Evaluation of Motor Function and Quality of Life In Patients with Cerebral Palsy Undergoing Selective Dorsal Rhizotomy

Evaluación de la Función Motora y la Calidad de Vida en Pacientes Con Parálisis Cerebral Sometidos a Rizotomía Dorsal Selectiva

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ABSTRACT

Background: *Cerebral palsy (CP) consists of a group of permanent neurological deficits of the nervous system. Thus, the main objective of management of CP is to mitigate spasticity, as it has a high potential to generate contractures, stiffness, dislocations, pain and deformities. More severe forms can be curbed by selective dorsal rhizotomy (SDR).* **Objective***: This study aims to evaluate the SDR outcomes and changes in the quality of life (QoL) of individuals with CP undergoing the procedure.* **Methods***: systematic review study with guiding question elaborated using the PICO strategy. Complete works available in Portuguese and English were selected, assigning 10 years. After the selection and eligibility process, 9 articles were selected.* **Results and discussion***: In SDR, electroneuromyography is used to assess the degree of hyperactivity of nerve roots from L1 to S2 and the response in the musculature of the corresponding segment. Each radicle is stimulated separately and only those with spastic activity are sectioned. The effect achieved is a reduction in the overstimulation of the muscles of the lower limbs. Studies show that SDR is accompanied by an enrichment of motor function, a significant reduction in spasticity and an increase in range of motion.* **Conclusion***: SDR is the most effective alternative for the treatment of spasticity in patients with CP with GMFCS level II or III due to the significant improvement in QoL provided by the reduction of spasticity and stiffness and the functional evolution. This reduces the need for further surgical interventions and improves independence in activities.*

Keywords: *Rhizotomy; Cerebral palsy; Muscle spasticity; Quality of life*

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RESUMEN

Introducción*: La parálisis cerebral (PC) consiste en un grupo de déficits neurológicos permanentes del sistema nervioso. Así, el principal objetivo de la conducción de la PC es mitigar la espasticidad, ya que tiene un alto potencial para generar contracturas, rigidez, luxaciones, dolor y deformidades. Las formas más graves pueden frenarse mediante la rizotomía dorsal selectiva (RDS).* **Objetivo***: El objetivo de este estudio es evaluar los resultados de la RDS y los cambios en la calidad de vida de las personas con PC sometidas a este procedimiento.* **Metodología***: Estudio de revisión sistemática cuya pregunta guía fue elaborada utilizando la estrategia PICO. Fueron seleccionados trabajos completos disponibles en portugués e inglés, con asignación de 10 años. Tras el proceso de selección y elegibilidad, se seleccionaron 9 artículos.* **Resultados y discusión***: En la SDR, la electroneuromiografía se utiliza para evaluar el grado de hiperactividad de las raíces nerviosas de L1 a S2 y la respuesta en la musculatura del segmento correspondiente. Cada radícula se estimula por separado y sólo se seccionan las que presentan actividad espástica. El efecto conseguido es una reducción de la sobreestimulación de los músculos de los miembros inferiores. Los estudios demuestran que la SDR va acompañada de un enriquecimiento de la función motora, una reducción significativa de la espasticidad y un aumento de la amplitud de movimiento.* **Conclusiones***: La SDR es la alternativa más eficaz para el tratamiento de la espasticidad en pacientes con PC con GMFCS nivel II o III debido a la importante mejora en la calidad de vida proporcionada por la reducción de la espasticidad y rigidez y la evolución funcional. Esto reduce la necesidad de nuevas intervenciones quirúrgicas y mejora la independencia en las actividades.*

Palabras clave: *Rizotomía; Parálisis cerebral; Espasticidad muscular; Calidad de vida*

INTRODUCTION

Cerebral palsy (CP) or non-progressive chronic encephalopathy consists of a group of permanent neurological disabilities of the nervous system[1-3]. This condition encompasses a heterogeneous group regarding etiology, clinical signs, and severity of impairments. Regarding etiology, it is multifactorial and it can result from pre-natal developmental malformations (cord malformations, alterations of maternal circulation, and uterine tumors) and perinatal central nervous system lesions (influenced by maternal characteristics such as maternal age, anesthesia, and placental anomalies), fetal factors (prematurity, twinning, and malformations), or postnatal factors (anoxia)[1,4,5]. These factors trigger various alterations in neurological development, such as movement and postural disorders and altered sensory perception that arise in the first years of life.

This encephalopathy can be classified according to the type of lesion and its main clinical characteristics, spastic subtypes (diplegia, hemiplegia, and quadriplegia), dyskinetic, and ataxic[6,7]. The spastic subtype is the most common, responsible for 70% of cases. Spastic CP is caused by damage to the cerebral motor cortex – which controls voluntary movement – and the pyramidal tracts – responsible for transmitting signals to muscles. Therefore, spasticity is a motor disorder characterized by the presence of high tone (increased myotatic reflexes, clonus, plantar reflex in extension – Babinski sign) and is caused by a lesion in the pyramidal system, which consists of an exacerbation of the medullary reflex arc in the absence of inhibitory influences from upper pathways[8-10].

Although this childhood neuromuscular disorder is not neurodegenerative, the consequent musculoskeletal involvement can increase disabilities as the nervous system matures. As previously discussed, CP involves disorders in voluntary motor function and a wide variety of symptoms that make up the upper motor neuron syndrome[2,11,12]. Various additional symptoms accompany primary motor abnormalities, including altered sensory perception, intellectual disability, communication difficulties (dysarthria), palate and tongue difficulties (dysphagia), as well as seizures and musculoskeletal complications[13].

Thus, the main objective of managing cerebral palsy is to alleviate spasticity, as it has a high potential to generate contractures, rigidity, dislocations, pain, and deformities, as well as impairing activities of daily living[14].

Treatment of chronic pain resulting from musculoskeletal dysfunctions, spasticity, deformities, and other associated comorbidities involves physiotherapy and occupational therapy, oral therapies, and the use of muscle relaxants such as baclofen

and tizanidine, as well as the use of benzodiazepines. Refractory pain can be treated with the administration of Botulinum Toxin A and intrathecal baclofen[2,15].

The most severe or widespread forms of spasticity can be curtailed through neurosurgical treatment, through selective dorsal rhizotomy (SDR), complementing and assisting the various existing therapeutic modalities. SDR effectively reduces sensory input in reflex arcs responsible for muscular hypertonia and preserves voluntary movement. This procedure can be isolated, or it can be combined with other treatments, such as intramuscular botulinum toxin application – causing flaccid paralysis of the affected muscle – and with intrathecal administration of baclofen – increasing inhibitory activity on muscle tone – in order to offer functional improvements and positively impact the QoL, comfort, and care of patients[2,15].

Due to the heterogeneity of CP regarding the severity of neuromuscular and musculoskeletal impairment, the Gross Motor Function Classification System (GMFCS) is used to plan the rehabilitation of children with CP[16]. This classification is based on voluntary initiated movement, with emphasis on sitting, transfers, and mobility, and it is possible to classify the child or adolescent with CP into five levels, ranging from I, which includes minimal or no dysfunction regarding community mobility, to V, where there is total dependence requiring assistance for mobility[1,17,18].

Therefore, children who fall into level II have limitations regarding their ability to run and jump or walk long distances. Children in level III usually need mobility equipment to assist them with walking. Children at level IV are usually transported in a manual or motorized wheelchair. At level V, there is a severe limitation in controlling the head and trunk, requiring extensive assistive technology and physical assistance[19].

In addition to using this functional level standardization system in rehabilitation planning, cranial and spinal magnetic resonance imaging is performed to ensure that the condition does not run with other factors that cause spasticity or that prevent the procedure from being performed[15].

For patients with spastic diplegia who present mild to moderate motor impairment (GMFCS level II or III), without significant weakness, and are cognitively capable and motivated to participate in postoperative rehabilitation, selective dorsal rhizotomy can be performed as an alternative or in conjunction with antispasticity therapy to improve gait[2,15,20,21]. Furthermore, SDR is an alternative option for non-ambulatory children (levels IV and V) to treat refractory spasticity, provide comfort, and promote participation in daily activities[21-23].

Thus, this paper aims to explain the available evidence related to selective dorsal rhizotomy in patients with cerebral palsy, while also evaluating its outcomes and the change in QoL of individuals undergoing the procedure.

METHODOLOGY

This is a systematic review study conducted in five stages, such as: (1) defining the research question and identifying the databases for consultation, (2) establishing eligibility criteria and searching for potentially eligible primary studies in the literature, (3) analyzing and evaluating study eligibility, (4) extracting relevant data, (5) discussing the synthesis of results and presenting the study.

Based on the theme and objective of the study, the research question was formulated using the PICO acronym strategy (Population: humans with cerebral palsy; Exposure: selective dorsal rhizotomy treatment; Comparison: without selective dorsal rhizotomy treatment; Outcome: improvement in QoL), and descriptors were listed based on the PICO elements to search for literature and define the guiding question: "Does selective dorsal rhizotomy treatment in individuals with cerebral palsy improve motor function and quality of life?"

Eligible study searches were conducted from December 17th, 2022, to December 31st, 2022, in the Virtual Health Library (VHL) database, using the PICO elements to obtain specific and controlled descriptors available in the Health Sciences Descriptors/Medical Subject Headings (DeCS/MeSH) database, for the keywords rhizotomy, cerebral palsy and QoL, which were combined using Boolean operators AND.

Complete works available in Portuguese and English were selected, with a temporal range of 10 years (2012-2022). Inclusion criteria were original articles whose main subject was related

to selective dorsal rhizotomy and cerebral palsy. Exclusion criteria were duplicated works, incomplete works, works without methodological description, study protocols, and articles outside the temporal range of the study.

The selection process began with reading the titles and abstracts of the articles, applying inclusion and exclusion criteria. Then, the selected articles underwent a second analysis, with the reading of the full text, to select articles that truly complied with the eligibility and exclusion criteria, methodology and theme.

RESULTS

From the use of the descriptors mentioned above, 17 articles were identified in the defined database for the search. After the process of selection and eligibility of the found works, 9 articles were selected for the systematic review (Figure 1).

Table 1 summarizes the studies selected to compose this systematic review. The main items included are author(s) and year of publication, study design, objectives, methodology, and main results.

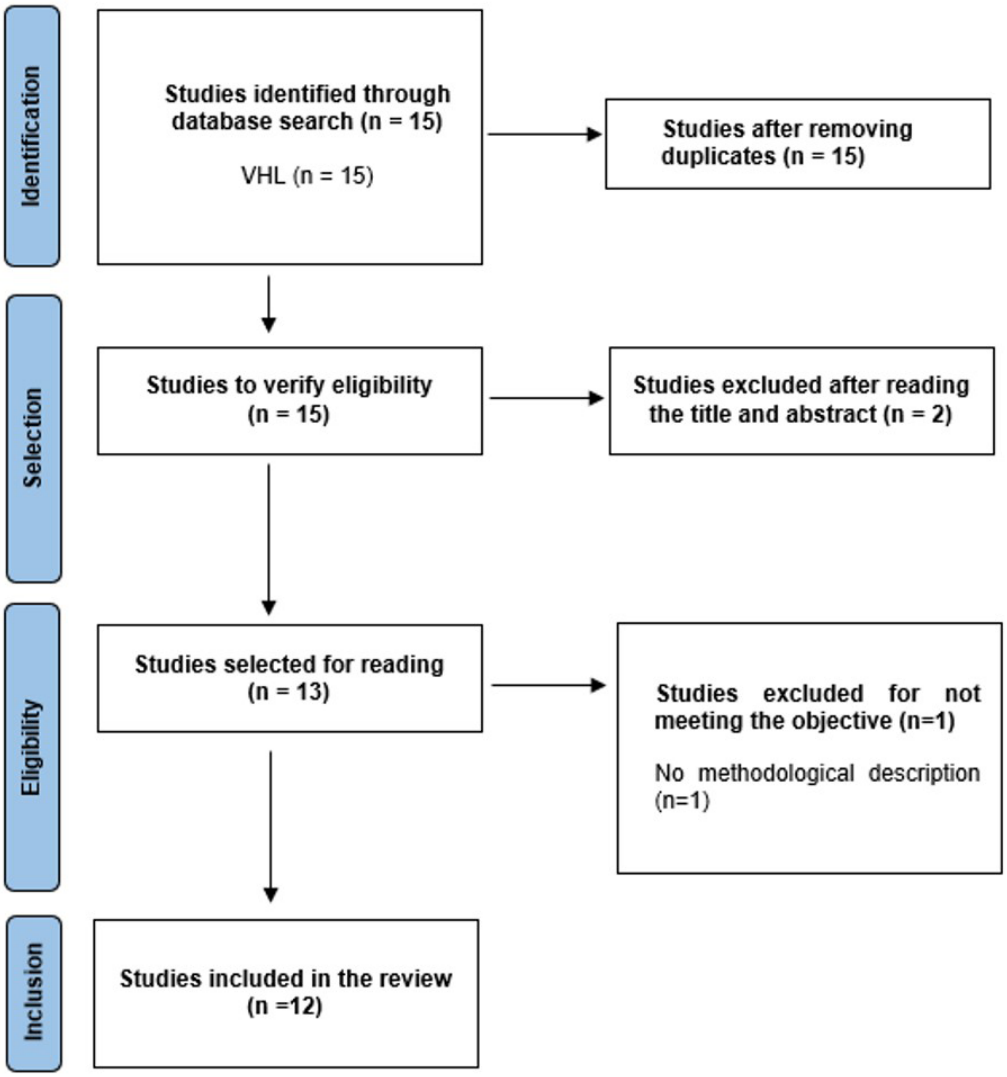

Figure 1. Schematic representation of the study selection stages.

Table 1. Studies found for systematic review.

Author and year of publication	Study design	Goals	Methodology	Main results
Gillespie et al.[21]	Prospective study.	To investigate the effect of age category, sex, GMFCS level, and presence of dystonia on changes in eight function test parameters 24 months after SDR.	Children aged 3 to 18 years with bilateral CP with spasticity who underwent SDR at a tertiary pediatric neurosurgery center between 2012 and 2019 were selected.	SDR can improve gross and fine motor function, mobility and self-care, QoL and overall outcome based on extensive testing of scoring parameters at 24 months.
			A linear mixed-effects model was used to assess longitudinal changes.	Atypical patient populations can benefit from SDR if properly selected.
				Multicenter prospective registries investigating the effect of SDR are needed.
Hurvitz et al.[24]	Prospective study.	To assess outcomes, interventions, life satisfaction, and subjective impressions of SDR in older adolescents and adults who underwent the procedure as children.	A survey was applied to older adolescents (16–20 years) and adults with CP who underwent SDR between 1986 and 2000 at two academic centers.	Most adults who underwent SDR as a child would recommend the procedure to others. Very few reported negative impressions of the procedure.
			Patients or their caregivers participated in telephone or clinic interviews.	Life satisfaction levels were generally high.
			Subjective impressions of SDR and a history of post-SDR medical interventions were obtained.	The prevalence of pain was similar to that reported in the literature for adults with cerebral palsy.
			Current functional status, history and pain assessments, educational achievement, living situation, and subjective health status were also recorded.	Despite the SDR, other interventions, both surgical and non-surgical, were used in most patients.
MacWilliams et al.[25]	Retrospective study.	To understand the long-term effects of comprehensive spasticity treatment, including SDR, in individuals with spastic CP.		Spasticity was effectively reduced at the long-term assessment in the group given SDR and remained unchanged in the group without SDR.
			Children were matched by age group and spasticity at baseline.	There were no significant differences between the groups on any measure except the Gait Deviation Index and walking speed.
			Children at one center underwent spasticity treatment including SDR (n=35) and antispastic injections.	The SDR group underwent more subsequent orthopedic surgeries and antispastic injections in the lower limbs.
			Children at two other centers had no SDR (n = 40) and limited antispastic injections.	
			Participants returned for comprehensive long-term evaluation (age ≥21 years, follow-up ≥10 years).	
			Assessment included spasticity, contracture, bone alignment, strength, gait, walking energy, function, pain, stiffness, participation and QoL.	

Table 1. Continued...

Author and year of publication	Study design	Goals	Methodology	Main results
Munger et al.[26]	Retrospective study.	Examine the long-term results of SDR 10 to 17 years after surgery.	Participants who underwent SDR had spastic diplegic CP, completed baseline gait analysis, and were 16 to 25 years of age at follow-up.	SDR and non-SDR groups had significant improvement in gait pathology over time.
			Control (non-SDR) participants were matched on key clinical parameters at baseline but did not undergo SDR.	The non-SDR group had significantly better gait compared to the SDR group at follow-up.
			All participants completed six surveys assessing pain, QoL, participation, function, and mobility. Treatment history for lower limb surgery and antispasticity injections was tabulated.	The groups had similar levels of energy cost, pain and QoL.
			A subset of each study group returned for gait analysis, including kinematics, metabolic energy expenditure, and physical examination.	Non-SDR participants underwent significantly more orthopedic surgeries and anti-spasticity injections than SDR participants.
			The Gait Deviation Index (GDI) was calculated to measure gait quality.	The use of a clinically similar control group highlights that different courses of treatment can result in similar outcomes in young adulthood.
Robins et al.[27]	Prospective study.	To present complete data for CPQoL results for patients undergoing RDS at a single institution at 2 years of follow-up.	Patients were operated on for a period of 5 years by the same surgeon using the same technique at a single institution.	Statistically significant improvement was seen in five of the seven CPQoL domains and was maintained up to 2 years after SDR.
			CPQoL questionnaires were completed by patients and family members preoperatively and at 6 months, 1 year, and 2 years after surgery.	
Spazzapan et al.[6]	Retrospective study.	To present the surgical technique and short-term results of a newly created surgical treatment in Slovenia.	A retrospective analysis of all patients who underwent SDR from 2017 to 2019 was performed. The median follow-up was 10 months.	There were no complications regarding wound healing, CSF leak or neurological disorders.
			The motor functions of all children were classified by the GMFCS GMFM-88.	Despite the relatively short follow-up, initial results confirm the effectiveness of SDR.
Summers et al.[20]	Prospective study.	To assess gross motor function before and after SDR and postoperative QoL in a study commissioned by NHS England.	Observational study in five hospitals in England that were contracted to perform SDR in children aged 3 to 9 years with spastic diplegic CP.	SDR improved function and QoL at 24 months after surgery in children with cerebral palsy classified as GMFCS levels II and III.
				Based on these findings, an interim national policy decision was made that SDR would be funded for eligible children in England from 2018.

Table 1. Continued...

Author and year of publication	Study design	Goals	Methodology	Main results
Tedroff et al.[28]	Prospective study.	To evaluate the long-term effects of SDR 15 to 20 years after surgery in patients with CP.	Eighteen children with bilateral spastic CP were prospectively evaluated after SDR.	The effect of normalized muscle tone in the lower extremities after SDR was sustained after a median of 17 years.
			Assessments include the Modified Ashworth Scale for Spasticity, the Gross Motor Function Measure (GMFM-88), the Wilson Mobility Scale, the Health Survey of Health-Related QoL, SF-36v2, and the Brief Inventory of Pain.	Improved gross motor function ability, according to the GMFM score, was observed at the 3-year follow-up, after a gradual decline followed.
				The spasticity-reducing effect of SDR does not improve long-term functioning, nor does it prevent contractures, but it may reduce the pain often experienced by individuals with CP.
Veerbeek et al.[29]	Retrospective study.	To determine the physical status, mental health and health-related QoL (HRQoL) of adults with CP who underwent SDR for at least 25 years, compared to matched typically developing (TD) individuals.	Adults with CP were recruited from a database of children who underwent SDR performed using the technique introduced by Professor Warwick Peacock between 1981 and 1991.	Normalized lower limb muscle tone was maintained 25-35 years after SDR.
		Investigate relationships between physical status and other outcome measures.	These individuals were matched for age, sex, body mass index, and socioeconomic status to a cohort of TD adults of a similar background.	Whereas the lower scores for physical assessments are in line with findings in other CP populations, notably, relatively good mental health scores and HRQoL were reported in this CP group despite their physical limitations.
			The parameters evaluated were muscle tone of the lower limbs, passive range of motion, muscle strength, selectivity, functional mobility and dynamic balance (Timed Up and Go test [TUG]), HRQoL (SF-36) and levels of anxiety and depression.	The strong correlation between muscle strength and TUG suggests that strength training after SDR may be of value in improving functional mobility and balance.

DISCUSSION

SDR is considered and widely accepted as a standard neurosurgical procedure for the treatment of spasticity associated with CP. A number of studies have reported the efficacy of SDR in reducing spasticity[6,20,25-29].

SDR involves partial sectioning of the sensory roots using electrophysiological stimulation. At each vertebral level to be addressed, a linear incision is made to expose the spinal cord and visualize the medullary cone and cauda equina. Electroneuromyography is used to evaluate the degree of hyperactivity of the nerve roots from L1 to S2 and the response in the corresponding segment's musculature, with care given to S2 to S4 to protect bladder and sexual function. Each radicle is stimulated separately, and only radicles that present spastic activity are cut[15,20,21,30,31].

The effect achieved is the reduction of the overstimulation of the lower limb muscles, generally resulting in a decrease of two levels on the Ashorth spasticity scale in the spastic muscle group

of the lower limbs[3]. This scale qualitatively assesses the degree of spasticity, measured according to the resistance to passive movement of a segment moved rapidly by the examiner[32]. Therefore, the earlier the surgery is performed, the lower the chances of the patient having musculoskeletal disabilities[6,21].

Data on the results of a large observational study of this type of procedure and long-term cost data in children who have undergone it or not show that rhizotomy is cost-effective, generating benefits in functionality, range of motion, pain, and spasticity, reducing care costs. Surgical intervention is less expensive than managing possible complications in patients who have not undergone this procedure, considering the improvement in clinical condition and QoL[2,33].

Studies show that SDR is accompanied by significant improvement in several parameters, such as motor function improvement, significant reduction in spasticity, and increased range of movement[6,21,26,28,29]. These benefits were reflected in GMFM scores after SDR, which increased linearly during the observation period after surgery[6,20,21,28]. Specifically, the QoL improved in terms of feelings about functioning, participation and physical health, emotional well-being and self-esteem, pain, and the impact of disability and family health[2,20,33].

Regarding motor function, SDR has traditionally been used in the management of GMFSC grades, a widely used tool to establish a child's function level and guide treatment[27].

In the context of CP, SDR is reserved for improving gait in children diagnosed with GMFCS grades II and III. In more severe non-ambulatory GMFCS grades IV and V, the main goal of treatment is to facilitate nursing care, usually using intrathecal baclofen pump (ITBP). Thus, in non-ambulatory CP, the child and caregiver's objectives should be carefully considered as not all children will have benefit from reducing spasticity as some may rely on spasticity to assist with transfers[2].

A 2019 review showed that the efficacy of the operation in severely affected children is likely best evaluated in terms of specific patient and family goals, rather than gross motor measures. In this sense, SDR aims not only to reduce spasticity but also to promote the child and caregiver's functional development and goals in a person-centered manner[22].

A review conducted by Peck et al.[2] analyzed seminal and emerging evidence on interventional therapy for chronic pain in cerebral palsy. The researchers raised the question of whether SDR could be a potential alternative in reducing spasticity and improving passive range of motion (ROM). The included studies showed that in GMFCS IV and V scenarios, although the ITBP is the treatment's basis, in moderate to severe GMFCS patients, postoperative 1-year RDS was more effective in reducing spasticity and improving ROM than ITBP.

A subsequent prospective study conducted in England investigated the Pediatric Evaluation of Disability Inventory (PEDI) assessment inventory of 42 patients followed for 24 months. This analysis is based on an interview used to monitor self-care, mobility, and social skills for children with CP. In summary, the authors concluded that PEDI self-care scores increased linearly after SDR, with a significant improvement in 24 months. Such an evolution was mainly observed in GMFCS levels I, III, and IV. The increase was greater in the age groups of 10 to 18 years but not in patients with dystonia[21].

On the other hand, a multicenter and retrospectively matched cohort study comprising 75 participants concluded that children with high levels of spasticity presented marked deviations in gait, high energy consumption, joint contractures, and low function. Moreover, high levels of spasticity were often accompanied by poor motor control, weakness, and other comorbidities associated with more severe CP[25].

The relationship between physical activity, physical health, gross motor function, and selective motor control was also investigated. The summary of the physical component showed correlations with the individual's GMFCS level, the Physical Activity Scale, and the total change in GMFM throughout the follow-up, indicating that individuals who reported better physical health were those with higher gross motor performance, more physically active, and with improvements in GMFM[28].

A cohort study with 35 participants suggested that many of the long-term outcomes of surgical treatment in the domains of the International Classification of Functioning, Disability and Health (evaluations of spasticity, range of motion, and gait patterns) are not significantly different from those obtained with alternative treatments. When viewed in isolation, without comparison with a clinically similar control group, SDR appears to be an appropriate

intervention for achieving improvements in various domains of the ICF that last until early adulthood. In the long-term follow-up, spasticity, gait, and function improved. Energy consumption showed a decreasing trend. Pain interference was low, and QoL was high. However, when comparing these improvements with a clinically similar control group, it seems that surgical intervention was not the only way to achieve these improvements[26].

The results suggest that, although SDR may lead to a high QoL, low pain, and improvements in gait and function as a young adult, other courses of treatment may result in similar outcomes. Despite the clear contribution that SDR provides to people with CP, the onset of declining function and comfort will likely occur in adulthood, and continuous monitoring of outcomes is necessary.

Regarding the decline of benefits and early aging, improvements in spasticity, when compared with the baseline, have been shown to persist for up to 20 years after the procedure, while other benefits, such as increased ROM and gross motor function, persisted only temporarily, gradually decreasing some years after the procedure[2]. It has also been found that many adults with CP experienced a functional decline in early adulthood accompanied by chronic pain and fatigue, a phenomenon that has been called early aging[24].

In theory, early-life spasticity treatment could improve several of the factors associated with this phenomenon. Abnormally increased tone interferes with motor control, decreasing gait efficiency and increasing energy expenditure. Spasticity also contributes to contracture and joint displacement, leading to arthritis and pain. These findings are supported by a cohort study conducted by Hurvitz et al.[24] revealing that rhizotomy did not eliminate the need for interventions, with more than half of the patients reporting the need for medication, injections, or pump implants.

Meanwhile, chronic pain is common in adults with CP, being associated with increased psychological distress and decreased life satisfaction. Participants who reported constant pain noted that this led to frustration due to loss of independence and difficulty to participate in activities and subsequently evaluated their life satisfaction at a lower level. However, whether they would require higher doses of medication or more combined interventions if they had not undergone surgery remains a question[2].

On the other hand, Tedroff et al.[28] prospectively followed 18 children with CP who underwent SDR in Sweden between 1993 and 1997, focusing on the outcome 15 to 20 years after the procedure. To assess the severity of pain and the interference of pain with general activities, the Swedish version of the Brief Pain Inventory – Short Form was used, which consists of two parts, the first containing eight items concerning pain location, pain intensity, analgesics used, and pain relief. In the second part, the individual is asked about pain interference with activities of daily living. In this study, 50% of participants reported pain; however, both the interference and severity of pain were low (<2 composite scores). This is lower than that reported previously in adults with CP. The results reveal a group of young adults with CP where pain seems to be a minor problem than previously reported in a series of studies. This may be an effect of the reduction of spasticity.

Thus, although these benefits decrease over time, the effectiveness of SDR is still noticeable compared to the baseline before the procedure[2].

In a retrospective analysis, Spazzapan et al.[6] selected children who underwent SDR between 2017 and 2019 and routinely evaluated them preoperatively, one month after surgery, and six months after surgery. The motor functions of all children were classified using the GMFCS, and spasticity was evaluated by the scale that assesses resistance during passive stretching of soft tissues (MAS). In the first few weeks after surgery, lower limb function and gait worsened due to paresthesias, loss of rigidity, and postoperative pain. The children were routinely transferred to rehabilitation hospital. At three months of follow-up, there was already an improvement in the GMFM score, and at six months of follow-up, the mean MAS scores were 0 for all evaluated muscles. The results showed that all children improved their gross motor functioning in the GMFM test.

Regarding QoL and daily activities, SDR aims to improve functional outcomes for patients with CP by reducing lower limb tone. Sustained reduction in spasticity has been widely reported. Numerous articles have found that most CP patients who undergo RDS are satisfied and rate their personal health as good[20,24,27-29].

QoL assessment is a complex task due to the need to balance the subjective perception about QoL for each child/family, along with the need to consider disease-specific factors as well as general measures of health, functioning, and the impact of a disability.

The CPQoL questionnaire was developed as a specific tool for assessing QoL in the condition of cerebral palsy and is designed to be completed by parents and completed by the patient at a later date. It is based on the International Classification of Function and the WHO definition of QoL by assessing the domains of "social well-being and acceptance", "feelings about function", "participation and physical health", "developmental well-being and self-esteem", "access to services", "pain and impact of disability", and "family health". It is also crucial for assessing the impact of surgical intervention on patient and family QoL[27].

To better understand QoL outcomes after SDR, Robins et al.[27] followed a cohort of 78 children with complete data preoperatively and at 6 months, 1 year, and 2 years post- SDR using a standardized QoL measure. They found that SDR has a beneficial effect on QoL in five of the seven domains for CPQoL. These were "feelings about functioning," "participation and physical health," "emotional well-being and self-esteem," "access to services," and "pain and impact of disability." All of these domains showed improvement at 6 months postoperatively that was maintained at 2 years after SDR. Surgical intervention did not have a statistical significance on feelings of "social well-being and acceptance" and "family health" as these two domains are highly complex and multifaceted and affected by numerous factors beyond the patient's physical functioning. "Social well-being and acceptance", for example, are influenced by the presence of other comorbidities (including difficulties), school and socio-environmental factors, and support structures. In addition, the analysis revealed that improvement in the gross motor function measure was observed to be greater in GMFCS level II and III children. Improvements in activities of daily living, self-care, and independence were reported[20,27].

In a 2013 descriptive study, the authors assessed the long-term perceptions of 88 older adolescents (16-20 years old) and adults with CP who underwent SDR as children. Overall or general life satisfaction was assessed using the Diener Satisfaction with Life Scale (SWLS), which rates 5 statements on a 7-point scale. SWLS scores were a predictor and overall health showed a tendency to be a predictor, with better scores on these parameters associated with increased odds of recommending rhizotomy to others[24].

When asked about their subjective impression of the procedure, the majority (65%) of the individuals interviewed believed that the SDR had a beneficial impact and reported that they would recommend the surgery to others. However, for 8% of the participants the surgical intervention decreased their QoL, citing pain and no effect as reasons. Most patients who reported decreased QoL were in the GMFCS levels with greater motor limitation[24].

In this study population, there was a high prevalence of both pain and post- SDR medical and surgical treatments for spasticity. However, despite continued residual pain and spasticity, most patients were satisfied with their lives and reported good to excellent health[24]. The hypothesis raised is that reduced spasticity and less pain may result in higher perceived health-related QoL and higher overall scores. When compared to the age-standardized sample, the study group exhibited a lower physical component summary but a higher mental health component summary, showing that they perceived their physical health to be worse and their mental health to be better when compared to the control group[28].

Additionally, a 2021 cross-sectional study conducted by Veerbeek et al.[29] investigated health concepts and their perceived impacts on QoL in adults with CP undergoing SDR in South Africa between 1981 and 1991. The concepts assessed were physical functioning, limitations in usual activities due to physical health problems, general health, vitality (energy and fatigue), social functioning, limitations in usual activities due to emotional problems, and general mental health (psychological distress and well-being).

The primary results discussed were that adults with CP perceived relatively good health-related QoL in all domains. Additional results included that although some study members had disability, were more dependent, and faced more difficulties in daily activities and social roles, they were satisfied in carrying out these lifestyle habits. In reference to mental health, only limited symptoms of anxiety and depression were found. These results reveal that adults with CP more than 25 years after SDR have good mental health, regardless of physical challenges[29].

CONCLUSION

The results obtained corroborate that selective dorsal rhizotomy is the most effective alternative for the treatment of spasticity in cerebral palsy patients with GMFCS level II or III due to the significant improvement in QoL provided by the reduction of

spasticity and muscle stiffness and by the functional evolution and mobility of the patient.

Studies show that surgical intervention can potentially lead to improvements in gross motor test and general function, mobility, QoL and self-care scores after the neurosurgical procedure. This reduces the need for further surgical intervention and improves independence in activities of daily living.

Therefore, most adults who underwent SDR had a positive impression of the surgery and would recommend it to others. Very few reported negative impressions of the procedure. Levels of satisfaction with life post- SDR were generally high.

Further large retrospective and prospective controlled studies or multicenter collaborations are needed to define the benefits of SDR, particularly with regard to long-term follow-up, but the data from the present study suggest generating an overall positive impression and a lack of negative consequences of SDR.

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