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Original article

Evaluation of the functional results in the treatment of pelvic limbs with multiple level surgery in spastic ICP patients

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ABSTRACT. The purpose of this study is to assess the effects of multiple level surgery of the pelvic limbs in patients with spastic infantile cerebral palsy seen at the National Rehabilitation Institute and show that their clinical improvement is comparable to the reports in the national and international literature. *Material and methods:* This is a longitudinal, prospective, descriptive, self-controlled, before-and-after clinical trial that included patients with spastic infantile cerebral palsy who underwent multiple-level single-stage surgery from January 2007 to August 2008. The inclusion criteria were as follows: both genders, ages 4 to 16 years, with a complete clinical file, with preoperative and 8-12 month postoperative rehabilitation. Elimination criterion: any event not related with multiple-level surgery. Exclusion criterion: any surgeries prior to admission. A descriptive statistical analysis was used, together with the Student t-test and the chi-square test. *Results:* 81 patients with a mean age of 7 ± 3.2, an age range of 4-16 years; 60.5% males and 39.5% females. The subtypes of spastic infantile cerebral palsy were as follows: biparesis 64.2%, quadriparesis 22.2%, hemiparesis 8.6%, double hemiparesis 4.9%. The clinical-surgical classification (14) changed as a result of improvement and according to the number of surgical procedures: 6 patients (7.4%) had significant improvement (p = 0.13) with one procedure; 44 patients (54.3%) had significant

RESUMEN. El objetivo de este estudio es evaluar los efectos de la cirugía multinivel en extremidades pélvicas de pacientes con parálisis cerebral infantil espástica, atendidos en el Instituto Nacional de Rehabilitación y demostrar que su mejoría clínica es comparable a lo reportado en la literatura nacional e internacional. *Material y métodos:* El diseño del estudio fue longitudinal, prospectivo, descriptivo, tipo ensayo clínico autocontrolado de antes y después en pacientes con parálisis cerebral infantil espástica que fueron intervenidos con cirugía multinivel en un solo evento de Enero de 2007 a Agosto de 2008. Criterios de inclusión: ambos sexos, edad entre 4 y 16 años, expediente completo, rehabilitación pre y de 8 a 12 meses postoperatoria. Criterio de eliminación: evento no relacionado con la cirugía multinivel. Criterio de exclusión: cirugías previas a su ingreso. Se utilizó análisis estadístico descriptivo, t de Student y chi cuadrada. *Resultados:* 81 pacientes con edad promedio de 7 ± 3.2 con rango de 4-16 años, masculino 60.5% y femenino 39.5%. Subtipos de parálisis cerebral infantil espástica: diparesia 64.2%, cuadriparesia 22.2%, hemiparesia 8.6%, doble hemiparesia 4.9%. Los cambios de la clasificación clinico-quirúrgica (14) se modificaron a la mejoría de acuerdo al número de procedimientos quirúrgicos: de un procedimiento fueron 6 pacientes (7.4%) con mejoría significativa (p = 0.13), con dos procedimientos

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improvement (p = 0.002) with two procedures; 28 patients (34.6%) had significant improvement (p = 0.04) with three procedures, and 3 patients (3.7%) had significant improvement (p = 0.19) with four procedures. On the other hand, when the number of surgical procedures was related with the diagnostic subtype of spastic infantile cerebral palsy, in those undergoing one procedure the clinical-surgical classification did not change in the cases of biparesis (p = 0.26), hemiparesis (p = 0.18), and double hemiparesis (p = 0.50). In those undergoing two surgical procedures the significant changes occurred for the cases of biparesis (p = 0.20), quadriparesis (p = 0.007), and double hemiparesis (p = 0.16). In those undergoing four procedures no changes occurred in the cases of biparesis (p = 0.26) and hemiparesis (p = 0.50). *Discussion:* An improvement in the clinical-surgical classification was observed (p = 0.0001) based on the results of Gazi Zorer, as well as a significant improvement (p < 0.001) and an improvement reported by the gait analysis by the following authors: Ugur Sayli, Gouth, MA Khan.

Key words: muscle spasticity, surgery, cerebral palsy, osteotomy, tenotomy.

44 pacientes (54.3%) con mejoría significativa (p = 0.002), con tres procedimientos a 28 pacientes (34.6%), con mejoría significativa (p = 0.04), con cuatro procedimientos a 3 pacientes (3.7%) con mejoría significativa (p = 0.19). Por otra parte al cruzar el número de procedimientos quirúrgicos por subtipo del diagnóstico de parálisis cerebral infantil espástica en los que tuvieron un procedimiento la clasificación clinico-quirúrgica no se modificó significativamente en los casos de diparesia su mejoría significativa (p = 0.26), hemiparesia (p = 0.18), doble hemiparesia (p = 0.50); en los que tuvieron dos procedimientos quirúrgicos los cambios significativos sucedieron en la diparesia (p = 0.0001), cuadriparesia (p = 0.003), pero no en la doble hemiparesia (p = 0.50); y en los que tuvieron tres cirugías los cambios significativos sucedieron en la diparesia (p = 0.020), cuadriparesia (p = 0.007), doble hemiparesia (p = 0.16) y los de cuatro cirugías no hubo cambios en la diparesia (p = 0.26) ni en las hemiparesias (p = 0.50). *Discusión:* Se apreció mejoría en la clasificación clinico-quirúrgica (p = 0.0001) a lo obtenido de Gazi Zorer a una mejoría significativa (p < 0.001) y la mejoría reportada con los análisis de marcha por los autores: Ugur Sayli, Gouth, MA Khan.

Palabras clave: espasticidad muscular, cirugía, parálisis cerebral, osteotomía, tenotomía.

Introduction

The neuromotor disorders caused by brain lesions are one of the serious problems of childhood and are amongst the main pediatric disabling conditions.[1] In Mexico we do not have accurate figures on the prevalence of infantile cerebral palsy. The report of the Ministry of Health in 1998-2002 was 3 per 10,000 live births.[2] From January 1st, 2006 to October 30, 2008, according to the overall discharge report of the National Rehabilitation Institute, 112 patients with a diagnosis of infantile cerebral palsy (ICP) received medical care. The basis for treatment lies in the analysis of the condition to determine which parts of it may be corrected and which may not, and thus the problem of managing spasticity in children with spastic ICP. In children under age 4, physical therapy, orthosis or botulinum toxin injections are recommended. Children develop a mature gait pattern at 4-6 years of age and are capable of cooperating with a postoperative physical therapy program, so the management of spasticity and contractures should include orthopedic surgery of the pelvic limbs at these ages and for thoracic limbs at 6-8 years of age. Once this window of opportunity has been lost, the results of surgery are less rewarding.[3] The technique and the management of spasticity used in children with ICP are driven mainly by the clinical and surgical breakthroughs with the main purpose being that the correction should improve the articular deformity, the torsional deformity and the abnormal motor control.[4]

The purpose of the treatment of spasticity is to reduce the contracture deformity, improve the patient's function and relieve pain. The simultaneous correction of deformities of spastic ICP in multiple joints has been recommended by Reimer-Blek and Rang,[5] and has been supported by other authors. This method causes less morbidity, reduces the hospital stay, facilitates the ambulation and quality of the gait, reduces spasticity, provides articular alignment and congruence, decreases the use of orthoses and simplifies the postoperative rehabilitation.[5] The concept in multiple level surgery refers to the correction of all the deformities (soft tissues and bones in a single surgical stage). This procedure integrates two prevalent concepts: Dr. Takashi Matzuo's orthopedic selective spasticity-control surgery,[3] based on the concept of multiarticular muscles, which have less anti-gravity

activity and are hyperactive in cerebral palsy. The spastic movements can therefore be controlled upon selectively releasing them. The monoarticular muscles, which have anti-gravity activity and are responsible for maintaining an upright position, are carefully preserved. The second concept refers to the bone correction (e.g., hip subluxation, femoral anteversion, tibial torsion and hind foot valgus), as proposed by Dr. James Gage.[3]

The purpose of this paper is to show that the simultaneous correction of the gross motor function in the pelvic limbs through multiple level surgery performed at a single stage in bony and soft tissues is effective to improve gait because it provides a more efficient use of energy and improves the overall quality of life of the patient with spastic ICP, in children treated at the National Rehabilitation Institute.

Table 1. Clinical classification. Measurement – Sex.

Gender	Clinical classification	Measurement: Preoperative n	(%)	Postoperative n	(%)	Total Preoperative n	(%)
Male	Grade I A	0	(0.0)	5	(10.2)	5	(5.1)
	Grade I B	4	(8.2)	7	(14.3)	11	(11.2)
	Grade II A	2	(4.1)	7	(14.3)	9	(9.2)
	Grade II B	3	(6.1)	1	(2.0)	4	(4.1)
	Grade II C	0	(0.0)	5	(10.2)	5	(5.1)
	Grade II D	8	(16.3)	3	(6.1)	11	(11.2)
	Grade III A	1	(2.0)	5	(10.2)	6	(6.1)
	Grade III B	4	(8.2)	4	(8.2)	8	(8.2)
	Grade III C	15	(30.6)	8	(16.3)	23	(23.5)
	Grade IV A	8	(16.3)	4	(8.2)	12	(12.2)
	Grade IV B	4	(8.2)	0	(0.0)	4	(4.1)
	Total	49	(100.0)	49	(100.0)	98	(100.0)
	P= 0.0001						
Female	Grade I A	0	(0.0)	3	(9.4)	3	(4.7)
	Grade I B	2	(6.3)	8	(25.0)	10	(15.6)
	Grade II A	6	(18.8)	3	(9.4)	9	(14.1)
	Grade II B	1	(3.1)	2	(6.3)	3	(4.7)
	Grade II C	1	(3.1)	0	(0.0)	1	(1.6)
	Grade II D	1	(3.1)	3	(9.4)	4	(6.3)
	Grade III A	1	(3.1)	7	(21.9)	8	(12.5)
	Grade III B	10	(31.3)	0	(0.0)	10	(15.6)
	Grade III C	4	(12.5)	5	(15.6)	9	(14.1)
	Grade IV A	5	(15.6)	1	(3.1)	6	(9.4)
	Grade IV B	1	(3.1)	0	(0.0)	1	(1.6)
	Total	32	(100.0)	32	(100.0)	64	(100.0)
	P = 0.0001						

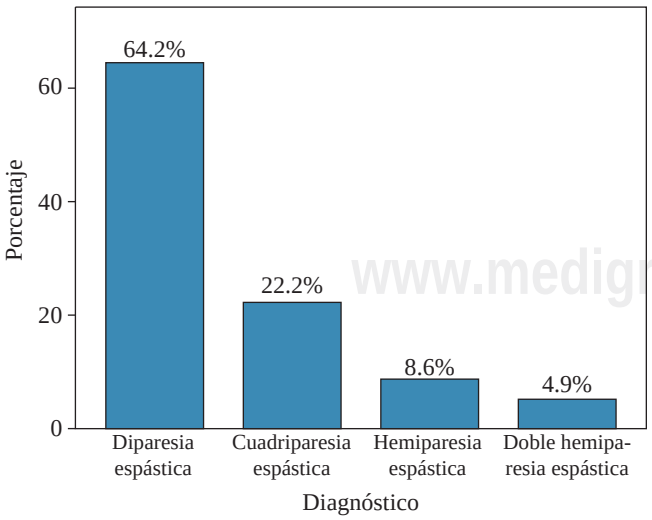

Chart 1. Distribution of the frequencies of the diagnosed subtypes of infantile cerebral palsy.

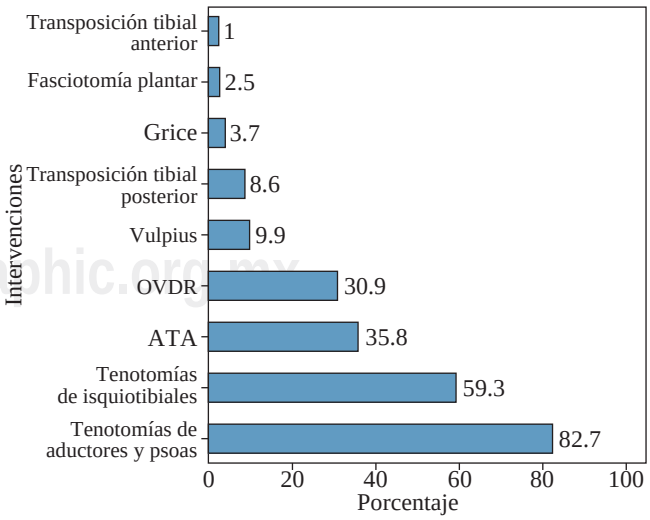

Chart 2. Distribution of the frequencies of the types of multiple level surgeries performed in patients with infantile cerebral palsy.

Material and methods

This is a longitudinal, prospective, descriptive, before-and-after self-controlled, clinical trial-like intentional intervention study. The records of 81 patients were reviewed from January 2007 to August 2008. The patient enrollment time line was followed and the individual form was filled out with the following inclusion criteria: children ages 4 to 16 years old, males and females, with preoperative and postoperative rehabilitation, with an 8-12 month postoperative follow-up period, with a clinical and surgical classification *(Table 1)* upon admission, and reassessment at postoperative months 8-12, with complete records, subtype of cerebral palsy and surgical procedures to be performed: adductor and psoas tenotomies, hamstring tenotomies, derotating varus osteotomy, tibial transposition, plantar fasciotomy, lengthening of the calcaneal tendon and extraarticular arthrodesis (Grice) according to each case's needs. The elimination criterion included complications or another event not related with multiple level surgery. The exclusion criteria included having undergone surgery prior to admission to the National Rehabilitation Institute and not having a complete record for evaluation.

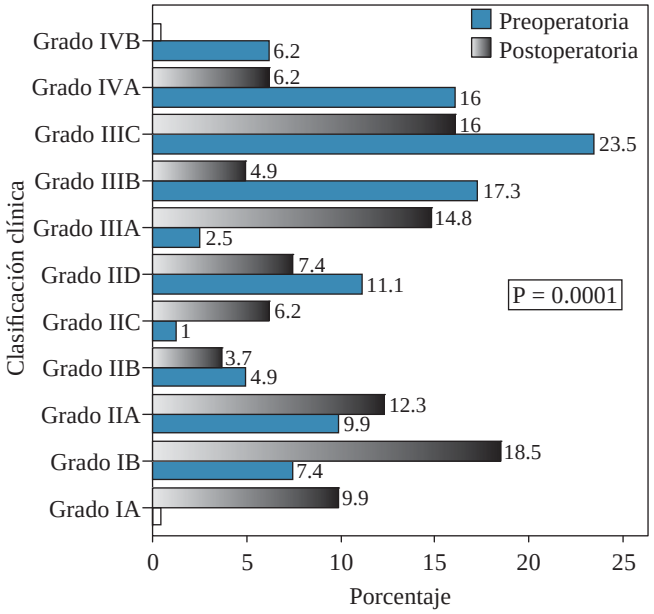

Chart 3. Change from the preoperative to the postoperative clinical classification after multiple level surgery in patients with ICP.

Table 2. Clinical classification. Measurement – Diagnosis.

Diagnosis	Clinical classification	Measurement Preoperative n	(%)	Postoperative n	(%)	Total Preoperative n	(%)
Spastic biparesis	Grade I A	0	(0.0)	3	(5.8)	3	(2.9)
	Grade I B	3	(5.8)	13	(25.0)	16	(15.4)
	Grade II A	6	(11.5)	9	(17.3)	15	(14.4)
	Grade II B	3	(5.8)	3	(5.8)	6	(5.8)
	Grade II C	0	(0.0)	4	(7.7)	4	(3.8)
	Grade II D	7	(13.5)	6	(11.5)	13	(12.5)
	Grade III A	2	(3.8)	10	(19.2)	12	(11.5)
	Grade III B	12	(23.1)	4	(7.7)	16	(15.4)
	Grade III C	19	(36.5)	0	(0.0)	19	(18.3)
	Total	52	(100.0)	52	(100.0)	104	(100.0)
	P = 0.0001						
Spastic quadriparesis	Grade III C	0	(0.0)	13	(72.2)	13	(36.1)
	Grade IV A	13	(72.2)	5	(27.8)	18	(50.0)
	Grade IV B	5	(27.8)	0	(0.0)	5	(13.9)
	Total	18	(100.0)	18	(100.0)	36	(100.0)
	P= 0.0001						
Spastic hemiparesis	Grade I A	0	(0.0)	3	(42.9)	3	(21.4)
	Grade I B	2	(28.6)	2	(28.6)	4	(28.6)
	Grade II A	2	(28.6)	1	(14.3)	3	(21.4)
	Grade II B	1	(14.3)	0	(0.0)	1	(7.1)
	Grade II C	0	(0.0)	1	(14.3)	1	(7.1)
	Grade II D	2	(28.6)	0	(0.0)	2	(14.3)
	Total	7	(100.0)	7	(100.0)	14	(100.0)
	P= 0.19						
Double spastic hemiparesis	Grade I A	0	(0.0)	2	(50.0)	2	(25.0)
	Grade I B	1	(25.0)	0	(0.0)	1	(12.5)
	Grade II C	1	(25.0)	0	(0.0)	1	(12.5)
	Grade III A	0	(0.0)	2	(50.0)	2	(25.0)
	Grade III B	2	(50.0)	0	(0.0)	2	(25.0)
	Total	4	(100.0)	4	(100.0)	8	(100.0)
	P= 0.0001						

Table 3. Clinical classification. Measurement – Diagnosis.

No. of interventions	Diagnosis	Clinical classification	Measurement Preoperative n	(%)	Postoperative n	(%)	Total Preoperative n	(%)
1	Spastic biparesis	Grade I A	0	(0.0)	1	(50.0)	1	(25.0)
		Grade I B	1	(50.0)	0	(0.0)	1	(25.0)
		Grade II A	0	(0.0)	1	(50.0)	1	(25.0)
		Grade III A	1	(50.0)	0	(0.0)	1	(25.0)
		Total	2	(100.0)	2	(100.0)	4	(100.0)
	Spastic hemiparesis	Grade I A	0	(0.0)	2	(66.7)	2	(33.3)
		Grade I B	2	(66.7)	1	(33.3)	3	(50.0)
		Grade II A	1	(33.3)	0	(0.0)	1	(16.7)
		Total	3	(100.0)	3	(100.0)	6	(100.0)
	Double spastic hemiparesis	Grade I A	0	(0.0)	1	(100.0)	1	(50.0)
		Grade II C	1	(100.0)	0	(0.0)	1	(50.0)
		Total	1	(100.0)	1	(100.0)	2	(100.0)
2	Spastic biparesis	Grade I A	0	(0.0)	2	(6.7)	2	(3.3)
		Grade I B	2	(6.7)	9	(30.0)	11	(18.3)
		Grade II A	5	(16.7)	4	(13.3)	9	(15.0)
		Grade II B	2	(6.7)	2	(6.7)	4	(6.7)
		Grade II C	0	(0.0)	2	(6.7)	2	(3.3)
		Grade II D	4	(13.3)	2	(6.7)	6	(10.0)
		Grade III A	0	(0.0)	7	(23.3)	7	(11.7)
		Grade III B	6	(20.0)	2	(6.7)	8	(13.3)
		Grade III C	11	(36.7)	0	(0.0)	11	(18.3)
		Total	30	(100.0)	30	(100.0)	60	(100.0)
	Spastic quadriparesis	Grade III C	0	(0.0)	7	(70.0)	7	(35.0)
		Grade IV A	7	(70.0)	3	(30.0)	10	(50.0)
		Grade IV B	3	(30.0)	0	(0.0)	3	(15.0)
		Total	10	(100.0)	10	(100.0)	20	(100.0)
	Spastic hemiparesis	Grade I A	0	(0.0)	1	(33.3)	1	(16.7)
		Grade I B	0	(0.0)	1	(33.3)	1	(16.7)
		Grade II A	1	(33.3)	0	(0.0)	1	(16.7)
		Grade II C	0	(0.0)	1	(33.3)	1	(16.7)
		Grade II D	2	(66.7)	0	(0.0)	2	(33.3)
		Total	3	(100.0)	3	(100.0)	6	(100.0)
		P = 0.0001						
2	Double spastic hemiparesis	Grade I A	0	(0.0)	1	(100.0)	1	(50.0)
		Grade I B	1	(100.0)	0	(0.0)	1	(50.0)
		Total	1	(100.0)	1	(100.0)	2	(100.0)
3	Spastic biparesis	Grade I B	0	(0.0)	3	(16.7)	3	(8.3)
		Grade II A	1	(5.6)	3	(16.7)	4	(11.1)
		Grade II B	1	(5.6)	1	(5.6)	2	(5.6)
		Grade II C	0	(0.0)	2	(11.1)	2	(5.6)
		Grade II D	2	(11.1)	4	(22.2)	6	(16.7)
		Grade III A	1	(5.6)	3	(16.7)	4	(11.1)
		Grade III B	6	(33.3)	2	(11.1)	8	(22.2)
		Grade III C	7	(38.9)	0	(0.0)	7	(19.4)
		Total	18	(100.0)	18	(100.0)	36	(100.0)
	Spastic quadriparesis	Grade III C	0	(0.0)	6	(75.0)	6	(37.5)
		Grade IV A	6	(75.0)	2	(25.0)	8	(50.0)
		Grade IV B	2	(25.0)	0	(0.0)	2	(12.5)
		Total	8	(100.0)	8	(100.0)	16	(100.0)
	Double spastic hemiparesis	Grade III A	0	(0.0)	2	(100.0)	2	(50.0)
		Grade III B	2	(100.0)	0	(0.0)	2	(50.0)
		Total	2	(100.0)	2	(100.0)	4	(100.0)
4	Spastic biparesis	Grade I B	0	(0.0)	1	(50.0)	1	(25.0)
		Grade II A	0	(0.0)	1	(50.0)	1	(25.0)
		Grade II D	1	(50.0)	0	(0.0)	1	(25.0)
		Grade III C	1	(50.0)	0	(0.0)	1	(25.0)
		Total	2	(100.0)	2	(100.0)	4	(100.0)
	Spastic hemiparesis	Grade II A	0	(0.0)	1	(100.0)	1	(50.0)
		Grade II B	1	(100.0)	0	(0.0)	1	(50.0)
		Total	1	(100.0)	1	(100.0)	2	(100.0)

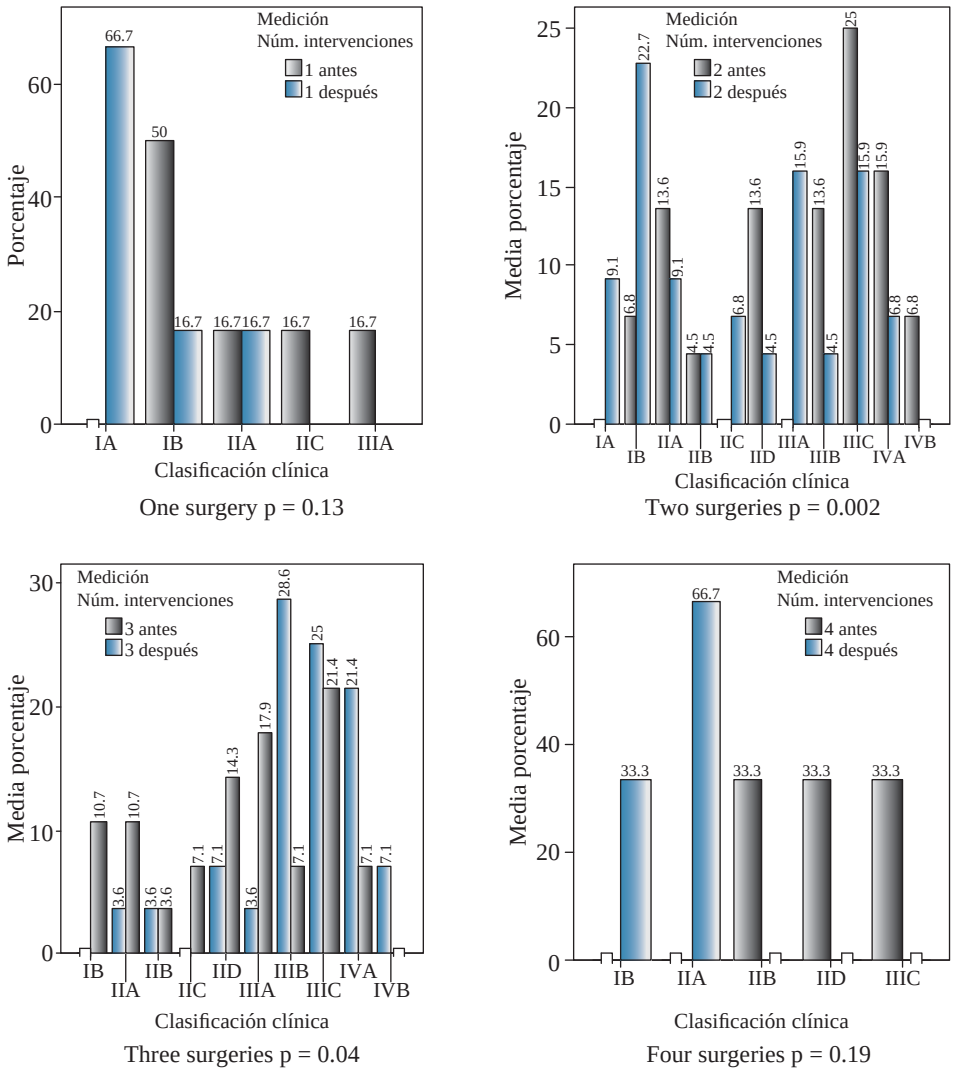

Chart 4. Showing the changes in the clinical classification according to the number of surgical interventions.

Statistical analysis: descriptive statistics were used (frequency, percentage) and for the hypothesis tests the chi square test, the Student t test and the one-way variance analysis sere used. The differences were considered as significant when p = 0.005.

Results

This is a sample of 81 patients with a mean age of 7 ± 3.2 years with a range of 4 to 16 years. 60.5% were males and 39.5% females. The subtypes of ICP diagnosed are included in *chart 1*.

The most frequent interventions were: first of all, adductor and psoas tenotomies; second, hamstring tenotomies; third, lengthening of the calcaneal tendon, and fourth, derotating varus osteotomy; the rest of the procedures, such as tibial transposition, extraarticular arthrodesis (Grice) and plantar fasciotomy, were performed in less than 10% *(Chart 2)*.

The clinical classification was modified significantly towards a clear improvement *(Chart 3)*.

The changes towards an improvement in the clinical classification were the same regardless of the sex of patients, i.e., they were equally significant in both males and females *(Table 1)*.

According to the subtype of ICP, the changes were significant in the cases of biparesis and quadriparesis but they were not significant in the cases of hemiparesis and double hemiparesis *(Table 2)*.

According to the number of interventions, one may see that the changes in the clinical classification at both ends (those with a single surgery and those with four surgeries) were not significant, probably because of the small sample size *(Table 3 and Chart 4)*.

Overall, 6 patients (7.4%) underwent a single surgery, 44 (54.3%) two surgeries, 28 (34.6%) three surgeries, and 3 (3.7%) four surgeries.

The mean age was significantly different according to the number of surgeries, with 9.3 ± 4.2 for those undergoing a single surgery; 6.8 ± 2.8 for two surgeries, 6.4 ± 3.2 for three surgeries, and 11.3 ± 2.5 for those who underwent four surgeries (p = 0.02).

Table 4. Universal clinico-surgical classification of patients with spastic ICP
Dr. Redón – Tavera.

Clinical Improvement means moving from one grade to another	
	Grade I – Mild
Grade I - A	Independent gait without contractures or walking aids (attitude very close to normal).
Grade I - B	Independent gait, without subclinical isolated contracture. a) Single-limb spasticity. b) Absence of fine voluntary control in one hand. c) Excessive wear of the tip of one shoe (spastic retraction of sural muscles and insufficient foot dorsiflexion)
	Grade II – Moderate
Grade II - A	Independent gait with dynamic contractures; aligned on the table. a) Walking with a spastic attitude (scissor gait) without assistance. b) Achieves complete ranges of passive motion.
Grade II - B	Independent gait with dynamic established contractures; contractured on the table. a) Walks with a spastic attitude (scissor gait). b) Does not achieve complete ranges of passive motion.
Grade II - C	Independent gait without contractures, assisted gait. a) Aligned postoperated child. b) Not strong enough to stand up. c) Gait assisted with hands and aids.
Grade II - D	Independent gait with contractures, assisted gait. a) Persistent contractures. b) Requires walking aids. c) Insufficient strength to maintain vertical bipedestation. d) Moves with bipodalic weight bearing.
	Grade III – Severe
Grade III - A	Dependent weight bearing and gait reflex, no contractures. a) Insufficient trunk strength and balance. b) Requires assistance (a person, wall, rail or furniture). c) Cannot use walker or crutches.
Grade III - B	Dependent weight bearing and gait reflex, with contractures. a) Insufficient strength to stand up on their own. b) Needs gait assistance. c) Adopts sitting position.
Grade III - C	Impossible gait, sitting trunk balance with contractures a) No weight bearing or gait reflex b) May sit down with a balanced trunk.
	Grade IV – Severe
Grade IV - A	No trunk balance, full assistance. a) Cannot hold the head and the trunk. b) Flaccidity of pelvic limbs. c) Spasticity of pelvic segments. d) Frequent mental impairment.
Grade IV - B	Spastic scoliosis a) Bipedestation impossible. b) Cannot sit down.

On the other hand, when the number of surgeries was related with the ICP diagnostic subtype, in those who underwent one surgery the clinical classification did not change significantly in the cases of biparesis (p = 0.26), hemiparesis (p = 0.18) and double hemiparesis (p = 0.50); in those who underwent two surgeries the significant changes in the clinical classification occurred for biparesis (p = 0.0001) and quadriparesis (p = 0.003), but not for hemiparesis (p = 0.19) or double hemiparesis (p = 0.50); in those who underwent three surgeries, the significant clinical changes also occurred for biparesis (p = 0.020), and quadriparesis (p = 0.007), but not for double hemiparesis (p = 0.16); finally, in those who underwent four surgeries there were no changes in biparesis (p = 0.26) and hemiparesis (p = 0.50) *(Table 2)*.

Discussion

The brain neurologic damage in children has become a public health problem[6] due to its high incidence that is partly due to the high survival rate of high risk neonates, and to the functional sequelae that are usually detected late.[7] Thus the health care institutions have established a standardization protocol using the gait-related technological developments and the rehabilitation programs as well as

those that include guidance on functional skills and quality of life measures.[3,8-11] The purpose of this study is to assess the functional and clinical results of the treatment of pelvic limbs with multiple level surgery in spastic patients selected by applying a previously defined standardized protocol at the National Rehabilitation Institute. Also, to compare the results obtained in studies reported by other authors: Dr. Metaxiotis[9] in a study of 20 children (40 pelvic limbs) with spastic ICP who underwent multiple level surgery showed an excellent improvement in the 3D gait analysis performed before and after the surgery.[12] Andi B. Gordon did a study to determine the efficacy of percutaneous tenotomy surgery in children with ICP (ambulatory) from 1996 to 2007 and assessed 50 patients. He showed a significant improvement in knee extension, increased velocity, longer strides and overall improved gait in the short term (less than 18 months after the surgery) and in the long term (after postoperative month 18) and showed efficacy with the 3D computed gait analysis performed before and after the surgery.[12] Gazi Zorer assessed the results of multiple level surgery in 23 patients with a mean age of 6 years, with a range of 4 to 17 years, and reported an improvement in patients' posture and gait; it became easier for them to use a walker and crutches. He evaluated the results with the gross motor function classification.[13] Gouth assessed 24 patients under 7 years of age; 13 children accepted his surgery (surgical group) and 11 did not (non-surgical group). Patients in the surgical group had improvement in the ranges of motion of the pelvic limb joints, when compared with the results of the non-surgical group.[10] M. A. Khan assessed 85 patients ages 5 to 12 years who could not walk and performed single-stage multiple level surgery. The assessments performed 2-5 years after surgery, with a mean of 3.5 years, found that the contracture levels in the static joints had resolved when gait improved.[11]

In this study Grade IV patients could easily change their position and remained pain free after treatment. Grade III patients were able to walk with minimal assistance and/or had independent gait with contractures. Grade II patients had improvement towards independent gait, subclinical contractures and more easiness in using a walker or an external aid. Grade I-B patients had a remarkable improvement towards independent gait without contractures or assisted gait. This clinico-surgical classification[14] is very objective because it allows us to make a clinical assessment of the patient with dependent or independent gait, as well as an exam in dorsal decubitus and thus determine the corresponding pre- and postoperative grade; the clinical improvement was confirmed by the subjective assessment by patients and their family. We therefore confirm that our functional results are comparable to those published in the international medical literature.[10-13] The postoperative functional result 8-12 months after the surgery was a clear improvement with a significant $p = 0.0001$ *(Chart 3)*. Clinically, local improvement was seen when they continued to be classified in the same grade and an overall improvement when they moved to a different grade (Grade III to Grade II).

Conclusion

This study shows the improvement of pediatric patients with cerebral palsy in different stages. Individualized surgical treatment plays an important role in the prevention of deformities, improves the muscular balance and allows for positive changes in the universal clinico-surgical classification *(Table 4)*.[14]

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