinal
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cord is opened and the lower end of the cord, with the sensory roots attached, is identified. Each of the sensory nerve roots is then subdivided into four or five rootlets. The rootlets that contribute most to the spasticity are identified by sequential stimulation and are subsequently divided. Between 50 and 75% of these nerve roots are divided during the procedure. The procedure is performed under the operating microscope. At the end of the procedure, the cover of the spinal cord is closed again, the back muscles are re-approximated and the skin is closed with absorbable sutures.

Is my child suitable for SDR?

Children between four and eleven years of age, with a diagnosis of spastic diplegia, following premature birth, should be considered for SDR. Children older than eleven are also considered on a case by case basis. Children with typical spastic diplegia, whether born prematurely or at term, should also be considered. There should be no significant damage to the areas of the brain involved in posture or coordination; this would be determined by a magnetic resonance scan of the brain.

Children suitable for SDR need to demonstrate adequate muscle strength in the legs and trunk. Their ability to support their full weight on their feet, to hold their posture against gravity, and to make appropriate movements to crawl or walk is evaluated. These children tend to have delayed motor development, and spasticity interferes with their progress.

Regular post-operative physiotherapy is necessary to obtain the best results after SDR and suitable children need to be motivated and show that they are able to cooperate with therapy. Although it is ideal that children
undergo SDR prior to orthopaedic surgery, if the latter has already been performed, it is recommended to delay SDR by at least six months to allow muscle strength to recover.

Some causes of cerebral palsy are not suitable for SDR. Children who have a history of meningitis, congenital infection, hydrocephalus unrelated to prematurity or head trauma do not do well with SDR. Similarly, children with severe muscle rigidity, poor muscle tone or dystonia do not benefit from SDR. SDR is also not very effective for children with severe cerebral palsy involving the whole body or when one side of the body is very weak. In children with severe scoliosis, SDR is not generally recommended as it may cause the existing spinal curvature to deteriorate.

**How will you find out whether SDR is the best option for my child?**

Most children are referred by a paediatrician, orthopaedic surgeon or neurologist. We will first organise an appointment to see you with your child at the neurosurgical spasticity clinic. At this clinic, the benefits and potential risks of SDR are discussed. We would also aim to have a full and frank discussion about your expectations, the consideration of other options and the need for post-operative physiotherapy.

We would then plan for a formal physiotherapy evaluation; this is carried out by two paediatric physiotherapists, with extensive experience in cerebral palsy. The evaluation is video recorded. This then forms the basis of a further multidisciplinary discussion, which would also involve a paediatric neurosurgeon, paediatric orthopaedic surgeon and a paediatric neurologist. At this stage, the brain scans, as well as the spine and hip x-rays, are reviewed. The aim of this meeting is to decide whether a child is suitable for SDR or whether other options may be potentially better. If the decision to proceed to SDR
is taken, a gait lab study, which will serve as a pre-operative baseline, is also performed.

**What happens before surgery?**

You and your child will be asked to come to the Barbara Russell Children’s Unit in Bristol one more time before the planned operation date. On this occasion, one of our paediatric neurosurgical nurse practitioners will see your child and make sure that there are no medical problems that would need to be sorted before he or she is safe to have surgery and anaesthesia. You will also be seen by our orthotist, who will prepare the splints and orthoses required for the first few months after surgery. We will then ask you to come to the hospital a day before the planned operation date. You should expect to be in hospital for about three weeks. Although we cannot guarantee that a family room will be available, we will do our best to make sure all your accommodation needs are met.

We will have an opportunity to discuss the surgery again with you and to answer any questions you may have. Your child will be asked not to have anything to eat or drink from midnight on the day of surgery. You will meet your anaesthetic team that morning, before accompanying your child to the anaesthetic room in theatre.

**What happens after surgery?**

After surgery, your child is taken to the high-dependency unit for an overnight stay. This facilitates close monitoring and ensures optimal pain control, usually by a combination of intravenous and epidural medication. The child is encouraged to lie on the back, but will be helped to turn from side to side every four to six hours. It is also normal for children to complain of headache at this stage.

On return to the neurosurgical ward the intravenous analgesia is reduced slowly. The bladder catheter is removed three days after surgery. Gentle physiotherapy in the bed is started on
day two. It is usual for children to have some numbness in their legs, and often some difficulties passing urine, in the first week. The legs will be less stiff than before surgery, but may also at this stage be significantly weaker.

Your child will be encouraged to start sitting out of bed on day three. Physiotherapy is then gradually increased, paying particular attention to maintaining good trunk balance and range of movement in the lower extremities. Muscle strengthening exercises are begun. In-patient physiotherapy will continue up to three weeks post-operatively, when most children would be ready for discharge. The aim of this programme is to continue to develop strength in the lower limbs, trunk and pelvis, increase range of movement in the legs, develop isolated lower extremity movements, and to develop and improve walking. All this takes time, and will be continued after hospital discharge through the local physiotherapy services. Parents will have the opportunity to learn how to participate in the rehabilitation process and will be given a home programme to follow.

Complications after SDR are rare. These include infection, leak of cerebrospinal fluid from the wound, development of a fluid collection below the skin, severe leg weakness and incontinence. In addition, there are risks associated with general anaesthesia, but these also are very rare.

The child will be followed up in the spasticity clinic three months post-operatively, and then again at 6, 12 and 24 months. These clinics will also involve a physiotherapy review. A gait lab evaluation will be repeated at two years. An open door policy will be maintained if any difficulties develop in the post-operative period.
What can I expect SDR to achieve?

SDR unmasks the leg weakness inherent to cerebral palsy. Although reduction in spasticity is immediate after the procedure, it takes time for the strength in the lower extremities to return. Through the physiotherapy programme, the child will learn to use his or her body in a new way. Many children develop hypersensitivity in the soles of their feet after surgery; this is transient and will improve on wearing thick socks. There may also be a transient bladder disturbance; this may cause a change in toilet habits and could be frustrating for both the child and the parents. It will become apparent with time that lower limb movement becomes easier and the level of control, dexterity, range and speed increases, although it may take up to two years for the full benefit of the procedure to become apparent.

There is now enough evidence to demonstrate that SDR is associated with long-term benefits. These are not only related to reduction in spasticity, but also relate to improved movement and gait and improved quality of life for both the children and their families. One study has shown that the benefits obtained one year after SDR were maintained twenty years after surgery. A reduction in the need for orthopaedic procedures after early SDR has also been demonstrated. Some relevant references may be found at the bottom of this leaflet. The most recent NICE guidelines may be found at

http://www.nice.org.uk/nicemedia/live/11220/52085/52085.doc
[Last accessed July 2011]
Are there any other options?

Early SDR is one option in the management of spastic diplegia in children with CP. It is the only procedure to permanently remove the spasticity in the lower limbs, which is the primary cause of disability and long-term deformities. There has in the past been some anxiety about the irreversible nature of this procedure. However, its effectiveness at reducing spasticity and improving quality of life has now been clearly demonstrated in several randomised trials and large prospective patient series.

Alternatives to SDR in spastic diplegia include long-term physiotherapy alone, use of botulinum toxin A injections into the spastic muscles, and multi-level orthopaedic procedures. The latter do not alter the background spasticity and may need to be repeated as the child grows and deformities progress; botulinum toxin injections need to be repeated frequently and become less effective over time. Oral baclofen does result in some improvement in spasticity, but doses high enough to do so often cause drowsiness and interfere with the child’s ability to learn and concentrate at school. Intrathecal baclofen therapy is another possible option. This requires a commitment to regular pump refills and exposes children to the risks of baclofen overdose and withdrawal as well as hardware malfunction; it is generally reserved for patients with severe whole body involvement. It should be noted, however, that not every child with cerebral palsy requires intervention, and some children are able to lead full and happy lives with physiotherapy alone.
References and sources of further information


Park TS, Gaffney PE, Kaufman BA, Molleston MC: Selective lumbosacral dorsal rhizotomy immediately caudal to the conus medullaris for cerebral palsy spasticity. Neurosurgery 33:929-933; discussion 933-924, 1993

If you or the individual you are caring for need support reading this leaflet please ask a member of staff for advice.

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