Surgical Outcomes of Single-Level Bilateral Selective Dorsal Rhizotomy for Spastic Diplegia in 150 Consecutive Patients

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■ OBJECTIVES: **Selective dorsal rhizotomy (SDR) is used to improve spasticity, gait, and pain in children with spastic diplegia. There is growing evidence supporting its long-term benefits in terms of functional outcomes, independence, and quality of life. There is, however, little contemporary work describing the surgical morbidity of this irreversible procedure. The purpose of this study is to evaluate the surgical outcomes and complications of SDR at a single United Kingdom center.**

■ METHODS: **Demographics, surgical, postoperative, and follow-up data for all patients undergoing SDR between 2011 and 2016 were collected from medical records.**

■ RESULTS: **Preoperative Gross Motor Function Classification System levels in 150 consecutive patients were II (35%), III (65%), and IV (1%). Median age was 6 years and 58% were male patients. There were no deaths, cerebrospinal fluid leaks, returns to theater, or readmissions within 30 days. There were no new motor or sphincter deficits. Postoperative neuropathic pain was reported by 5.3% and sensory symptoms by 8.7%. Other complications included: postoperative nausea and vomiting (19.3%), superficial wound infection (3.3%), urinary retention (1.3%), headache (6.7%), and urine or chest infection (4.7%). Follow-up data were available for all patients (93% to 12 months, 72% to 24 months). Persistent neuropathic symptoms were reported in 6.5% at 24 months.**

■ CONCLUSIONS: **SDR using a single-level approach is a safe procedure with low surgical morbidity. This study complements the growing evidence base in support of SDR for spastic diplegia and should help inform decisions when considering treatment options.**

INTRODUCTION

Cerebral palsy (CP) has a prevalence of 2–3 per 1000 live births,[1] and leads to a spectrum of disabilities from mild spasticity of 1 limb to severe dyskinetic spastic quadriparesis leaving individuals wheelchair-bound and heavily dependent.[2] Severity of CP can be classified by the Gross Motor Function Classification System (GMFCS) from grade I to V.[3] Even in its milder forms pain, spasms, and gait disturbance can impact negatively on a child's quality of life. In adulthood, this may lead to disadvantages in social and employment opportunities and the development of psychological symptoms.[2] Selective dorsal rhizotomy (SDR) is a procedure shown to be effective at reducing spasticity by downregulating the overactive spinal reflex in CP.[2-5] The long-term benefits remain

Key words
- Cerebral palsy
- Complications
- Operative outcomes
- Selective dorsal rhizotomy
- Spastic diplegia

Abbreviations and Acronyms
CP: Cerebral palsy
CSF: Cerebrospinal fluid
GMFCS: Gross Motor Function Classification System
NHDU: Neurosurgical high dependency unit
SDR: Selective dorsal rhizotomy

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Table 1. Selection Criteria and Outcome Measurements for Children Undergoing Selective Dorsal Rhizotomy

Selection Criteria
Diagnosis of spastic diplegia with periventricular leukomalacia evident on magnetic resonance imaging and no evidence of dystonia
Gross Motor Function Classification System level II or III
Aged 2—18 years
Multi-level spasticity of lower limb muscles
Moderate to good lower limb antigravity strength and selective motor control
Rivermead Mobility Index (assessing hip subluxation) of <40%
At least 3 months since last botulinum toxin injection
At least 6—12 months following previous orthopedic surgery
Good engagement from child and family to participate in intensive rehabilitation program
Outcome Measures
Passive range of motion
Tone—Modified Ashworth Score
Strength—Medical Research Council Scale
Selective Motor Control—Boyd and Graham Selective Motor Control Scale
Gross Motor Function Measure (GMFM 88 and 66)
Gross Motor Function Classification System level
Cerebral Palsy Quality of Life (includes a pain score)
Movement Assessment Battery for Children
Pediatric Evaluation of Disability Inventory—self-care domain
3-dimensional video gait analysis

contentious, however there is increasing evidence that for a selected group of ambulant patients (mainly spastic diplegia GMFCS II and III), sustained improvements in lower limb muscle tone and gross muscle function are achieved.[6,7] This translates into a reduction in the need for orthopedic interventions with improved independence and quality of life.[3-5,8]

SDR was first used for spasticity more than a century ago but its high morbidity limited its application. It re-emerged in the 1980s with the advent of intraoperative neurophysiological monitoring and the procedure has been further developed since.[5,9] Improvements in intraoperative neurophysiological monitoring, microsurgical instrumentation and microscopes, and the minimization of the approach to a single-level opening rather than a multi-level laminectomy[10] have contributed to this procedure gaining popularity in the management of spastic diplegia. Recently publications have promoted the wider application of SDR, including the management of tone in higher GMFCS level (non-ambulant) groups and non-CP related spasticity.[11-15] There is very limited data in the modern literature concerning surgical morbidity and complication rates to support decision-making. The aim of our study was to comprehensively audit the safety and efficacy of our local management protocol by analyzing surgical complications and functional outcome data. In this article, we present the surgical complications and morbidity. This will be followed by a series of articles investigating functional outcome, prognostic markers, quality of life, and their relation to surgical technique.

MATERIALS AND METHODS

Data for all patients undergoing SDR between May 2011 and August 2016 were collected using a customized database. Multiple outcome measures, including pre- and postoperative functional scores, were collected prospectively for all patients. Postoperative surgical complications were identified from retrospective case-note review for the first 106 cases (before May 2014) and prospectively for the subsequent cases. This study was registered with and approved by the local clinical audit department.

Selection Process and Preoperative Evaluation

During the study period, both National Health Service and self-funded patients were enrolled into the SDR program. Our comprehensive spasticity program has been developed to ensure that SDR is only offered to patients who have a reasonable potential to benefit from surgery. Once identified as a potential candidate, patients undergo rigorous clinical assessment by the multidisciplinary team consisting of neurosurgeon, neurologist, pediatric orthopedic surgeon, and specialist physiotherapists. Evaluation of the functional status is video-recorded, and all candidates undergo 3-dimentional gait analysis. Spine and hip radiographs to assess scoliosis and degree of hip subluxation are undertaken. Magnetic resonance imaging of the brain to confirm the presence of periventricular leukomalacia is also required preoperatively. The complete evaluation is presented at the pediatric spasticity multidisciplinary team meeting before patients are accepted for surgery. All patients attend a comprehensive preoperative assessment (advanced nurse practitioner led) allowing same-day admission for surgery. A summary of selection criteria and functional measurements are provided in **Table 1**.

Surgical Protocol: Single-Level Approach

Patients are admitted to the hospital on the morning of the planned procedure. A single preoperative dose of gabapentin is administered, and it is continued postoperatively, for up to 3 weeks' duration depending on sensory symptoms.

Anesthesia is maintained with isoflurane (minimum alveolar concentration of 0.7—0.8) and remifentanyl to minimize interference with intraoperative electromyography. Propofol is avoided because of severe muscle spasms that can occur during electrical stimulation of the sensory nerve rootlets.[16]

Patients are positioned prone with the head lower than the lumbar spine to minimize cerebrospinal fluid (CSF) loss and postoperative low-pressure symptoms. Using fluoroscopy, the T12-L1 level is identified and a small (approximately 1.5—3.0 cm) midline incision is made. Subperiosteal dissection of the paravertebral muscle is undertaken followed by a single-level intersegmental fenestration. The level of the conus is confirmed using ultrasound, with extension to a complete laminectomy at either T12 or L1, if required, to access the conus. Following meticulous epidural hemostasis, the dura is opened at the caudal part of the

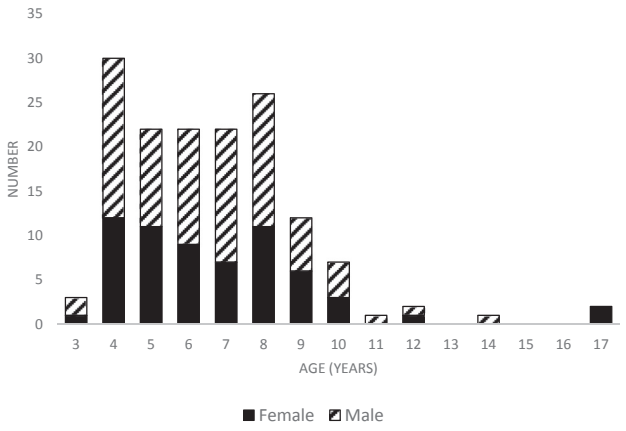

Figure 1. Age distribution of children undergoing bilateral selective dorsal rhizotomy from 2011–2016.

conus and retracted with 6/o polypropylene sutures. Irrigation is avoided during the SDR itself to avoid interference with intraoperative neurophysiological monitoring of responses.

With all the roots exposed, the dorsal roots from L2 to S2 are isolated using a silastic sloop, with the exiting L1 dorsal roots separately identified. Confirmatory checks to ensure all dorsal roots are contained within the sloop are made using neurophysiological monitoring. The dorsal (sensory) roots on 1 side are sequentially identified from L1 to S2, divided into fascicles and tested electrophysiologically. Differentiation between motor, sensory, and sphincter (either motor or sensory) fascicles and confirmation of the root level is achieved by fascicle stimulation and detection of the "threshold amplitude" at which a response is elicited. Direct stimulation of a ventral (motor) root/fascicle will produce a response at a low intensity, typically 0.2–0.4 mA, whereas a higher amplitude is required to excite the monosynaptic reflex response after stimulation of the dorsal (sensory) roots. Tetanic stimulation of each dorsal root fascicle is then undertaken by stimulating for 1 second using a 50 Hz pulse and the spread of the response graded as described by Park and Johnston.[10] Fascicles are grouped according to grading with the most abnormal responses (i.e., spread beyond their segment or to the contralateral side) selected for sacrifice, with 66% of L1 to L4 dorsal roots and 75% of L5, S1, and non-sphincteric S2 dorsal roots sectioned. All motor and sphincter stimulating fascicles are preserved. The process is then repeated on the other side.

Table 2. Gross Motor Function Classification System Level of Children Undergoing Selective Dorsal Rhizotomy From 2011–2016

GMFCS Level	Number of Patients	Percentage of Patients
I	0	0%
II	52	35%
III	97	65%
IV	1	1%
V	0	0%

GMFCS, Gross Motor Function Classification System.

Table 3. Postoperative Care of 150 Consecutive Cases of Selective Dorsal Rhizotomy

Characteristic	Value or n (%)	
Postoperative nights on NHDU		
0	1	(1)
1	20	(13)
2	65	(43)
3	58	(39)
4	4	(3)
Not known	2	(1)
Postoperative opiate analgesia		
Oxycodone PCA/NCA	125	(83)
Morphine PCA/NCA	20	(13)
Oral opiate	1	(1)
Not known	4	(3)
Initiation of gabapentin		
Preoperatively	136	(91)
Postoperatively	13	(9)
Not known	1	(1)
Duration of gabapentin treatment		
Median (IQR)	21 days	(14–45)
Catheter removal, postoperative day		
0	2	(1)
1	2	(1)
2	14	(9)
3	123	(82)
4	6	(4)
Not known	3	(2)

NHDU, neurosurgical high dependency unit; PCA, patient-controlled analgesia; NCA, nurse-controlled analgesia; IQR, interquartile range.

A watertight dural closure is made with 6/o polypropylene suture and a spinal sealant (DuraSeal Xact; Integra LifeSciences, Plainsboro, New Jersey, USA). The wound is closed in multiple layers with absorbable subcuticular suture to skin.

Postoperatively, patients are cared for on flat bed rest for 48 hours initially in a pediatric neurosurgical high dependency unit (NHDU). Analgesia is maintained with regular paracetamol and gabapentin. Diazepam and an intravenous opiate (oxycodone or morphine) nurse-controlled or patient-controlled analgesia is used as required. We do not use epidural or spinal anesthesia or lumbar drains. All intravenous fluids and lines are removed as soon as oral analgesia is fully established. A urinary catheter is kept until day 3

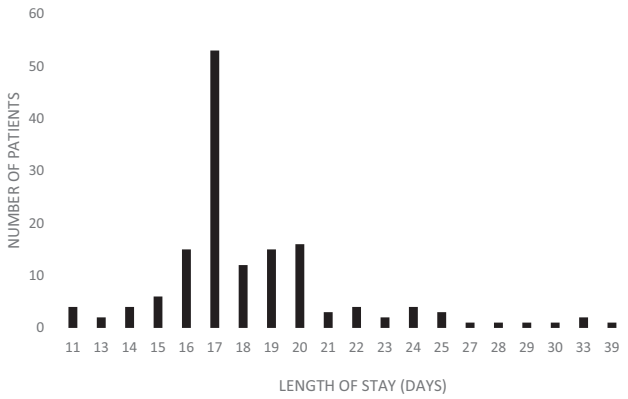

Figure 2. Length of stay for selective dorsal rhizotomy.

when mobilization is started with a physiotherapist. Following this, patients are transferred to a pediatric neuroscience ward where a 14-day intensive rehabilitation program is commenced. They are normally discharged with a personalized physiotherapy plan on day 17. Longer stays are sometimes required if further orthopedic procedures, such as tendon release, are required to facilitate rehabilitation.

Follow-Up

Follow-up examinations are undertaken at 6 months, 12 months, and 24 months after surgery, although patients have open access for advice. Follow-up data are prospectively recorded in our SDR database.

RESULTS

Patients and Demographics

One hundred fifty children aged 3–17 years underwent bilateral SDR between May 2011 and August 2016. The median (interquartile range) age at operation was 6 (5–8) years and 58% were male patients (Figure 1). Preoperative GMFCS levels are shown in Table 2. The majority (64%) of patients received National Health Service funding for their treatment.

Table 4. Additional Postoperative Complications Reported

Complication	Frequency
Urine or other infection	4
Gabapentin intolerance/adverse reaction	4
Lower respiratory tract infection	3
Opiate adverse reaction	2
Allergy to dressing	1
Pressure sore	1
Hallucinations	1
Dystonia	1

Table 5. Follow-Up of 150 Consecutive Patients

Outcome	6 Months (n = 150)	12 Months (n = 142)	24 Months (n = 108)
Attended	149 (99.3%)	135 (95.1%)	92 (85.2%)
Did not attend	1 (0.7%)	4 (2.8%)	3 (2.7%)
Awaiting assessment	0	3 (2.1%)	6 (5.6%)
Unknown			7 (6.5%)
Total	150	142	108

Surgery and Postoperative Course

Surgery was performed by 3 consultants (K.A., I.P., R.E.), responsible for 35 cases, 54 cases, and 61 cases, respectively. Sixty-three (42%) cases were jointly performed by 2 consultants to minimize any learning-curve effects and provide internal quality

Table 6. Surgical Outcomes at 6 Months, 12 Months, and 24 Months Postoperatively

	n (%)					
Characteristic	6 Months (n = 149)		12 Months (n = 135)		24 Months (n = 92)	
Neurologic deficit						
None	145	(97.3)	130	(96.3)	88	(95.7)
New motor deficit	1	(0.7)	0	(0)	0	(0)
New sensory deficit	4	(2.7)	4	(3.0)	1	(1.1)
Sphincter deficit	0	(0)	0	(0)	0	(0)
Unknown	0	(0)	1	(0.7)	3	(3.3)
Dysesthesia/neuropathic pain						
No	135	(90.6)	1276	(94.1)	83	(90.2)
Yes	12	(8.1)	1	(4.4)	6	(6.5)
Unknown	1	(0.7)		(0.7)	3	(3.3)
Back pain						
No	147	(98.7)	132	(97.8)	87	(94.6)
Yes	2	(1.3)	2	(1.5)	2	(2.2)
Unknown	1	(0.7)	1	(0.7)	3	(3.3)
Constipation						
No	143	(96.0)	126	(90.6)	81	(88.0)
Yes	6	(4.0)	8	(5.6)	8	(8.7)
Unknown	1	(0.7)	1	(0.7)	3	(3.3)
Arachnoiditis/syringomyelia						
No	149	(100)	134	(99.3)	88	(95.7)
Yes	0	(0)	0	(0)	1	(1.1)
Unknown	0	(0)	1	(0.7)	3	(3.3)

assurance of consistency of technique. The median (interquartile range) duration of surgery was 180 (150–195) minutes.

Postoperatively patients were cared for in the pediatric NHDU. Except for 1 patient (due to another emergency admission), all patients spent at least 1 night in the NHDU, with most being discharged to the ward on the second or third postoperative day. Oxycodone (83%) or morphine (13%) patient-controlled/nurse-controlled analgesia was used for in all but 1 patient. Four patients early in our series also received an epidural infusion of local anesthetic. The majority (91%) received the first dose of gabapentin preoperatively and continued this for a median duration of 21 days. Forty-seven (31%) patients required diazepam in the postoperative period for muscle spasm (Table 3).

Median length of stay was 17 days. The longest inpatient stay was 39 days, prolonged because of a requirement for multiple orthopedic procedures (Figure 2), owing to preexisting orthopedic soft-tissue deformity that required correction to progress rehabilitation.

Inpatient Adverse Events and Complications

There were no significant intraoperative complications and no deaths. One patient developed subglottic swelling from tracheal intubation and required 3 days of postoperative ventilation and was then uneventfully extubated. Three patients had urinary catheter-related complications: 2 had difficult catheterizations requiring assistance from a urological surgeon, and 1 had transient hematuria. Following removal of catheters, 2 further patients (1.3%) had temporary urinary retention (requiring recatheterization for 1 day and 3 days). There were no confirmed CSF leaks. Although 1 wound had a minor fluid leak, no diagnostic investigations were undertaken, and it settled spontaneously without intervention. Postoperative nausea and vomiting occurred in 29 (19.3%) patients. Five (3.3%) patients were treated with oral antibiotics for superficial wound infections but there were no instances of deep-seated infection or meningitis. There were no returns to theater and no readmissions within 30 days of discharge.

During their inpatient stay, 8 (5.4%) patients reported neuropathic pain. Four of these occurred in the immediate postoperative period and a further 4 patients developed pain on weaning of gabapentin necessitating an increased dose or prolonged course of medication after discharge.

One patient had an objective temporary worsening of motor function (modified Medical Research Council grade in antigravity muscles 3++ preoperatively, 3– postoperatively). Most patients reported transient paresthesia, hypersensitivity, or unusual sensation in their legs following SDR, which usually improved within a few days. At discharge, persistent sensory symptoms were reported by 13 (8.7%) patients (hypoesthesia in 2 [1.3%], paresthesia in 5 [3.3%], and dysesthesia in 6 [4%]).

Orthostatic headaches were reported in 10 (6.7%) patients all of which resolved in 2–7 days. One patient (who had a ventriculoperitoneal shunt in situ) underwent a period of intracranial pressure monitoring because of persistent postoperative headache. One patient was found to have a slender subdural effusion on computed tomography scan, which was managed conservatively.

Other postoperative complications reported included adverse reactions to medication and non-wound related infections, which are summarized in Table 4.

Follow-Up

By the end of the study period, all patients had reached at least 6 months follow-up and attended at least 1 postoperative assessment. One hundred forty-two (93%) had reached 12 months and 108 (72%) had reached 24 months follow-up. One patient did not attend the 6-month review but was seen subsequently at 12 months and 24 months. Two (1.3%) patients were lost to follow-up beyond 6 months, and clinical records in a further 11 (7.3%) patients were incomplete or missing for 1 or more of their follow-up appointments (Table 5).

A summary of symptoms and problems identified at each follow-up appointment is provided in Table 6. The most commonly reported symptom was dysesthesia (particularly hypersensitivity of the feet) or neuropathic pain, with 8.0% of patients reporting this at 6 months, and 6.5% at 24 months. Back pain was reported only in 2 patients. Constipation was also commonly reported (8.7% at 24 months) but some children had preexisting problems with constipation.

Pure sensory deficits were recorded in 3 patients at 6 months and persisted at 12 months in all (it had resolved in the only patient to date who has reached the 24-month follow-up). Two patients who had no documented sensory deficit at 6-month review subsequently reported 1 at 12- or 24-month reviews. The 1 patient who had an immediate postoperative deterioration in motor function had recovered by the 12-month review. One patient developed worsening foot pain 18 months postoperatively and was found to have developed a holocord syrinx. This patient had a preexisting CSF disorder with a fourth ventricular shunt in situ.

DISCUSSION

This study demonstrates that single-level SDR for spastic diplegia is a safe procedure with low long-term surgical morbidity. To our knowledge, this is the largest single-center cohort in the United Kingdom and one of the largest published series of surgical outcomes worldwide. In 150 consecutive patients, there were no motor deficits or incontinence or other serious postoperative complications. Serious perioperative adverse events were rare and there were no instances of confirmed CSF leak requiring intervention.

The most frequent postoperative problem was nausea and vomiting, occurring in one fifth of our patients. This is a common problem in all pediatric anesthesia with a reported incidence of 13%–42%.[17]

Low-pressure orthostatic headaches, secondary to CSF egress during surgery, is an anticipated complication and occurred as a transient problem in 6.7% of our patients. We minimize intraoperative CSF loss by positioning the patient with head-down tilt, refilling the thecal sac with artificial CSF prior to closure, and meticulous dural closure under the operating microscope. It is also possible that arachnoid irritation from blood within the CSF is a cause of postoperative headaches.

Preoperative initiation of gabapentin therapy is intended to reduce the risk of postoperative neuropathic pain. This is an

important consideration as pain will interfere with rehabilitation and the long-term use of medication may be accompanied by unpleasant side effects. We found that the drug was generally well tolerated and neuropathic pain was uncommon, with just 2.7% reporting immediate leg pain and a further 2.7% developing pain on weaning of the medication. Our data show that most patients required only a short course of gabapentin (21 days median duration), and the incidence of neuropathic symptoms at 2 years was 6.5%, indicating that postoperative neuropathic pain is usually not persistent.

The use of modern neurophysiological techniques means that neurologic deficits following SDR are unexpected, which is confirmed in our series. The 1 case of temporary deterioration in motor function was not the result of an intraoperative ventral root injury, but most likely because of unmasking of an underlying weakness by a reduction in spasticity. Sensory changes are however anticipated; given the high proportion of sensory root fascicles sectioned during the procedure it seems intuitive that some disturbance of sensation is almost inevitable. Many of our patients complained of paranesthesia, numbness, tingling, or hypersensitivity in the days following SDR. Most of these settled during admission and only 13 (8.7%) reported persistent and troublesome sensory symptoms at discharge. Gaiters and fixed ankle foot orthoses can help to minimize foot hypersensitivity and we provide these routinely to all patients.

Our overall morbidity is very favorable compared to the published literature. Although Park and Johnston[10] report just 1 CSF leak requiring operative repair (the total number of leaks is not specified) in 1500 cases, other complications are not published. Smaller published series do however provide more detailed, albeit heterogeneous, surgical morbidity data. Nordmark et al.[18] report a CSF leak rate of 11.4% in their 35 patients, with a similar incidence of urine infection, chest infection, and urinary retention. Trost et al.[19] report transient complications including bowel and bladder disturbance, headache, and wound problems in up to 8% of 136 patients. Steinbok and Schrag[20] provide the most detailed information, reporting postoperative complications in 43.6% with sensory changes (8.9%), urinary retention (4.4%), and pneumonia (1.3%) occurring most frequently in their cohort of 158 patients. Abbott et al.[21] report complications in 50% of patients and serious complications in 17.5% of 200 patients, although modification of intraoperative and postoperative management did significantly improve morbidity. All these studies relate to patients operated on between 1986 and 2003, so direct comparison with our series requires some consideration. We have adopted Park and Johnston's[10] single-level technique, and using ultrasound and the modern high-powered operating microscope, the approach is minimally invasive, removing some of the risks associated with multilevel laminectomy and durotomy. Similarly, pediatric anesthesia and postoperative high dependency care has advanced, and through a combination of evidence-based medicine and our own experience, our perioperative protocols have evolved to minimize morbidity. The low incidence of non-procedure related morbidity, including respiratory and urine infections, in our series may be attributable to this.

Although most studies have focused on the long-term functional outcomes of SDR, few have reported the short- and long-term morbidity of the procedure. Our series demonstrates its safety in a large cohort, two thirds of whom have been followed up to 2 years. Long-term neuropathic pain, dysesthesia, and back pain in our series is uncommon. Many of our patients reported some occasional pain and spasms, but this was usually related to physical therapy or orthoses and was often better than preoperative pain. Quantitative measures of pain and quality of life are to be reported in subsequent work.

In a publicly funded health system, the merits and cost-effectiveness of SDR remain contentious. Although this study does not address this question, our data do provide evidence that costs should be predictable and relatively constant. A planned rehabilitation program of 14 days meant that length of stay was mostly 16–20 days (depending on whether surgery was performed on a Monday or Friday) and few patients exceeded this. The low morbidity rate and a zero return to theater and readmission rate also indicates that unanticipated financial costs will be low.

The importance of patient selection in SDR is often emphasized,[3,5,6,22,23] and the application of our strict selection criteria ensures that only children who are most likely to benefit from SDR are offered the procedure. Meta-analysis or 3 small randomized trials, in which a much lower proportion of sensory roots were sectioned than in the current series, concluded that SDR (using the multi-level laminectomy technique) may be most effective in children aged between 3 and 8 years, with GMFCS levels III and IV;[6] although the conclusions regarding GMFCS IV children are speculative given the small numbers of patients from this group in the pooled analysis. It is generally agreed now that good long-term outcomes are most likely to be achieved in diplegic children with GMFCS level II or III.[5] This is the basis for our criteria, with most of our patients aged between 4 and 8 years and nearly all GMFCS level II or III.

This study forms part of a long-term prospective evaluation of our service, although the surgical morbidity data were collected retrospectively in the first two thirds of patients before the establishment of a contemporaneous database (prior to this only outcome data were collected prospectively). The limitations of retrospective case-note review are well known; however, the completeness of our follow-up with prospectively collected post-discharge data demonstrates a robust data collection process. The long-term morbidity data are mostly from parent-reported symptoms meaning that we may underestimate the incidence of some postoperative sequelae (e.g., sensory loss). Younger children, in particular, may find it difficult to describe some symptoms, however, parents are likely to report anything that causes concern or distress so this may in fact represent a more pragmatic overview. Although some of our patients are now into their fifth postoperative year, our service is only funded for formal follow-up to 2 years and so our study does not offer any insight into longer-term outcomes. This may be more significant when addressing functional outcomes or post-SDR hip migration and spinal deformity.

CONCLUSIONS

Our SDR program is intended to improve independence, reduce the need for orthopedic deformity surgery, and improve the quality of life in children with spastic diplegia. As such, the risks must be

low to justify undertaking this irreversible procedure. This study demonstrates that, in a single United Kingdom center performing, on average, 30 cases a year, the surgical morbidity of SDR is low. This should provide reassurance to parents wanting to consider the procedure, and it adds to the growing evidence base in support of SDR as an effective and viable treatment option in spastic diplegia. Further work is required to confirm the reported functional and quality of life benefits, which will be the focus of future work published by our group.

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