Oral-Motor and Respiratory Changes in Children With Spastic Cerebral Palsy Following Selective Posterior Rhizotomy

Modification de la motricité orale et de la respiration chez des enfants ayant la paralysie cérébrale spasmodique après une rhizotomie postérieure sélective

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Abstract

Selective posterior rhizotomy (SPR) is a neurosurgical procedure performed to reduce spasticity in the lower extremities of children with spastic cerebral palsy. Sensory nerve rootlets in the lumbar area that are associated with abnormal responses on electrical stimulation are severed in this procedure. The secondary benefits reported are the increased function in the upper extremities as well as improvement in speech intelligibility, length of utterance, respiratory function, feeding and decreased drooling. One child, who demonstrated improvement in several areas, is the focus of this article and speculation regarding reasons for improvement are discussed. Assessment of oral-motor and speech functions with respect to both instrumental and perceptual measures is examined. The importance of having a speech-language pathologist on the rhizotomy team is also addressed.

Résumé

La rhizotomie postérieure sélective est une intervention neurochirurgicale qui vise à réduire la spasmodicité des membres inférieurs chez les enfants ayant la paralysie cérébrale spasmodique. Elle comprend le sectionnement de racines de nerfs sensitifs de la région lombaire qui sont associés à des réactions anormales à la stimulation électrique. Cette intervention a pour avantages secondaires un meilleur fonctionnement des membres supérieurs, une amélioration de l'intelligibilité de la parole, de la longueur de l'énoncé, de la respiratiton et de l'alimentation et une réduction du bavage. Le présent article porte sur un enfant qui a présenté des améliorations à plusieurs égards et offre des hypothèses sur les causes de ces améliorations. En outre, on y aborde l'évaluation de la motricité orale et de la parole par des mesures instrumentales et perceptives. On mentionne également qu'il est important qu'un/e orthophoniste fasse partie de l'équipe de rhizotomie.

Selective posterior rhizotomy (SPR) is a neurosurgical procedure performed to reduce spasticity in the lower extremities of children who have spastic cerebral palsy. This procedure involves selective division of lumbosacral posterior nerve rootlets. Only those rootlets associated with an abnormal response to electrical stimulation are sectioned. The remainder are spared to preserve tactile and proprioceptive sensation (Staudt & Peacock, 1988).

SPR has been effective in reducing spasticity in the lower extremities of children who have spastic cerebral palsy (Berman, 1989; Peacock & Arens, 1985; Staudt & Peacock, 1988). Additional benefits as a result of the surgery have been reported improvements in both upper extremity function and speech (Berman, 1989; Jackson, 1989; Peacock, Arens & Berman, 1987; Staudt & Peacock, 1988). Other remote effects noted were improved respiratory control, cessation of drooling and improved feeding (Peacock & Arens, 1985; Peacock, Arens & Berman 1987; Sykanda, 1989; Sykanda, personal communication, 1991).

Cerebral palsy is a neurological disability caused by a lesion in the motor centre of the brain before, during or shortly after birth. The spastic type of cerebral palsy accounts for the majority of cases (Peacock, Arens & Berman, 1987). Resistance to movement due to increased muscle tone is a major problem for these children (Peacock & Arens, 1985).

Children who have spastic cerebral palsy often have speech difficulties involving respiration (Blumberg, 1955; Clement & Twitchell, 1959; Hardy, 1961), intra-oral breath pressure (Hardy, 1961), phonation and articulation (Byrne, 1959; Clement & Twitchell, 1959). The speech difficulties relate to faulty integration of the movement of the tongue, lips and associated musculature. An abnormal degree and distribution of tone may also be manifested in the oral-facial area impeding fine, coordinated and dissociated oral movements (Scherzer & Tscharnuter, 1982). Maturation of the breathing pattern may also be impaired and affect speech production. Oral-motor difficulty also may adversely affect chewing, swallowing and/or drinking.

Oral-motor functions, including speech production, are strongly affected by postural functions (head control, trunk control and shoulder girdle stability). Limitations in this postural control may further affect the child's ability to actively participate in the feeding process (Scherzer & Tscharnuter, 1982). For example, graded jaw movements require some degree of postural stability of head, neck and shoulder girdle.

Oral weakness can reduce the ability to generate adequate intra-oral breath pressure for consonant production (Hardy, 1961). A child with cerebral palsy may not be able to generate adequate intra-oral breath pressure due to weakness or poor coordination of the palatal, respiratory and articulatory muscles (tongue, lips and jaw) (Hardy, 1961). These weak articulators are less effective in impeding the air stream during consonant production. The adequacy of respiratory support may be affected by the efficiency of valving at three points: laryngeal, velopharyngeal or oral articulatory. Poor respiratory support and inadequate valving can negatively affect speech production (McLean, 1988).

Respiration is one of the most important aspects of speech since it generates the air currents for phonation and voiceless sounds. It is also important in proper phrasing. Irregular respiratory function and reduced control may result in poor phonation, weak volume, halting speech and speech production on inspiration (Blumberg, 1955).

Drooling is also a problem for many children with cerebral palsy who demonstrate an inefficient swallow and diminished swallowing frequency. In this population, factors such as head position, sitting posture, attention span, anatomic and dental malformations, tongue size and control, decreased oral-sensory awareness and inability to nose-breathe may contribute to drooling (Sochaniwskyj, Koheil, Kazek, Milner & Kenny, 1986).

The purpose of this article is to highlight issues, for speech-language pathologists, on oral-motor and respiratory changes in a child who has spastic cerebral palsy and has undergone SPR. Although the following information is based on uncontrolled clinical observations and subjective descriptions of an uncontrolled case report, it provides some insights that may be valuable for future research.

The Neuromotor Clinic treatment team (made up of professionals in Occupational Therapy, Physiotherapy, Speech-Language Pathology, Psychology and Social Work) at Alberta Children's Hospital participated in pre- and post-operative SPR assessments between March 1989 and October 1990. This article presents the findings of the speech-language pathologist.

Case Report

Case Description

SN was a 7-year old male with spastic quadriplegia who initially was using a range of one- to three- word utterances with poor intelligibility for an unfamiliar listener. SN was receiving speech therapy once weekly at school with emphasis on decreasing drooling, improving phrasing and articulation as well as pointing to beginning sounds of words on an alphabet board to augment communication. His personal aide carried out activities prescribed by the speech-language pathologist on a daily basis. According to SN's mother, he used only verbal communication at home and she understood him the best. Decreased intelligibility reportedly presented difficulty for his father, as it did for therapists during the assessment, even for a known context.

Oral-Motor, Speech and Respiratory Assessments

All assessments were carried out by the speech-language pathologist on the Neuromotor Clinic team at Alberta Children's Hospital. Initial assessment occurred within the three month period prior to surgery with reassessments performed six weeks, three months, six months and twelve months after surgery. An attempt was made to keep the assessment format and seating arrangements for the pre-operative and post-operative assessments consistent. However, the child arrived with a different seating system for the initial assessment than for subsequent assessments and did not always comply with tasks. As a result, the information obtained was not consistent across the multiple assessment sessions.

The Goldman-Fristoe *Test of Articulation* (1972) was used to assess single-word production. Speech intelligibility in spontaneous conversation was informally judged in comparison to single-word production by the author at the time of the assessment. All tasks were videotaped. An oral peripheral examination was performed to assess voluntary oral movement abilities for speech and non-speech tasks, including diadochokinetic rates. Sustained phonation was used to reflect maximum respiratory capacity and laryngeal valving. Oral-motor control during oral preparation of food, swallowing and drinking was assessed by observing eating of a solid food (cookie), spoonfeeding (pudding) and drinking (juice) from a cup and straw. The presentation of food and drink was consistent across assessment sessions. Finally, drooling was assessed via observation. Additional information in all the above-mentioned areas was gathered through parent report.

Pre- and Post-Surgical Observations

Table 1 summarizes the observations made regarding speech, oral-motor, respiratory control, drooling and feeding at the pre- and post-surgery assessments. Results of each assess-

ment are compared to the preceding one, indicating changes in some areas at specific assessments, and at other times no change. When the results of the pre- and post-surgery assessments are compared, SN demonstrated improvements in all areas at some point during the reporting period. In the area of articulation, SN showed noticeable improvements in intelligibility by targeting more final consonants and also expanding his consonant substitutions with closer approximations to target phonemes. Improved volitional tongue movements were demonstrated during non-speech tasks and he was spontaneously retracting his tongue, closing his lips and swallowing more frequently. SN's respiratory control appeared improved as he was using three-word utterances more consistently and demonstrating more spontaneous speech. Anecdotal report from parents indicated that SN could now blow out a candle. Drooling decreased noticeably and, as previously stated, SN was closing his mouth and swallowing more frequently. While SN continued to demonstrate immature patterns for eating and drinking, there were changes in how he managed food orally, as there was a decrease in the amount of choking and he was now able to eat foods he choked on prior to surgery.

Table 1. SN's Oral-Motor and Respiratory Functioning Before and After SPR

Assessment	Speech	Oral-Motor	Respiratory Control	Drooling	Eating/Drinking
Pre-Surgery	Poor	Poor	Poor	Present	Difficulty
6 weeks	+	+	o	+	o
3 months	o	o	o	o	+
6 months	+	+	+	o	+
12 months	+	o	o	o	o

Entries are relevant to each preceding assessment.
+ = improvement
o = no change

Discussion

SPR has shown to be effective in reducing spasticity in the lower extremities of children who have spastic cerebral palsy (Peacock & Arens, 1985; Berman, 1989; Staudt & Peacock, 1988). Additional benefits reported have been improvement in upper extremity, oral-motor and respiratory function (Berman, 1989; Jackson, 1989; Peacock, Arens & Berman, 1987; Staudt & Peacock, 1988). Some parents have also reported an increased attention span in their children after surgery.

Speculation can be made as to the reasons for oral-motor and speech improvements following SPR. One explanation may be that reduction of spasticity in the lower extremities can contribute to improvement in sitting posture (Staudt & Peacock; 1989). Improved sitting posture, in which head and trunk are better stabilized and in better alignment, may in turn contribute to improved respiration and subsequently improved speech production. Postural alignment also can contribute to volitional control of oral-pharyngeal musculature movement as upright head control brings the tongue and lips into a more forward position and reduces abnormal posturing of the mouth and pharynx (Morris, 1977; 1984). Greater oral motor control may also help improve feeding (Hulme et al, 1989). Normalizing muscular tone through the use of adaptive seating devices can also improve sitting posture.

Another possible explanation for improvement in speech may be that the muscles of respiration become less spastic as a result of the SPR. That is, there is a reduction of input in the ascending collaterals of the posterior spinal rootlets as a result of the rhizotomy (Jackson, 1989; Staudt & Peacock, 1989). This may ultimately contribute to better intelligibility through improved respiration. In Jackson's study, it was hypothesized that intelligibility in children with spastic cerebral palsy would increase after SPR as a result of improved respiratory functioning due to decreased spasticity of the muscles of respiration. Improved respiratory functioning was inferred from an increase in correct production of high lung volume expenditure consonants (voiceless stops and fricatives). She concluded that this preliminary investigation revealed a post-rhizotomy increase in intelligibility in two of the four children, but that there was not overwhelming support for the hypothesis as respiratory functioning was inferred from articulatory data. She recommended direct assessment of respiration in future studies.

To date, Jackson's is the only paper that specifically documents speech changes following SPR. Nonetheless, oral-motor changes have been described in several published articles that primarily focused on physical changes in the lower extremities. It may be that detailed reporting in this area has been limited because centres performing this surgery do not include speech-language pathologists on their team performing pre- and post-surgical assessments.

The information presented in this article was based on clinical observation and anecdotal reporting. However, the information has identified potential changes in oral-motor and respiratory functions that might not be initially expected from the SPR. This can alert researchers and clinicians of the need to evaluate and document changes in speech and non speech aspects of oral-motor and respiratory functions in children who are candidates for this surgical procedure. In addition, it brings to light the importance of appropriate seating and postural stability for optimal speech production and for feeding.

Future evaluation and documentation of the named population should be carried out within the framework of research design and methodology. Measurement could be either perceptual or instrumental. While each method has limitations, each provides valuable information that can complement the other.

Instrumental measures can provide more information about the neuromuscular deficits underlying the perceptual symptoms, but some do not lend themselves to measurement of integrative activities (McLean, 1988). In addition, some instrumentation measurements are adversely affected by posture, body movement, vocal quality, high fundamental frequency and hypernasality. These possibilities may make them a poor choice for young children with cerebral palsy (Baken, 1987; Hodge & Rochet, 1989; Kent & Read, 1992; M. Hodge, personal communication, 1992).

Perceptual measures of intelligibility are a valid method of speech assessment when factors in the assessment environment (judge familiarity with clinical measurement and format, transmission system and speaker's task) are appropriately controlled. Measures of speech intelligibility (in combination with measures of speaking rate) provide a useful assessment of all components of speech production including oral articulatory performance, respiratory, phonatory and velopharyngeal performance. These are important measurements as reduced intelligibility and speaking rates are common factors of dysarthria regardless of the underlying neuro-motor impairment. But it is this integrative nature of perceptual measures that may be a disadvantage if inferences about physiological phenomena are made from perceptual measures alone, as the same symptoms may result from different underlying conditions (McLean, M., 1988).

It is also recognized that speech improvement attributed to developmental changes cannot be ignored. Kent (1976) indicated that anatomical changes and motor control in the normally developing child do not fully mature until 11 or 12 years. The neurologically involved child who is following a normal but delayed course of speech development may continue to demonstrate changes over a longer period of time (Byrne 1959).

It is clear that more rigorous research designs are required in order to rule out potentially confounding variables such as maturation. Certain quasi-experimental designs such as the time series design (Campbell & Stanley, 1969) and some single-subject randomization designs (Rvachew, 1988) would be appropriate.

In summary, this article adds to a growing body of case observations and anecdotal reports describing improved oral-motor and respiratory functions following SPR in children who have spastic cerebral palsy. In order to determine how SPR contributes to improved oral skills, it would be necessary to ensure that speech-language pathologists are included on the SPR management team, that perceptual outcomes are measured in a controlled method using an inter-judge reliability rating method, that instrumentation be used where appropriate and in a controlled method, and that quasi-experimental or experimental research designs be employed.

It appears that at least some children with cerebral palsy may experience improvements in speech, oral-motor control, respiration, feeding and decreased drooling following SPR. It is important that these improvements be documented by speech-language pathologists employing procedures previously described for both pre- and post-surgery assessments. The information provided by such assessments may help us determine the causes of the reported improvements in speech, and identify treatment targets and intervention methods to be used with post-rhizotomy patients.

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