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### Electrophysiologic Studies in Selective Dorsal Rhizotomy for Spasticity in Children with Cerebral Palsy

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**Key Words.** Cerebral palsy · Spasticity · Dorsal rhizotomy ·  
Somatosensory evoked potentials · Surgery for spasticity

**Abstract.** A group of 20 children with spastic cerebral palsy underwent selective dorsal rhizotomy for alleviation of spasticity. Pre- and postoperatively, cortical somatosensory evoked responses (cSSEP), H reflex and F wave studies were done. Clinically there was dramatic reduction of tone without noticeable sensory loss. The electrophysiologic studies showed several findings: (1) many children have abnormal cSSEP preoperatively; (2) surgery seldom leads to a loss of cSSEP; (3) in many patients, there is a noteworthy improvement in the cSSEP wave form; (4) some children have electrophysiologic evidence of spinal cord dysfunction preoperatively and (5)  $H_{max}/M_{max}$  ratio decreases after surgery confirming decrease in tone.

#### Introduction

Spasticity is a major clinical disability in some children with cerebral palsy. When spasticity has not responded to physical and occupational therapy, there may be a role for neurosurgery to alleviate it [2, 5, 7-9].

Ten years ago, Fasano [2] described selective dorsal rhizotomy and reported impressive beneficial effects in reducing spasticity in children with cerebral palsy. Peacock and Arens [8] modified Fasano's procedure and verified its clinical benefit.

## Material and Methods

The operation consists of a narrow laminectomy from L2 to the upper sacrum. The L2-S1 roots are identified as they exit the dura. The dorsal root is separated from the ventral and divided into rootlets (usually 4–8 rootlets), which are stimulated. The threshold is identified by single stimulation with 0.3-ms square wave. Repetitive stimulation at 50 Hz for 1 s is then performed. The 'normal' response to repetitive stimulation is a brief contraction of the appropriate myotome which relaxes during stimulation. The 'abnormal' response to stimulation is a contraction which spreads to other myotomes of the same or opposite leg and which is sustained. Rootlets giving the later response are cut.

At UCI Medical Center, we have performed this operation on 20 children with cerebral palsy. All children were studied preoperatively, and 1 week and 3 months postoperatively but we report only the 1-week postoperative findings: (1) Cortical somatosensory evoked potentials (cSSEP) were recorded using Neuroscope Siegen equipment. The procedure involved stimulation of the posterior tibial, sural (at ankle), peroneal nerves (at knee) and median nerves bilaterally. Dermatome stimulation at L4, L5, S1 were also done by stimulating the skin over the medial calf (L4), medial foot (L5) and lateral foot (S1) bilaterally. The responses were monitored at the lumbar region (L1–L5), and at the scalp (C3, C4 and Cz). The stimulation intensity was 5–10 mA at 4.8 Hz. The high and low frequency filters were 5–300 Hz. A total of 350–550 stimulations were averaged. Three independent trials were done for each nerve and dermatome.

(2) F wave and H reflex studies were also performed. The H reflex involves stimulation of the posterior tibial nerve at the popliteal fossa and monitoring the motor response of the gastrocnemius/soleus muscles by a surface electrode on the calf. The H reflex is done with the patient in the prone position with the leg straight at the knee and the foot flexed to 90°. (Some of these patients have such a severe equinus deformity, that a full 90° position could not be achieved.) The maximum M and H response was noted. The F wave was measured by stimulation of the posterior tibial and peroneal nerves. A supra-maximal stimulation was given at 0.5 Hz for 16 stimulations. The average amplitude of the present F waves was calculated [1, 3, 4, 6].

## Results

Twenty patients were studied including 9 girls and 11 boys. The age range was 2.5–9.8 years. Clinically, all these children were diagnosed as spastic diplegia or spastic quadriplegia; no children were dystonic. Four had been full-term infants, while 16 were premature.

*Results of Posterior Tibial Nerve cSSEP Studies.* Nineteen of 20 patients had intact normal lumbar root entry potentials. Eleven of 20 had normal cortical responses. In 9 patients, there were absent or severely abnormal wave forms. Of the 9 patients with abnormal evoked potentials, 8/9 had median nerve evoked cortical potentials studies. In all 8 patients, the median nerve cSSEP were normal.

Postoperatively, of the 19 patients with present preoperative lumbar root entry potentials, 5 had absent lumbar volleys while the remaining 14 had volleys which showed a significantly reduced amplitude.

Of the 11 patients with normal preoperative posterior tibial cSSEP, 3 had abnormally altered responses postoperatively. Six patients who had absent or markedly abnormal preoperative cSSEP showed normal responses postoperatively.

*H Reflex and F Wave Measurements.* In 7/8 patients, there was a significant decrease or absence of the postoperative  $H_{\max}/M_{\max}$ . In 1 patient, there was an increase in the  $H_{\max}/M_{\max}$  ratio. F wave was recorded from posterior tibial nerve in 6 patients, and from the peroneal nerve in 8 patients, and in 3 patients, both nerves were recorded. Postoperatively, the posterior tibial  $F_{16}$  average was reduced in 3 patients, minimally increased in 2 patients, and significantly increased in 1 patient. Postoperatively, the peroneal nerve response was significantly decreased in 3 patients, with minimal change in the rest.

## Conclusions

Many patients (9/20) may have abnormal cSSEP preoperatively, suggesting that the lesions of cerebral palsy may be more widespread than strictly involving the motor system.

In some patients, there is electrophysiologic evidence of spinal cord dysfunction, especially in full-term infants.

Selective dorsal rhizotomy has minimal (if any) effect on the clinical sensory examination. These studies confirm that the cSSEP's are usually unchanged by this operation as well.

In fact, in several patients, the morphology of the postoperative cSSEP is more nearly normal than the preoperative study. We note that during normal maturation, infants < 1 year of age often show a poorly developed cSSEP. Normally, as a child matures, the cSSEP becomes more delineated. In some patients, this operation was associated with an analogous improvement in the cSSEP.

$H_{\max}/M_{\max}$  ratio is significantly reduced, confirming the clinical observation of decreased reflexes and lessened spasticity. This also indicates that the operation has sectioned Ia fibers.

The observation that surgery can lead to decreased H reflex yet

preserved or even improved cSSEP may have implications in our understanding of the pathways measured by cSSEP.

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