REVISTA CHILENA DE PEDIATRÍA
www.revistachilenadepediatria.cl
www.scielo.cl

Rev Chil Pediatr. 2017;88(4):478-486
DOI: 10.4067/S0370-41062017000400006

ORIGINAL ARTICLE

Morbimortality associated to nutritional status and feeding path in children with cerebral palsy

Morbimortalidad asociada al estado nutricional y vía de alimentación en niños con parálisis cerebral

Figueroa MJ.[a], Rojas C.[b], Barja S.[c]

[a]MSC in Pediatric Nutrition Faculty of Medicine Pontificia Universidad Católica de Chile. Family Physician. NINEAS Hospital Sótero del Río
[b]Neurologist Children, specialist in Neuro-Rehabilitation, Hospital Sótero del Río
[c]MSC in Pediatric Nutrition Josefina Martínez Hospital, Associate Professor of the Department of Pediatric Gastroenterology and Nutrition. Pediatrics Division. Faculty of Medicine Pontificia Universidad Católica de Chile

Received: 3-11-2016; Accepted: 15-12-2016

Abstract

Introduction: Children and adolescents with cerebral palsy (CP) have a high prevalence of malnutrition associated to poor prognosis. For an adequate nutritional assessment, new growth curves (Brooks, 2011) are available, in which precise cut-off points in Weight/Age index correlate to increased morbidity and mortality rate. **Objective:** To evaluate risk of hospitalization and death in patients with CP, according to nutritional risk (NR). **Patients and Method:** Observational and prospective cohort study of patients with CP in an outpatient referral center. We registered demographic, socioeconomic data and nutritional assessment. During a one-year follow-up, hospitalizations and mortality were recorded. The correspondent committee extended an ethical approval. **Results:** 81 CP patients were recruit, age 131.6 ± 60.4 months (25-313), 60 % male, 77.5 % without independent mobility. The 23 NR patients (28.4%) had lower muscle and fat mass (p = 0.000). During the follow-up, 29/81 patients required hospitalization (35.8%) and 4/81 died (4.9%). There was not an increased risk of hospitalization and/or mortality in NR group, but both were significantly higher in gastrostomy-fed children (RR: 2,98 CI 95%: 1.32-6.75 combining both variables). **Conclusions:** In this study, children and adolescents with severe CP and nutritional risk had similar morbidity and mortality during a one-year follow-up, compared to those with acceptable nutritional status. Both risks were higher in gastrostomy-fed than the orally fed children.

Keywords:
Cerebral Palsy,
Gastrostomy,
Growth Charts,
Nutritional status,
Nutritional risk

Correspondence:
Figueroa MJ
mjfigueroasgro@gmail.com

Introduction

Cerebral Palsy (CP) comprehends a group of permanent disorders related with movement and posture, which cause several limitations. It is the result of a non-progressive process that occurs during the fetus development or in the child's brain up to 5 years of his/her life[1]. It is the most common physical disability in children, and it affects 2.11 from each 1000 live births[2], being more frequent in preterm infants[3]. Its mortality is fifty times greater than other causes in the pediatric population, according to its severity and associated comorbidities[4,5], rating a survival of 60% at 19 years, at date[5].

These patients need a complex multidisciplinary care[6], in which the nutritional treatment is fundamental, since they present high prevalence of malnutrition[7], deficient staturo-ponderal rates and even overweight or obesity[8], as well as deficits of micronutrients[9,10], osteopenia and osteoporosis[12]. They commonly present swallowing disorders, oral motor dysfunctions and gastroesophageal reflux[7]. Malnutrition affects respiratory and cardiac function, decreases immunity, brain growth, cognitive development, and social participation[12].

For their nutritional evaluation, it is necessary to consider that children with CP present different growth to healthy, due to factors that do not depend only on nutrition, but also on the type and severity of neurological deficit, ambulation, cognitive ability and neuro-endocrine factors[12]. They also have different body composition and sexual maturation[13,14].

This difference was evidenced by the publication of Day S. et al., of specific growth curves for children and adolescents with CP[15]. Built based on 141,961 measurements on 24,920 patients at a referral center in California, the authors also identified the need to subdivide them according to Gross Motor Function Classification System (GMFCS[16]). They established percentile values (p 10, 50 and 90) for weight/age (W/A), height/age (H/A) and body mass index (BMI)/age, by gender and for each functional group[15]. We observed that ideal parameters in healthy children were far from them, in children with moderate and severe CP.

Subsequently, Brooks J. et al. published new curves based on the same population, but with prescriptive value, defining cut points in W/A under which there was greater morbidity and mortality. Thus, patients with GMFCS I and II with W/A lower than p5 had a relative risk of mortality (RR) of 2.2 (95% CI 1.3-3.7). On the other hand, in children with GMFCS III to V and W/A less than p20, RR was 1.5 (95% CI 1.4-1.7)[17]. Based on this, our hypothesis was that Chilean children with CP and NR according to these curves, would also have greater morbidity and mortality.

It is not reported in Chile with studies of prevalence of malnutrition in children and adolescents with CP or their association with morbidity and mortality. The objective of this investigation was to study the association between NR (nutritional risk) and risk of hospitalization or death in children with controlled CPs in a comprehensive care center in Santiago, Chile. Secondarily, describe the socio-demographic, functional and medical characteristics of children with CP and their caregivers, seeking to identify other variables that are associated with poorer prognosis in these patients.

Metodology

Observational and prospective study of a cohort recruited for convenience (non-probabilistic sample) of children with CP, belonging to the South-East sector of Santiago, controlled in an outpatient center for children with special health care needs (NINEAS, according to its acronym in spanish) from the Dr. Sótero del Río Hospital. For three months, the families of 85 patients, aged 2 to 19 years who met the definition of CP, were invited to participate, whose caregivers (responsible adults) completed the informed consent process. Those with information and complete follow-up for one year were included, leaving finally the sample conformed by 81 patients.

Age, gender, socioeconomic level, occupation of the caregiver and educational level of the child and the caregiver, the feeding route, age of gastrostomy or probe installation if appropriate, associated pathologies and medication use were recorded. The variables were obtained through a survey designed for this study and applied by the principal investigator.

Nutritional evaluation

Measurements were made by the principal investigator, previously trained (MJF):

Weight (kg): Patients were weighed in a chair-scale brand DETECTO®, calibrated; If it was not possible to sit the child, he/she was weighed in the arms of the caretaker, in a foot scale mark DETECTO®, substracting the weight of the adult from the total.

Size (cm): Measured with a rigid pedometer of 1.8 m in length, in dorsal decubitus and in full extension. If this was not possible, knee height was measured with Ross anthropometer and the size was estimated using Stevenson's equations[18] validated by Amézquita V. et al. in Chilean children with CP[19].

Cutaneous folds (mm): Measured with a Harpenden® caliper, with standardized measurement technique[20], in four points: subscapular, tricipital, bicipital and suprailiac. Two measurements were taken at a time and both were averaged.

Brachial perimeter (cm): It was measured at the midpoint of the right arm length, with inextensible plastic breath, with a precision of 0.1 cm[20].

Nutritional Diagnosis: Based on the anthropometric measurements, we calculated the Weight/Age (W/A), Size/Age (S/A) and BMI (Body Mass Index) indices as per NCHS-CDC 2000[21] and Brooks 2011[19]. The last two indices were also expressed as z-scores according to the first reference. Low Weight was defined as W/S ≤ 1DS (WHO)[22] and BMI ≤ p10 for NCHS-CDC or Brooks 2011 curves[17]. According to the latter, nutritional risk (NR) was defined if W/A was lower than p5 (in children With GMFCS I and II) or lower to p20 (in children with GMFCS III to V).

Body Composition

The percentage of Fat Mass (% MG) was estimated according to the sum of 4 folds[23]. The arm area (AA in mm2) was calculated from the variables, the tricipital fold and the brachial perimeter, according to the formula proposed by Frisancho[24].

Functional Motor Capacity

The motor function of the patients was evaluated by a neurologist, according to the GMFCS classification[16], and assigned to the corresponding growth curve. GMFCS is described in five groups:

Group I: Children who walk, climb stairs, run and jump, but with difficulties in speed, balance and coordination.

Group II: Children walking and climbing stairs, but with difficulty on uneven/sloping surfaces.

Group III: Children who walk on flat surfaces with technical aids, and who depend on the function of their upper extremities, being independent in their wheelchair.

Group IV: Children who do not wander, use automatic wheelchairs, control head and trunk.

Group V: Children who do not wander, with difficulty in controlling their head and trunk; Can sit or stand with technical aids, but are transported by other people or in wheelchairs, neurological and automatic ones.

Evaluations and Follow-up

During 12 months (between January 1 and December 31, 2013), three nutritional assessments were performed for each patient, at 0, 6 and 12 months of age. In the first evaluation, a card with the described variables was completed and it was determined whether or not the patient belonged to the NR group. In the following evaluations, the non-change of risk group at follow-up was certified. Each patient had a notebook, to record the appointments in emergency service and hospitalizations of the child for one year. In addition, telephone follow-up was carried out in two opportunities between controls and income was reviewed in the hospital records.

Statistical analisys

Descriptive statistics were performed on the sample, with averages (SD) if the variables were distributed in a normal way, or with medians (ranges) if they did not (Mann-Whitney test). The categorical ones were described according to number and percentages. To study the differences between the NR versus non-NR group, the numerical variables were compared using the Student's Test (normal distribution variables) or with some non-parametric test (for variables without normal distribution) and proportions using the Chi-square. The RR of hospitalization or mortality was calculated according to NR, and also according to gastrostomy, as well as Pearson or Spearman correlation for the association between nutritional status (% BMI) and GT (Gastronomy) characteristics (Age of installation, and time). A $p < 0.05$ was considered significant. The statistical program MINITAB-17 was used.

Ethical aspects

This study was approved by the Research Ethics Committee of the Dr. Sotero del Río Medical Assistance Center, Metropolitan Health Service of the South East. The patient's primary caregiver, aged over 18 years, signed the informed consent document at the time of study entry.

Results

Patients' characteristics

81 children, whose characteristics are described in table 1. The main etiology of CP was perinatal (53.01%), followed by prenatal (27.1%), postnatal (15.6%) and causes Unknown (3.6%).

Table 2 shows the nutritional parameters. According to the nutritional diagnosis in the baseline evaluation, 37 patients (45.7%) had low weight according to the WHO curves or CDC-NCHS (according to the age of the patient), in contrast to 18 patients (22.5 %)

With this diagnosis, according to Brooks curves 2011 (Chi2 p = 0.000).

According to the cut-off points proposed by Brooks, 28.4% of the patients (23/81) were in NR. Table 3 shows the characteristics of the patients. As expected, patients with NR had lower BMI, zIMC, zS/A, brachial muscle area and midbrachial fat area. There was no difference between the two groups in the caregiver's age (41.6 10.4 vs. 39.5 ± 9.5), family economic income < 200,000 CP (30.4 vs. 31%), caregiver education (Average Education: 69.57 vs. 60.34%), nor if they did work outside home (6.17 vs. 16.04%), all with p > 0.05 Chi2 test.

One-year follow-up

During the follow-up period, four patients (4.9%) died from respiratory infections at the ages of 5, 5, 8 and 18 years. Three of them were women; all four had Post-Infectious Chronic Lung Damage, GMFCS-V and they were gastrostomized (with associated anti-reflux surgery in three of them). Only one had NR.

As for major morbidity: 29 children required hospitalization (35.8%), half with a stay shorter than 7 days and 9 with more than one hospitalization. The main cause was respiratory infections.

NR and its association with morbidity

There was no difference between patients with and without NR in terms of the need or number of hospitalizations (Chi2 test, p = 0.53) or mortality (p = 0.93) (Figure 1), nor when considering both results together, that is, morbimortality (p = 0.791).

There was also no association between NR and intellectual, visual, auditory deficit, active epilepsy, use of anticonvulsants, scoliosis or need for oxygen, although it was observed that in the group with NR there was a tendency to more patients with lung damage than in the group Without NR (Chi2 = 0.073). Finally, in patients without NR, there was a higher frequency of hip dislocation (p = 0.032).

Food Route and its association with morbidity and mortality

From the total sample, 37 (45.7%) patients were fed via GT, from which 32 (86.5%) had associated anti-reflux surgery. Table 4 shows the comparison with the patients without GT: the former had an older age and a non-significant tendency to a lower BMI. As seen in Figure 2, GT users required hospitalization more frequently (Chi2 = 0.002, RR: 2.32 CI 95% 1.05-5.14), as well as presenting higher mortality rates than those who were fed orally (Chi2 = 0.027). The deceased patients also had a shorter GT installation time, although with no significant difference: Median 3.0 years (Range: 1 to 4) vs. 5 years (1 to 17), Mann-Whitney test, p = 0.09.

When these two results were combined (hospitalizations + mortality), the difference was significant, with a higher risk for patients with GT (RR: 2.98; 95% CI: 1.32-6.75). Finally, as shown in figure 3, the older is the patients who recieved the GT installation, the lower the actual BMI% would be.

Table 1. Characteristics of 81 children and adolescents with Cerebral Palsy

Characteristic	Description
Age in months (Mean ± SD)	131.6 ± 60,4 (Rank: 25-313)
Male Sex (%)	60.5
GMFCS (%)	I (12) II (1) III (3) IV (9) V (75)
Clinical Form CP (%)	Tetraparesia (77.1) Diparesia (14.4) Hemiparesia (7.23) Ataxia (1.2)
Comorbidities (%)	Intellectual Disability (83) Active Epilepsy (64) Sleep Disorders (40) Visual Deficit (33) Hearing Deficit (12)
Schooling (%)	Did not attend 47% Special School 35% Language School 5% Normal School 4% Does not match 9%

Table 2. Nutritional Evaluation of 81 children and adolescents with Cerebral Palsy#

Parameter	Mean ± SD o Median (Rank)
BMI basal (kg/m²)	15.40 ± 2.85
Basal BMI (%)	89.11 ± 18.97
BMI z[17]	-1.26 (-9.68 a +2.7)
H/A z[17]	-2.29 ±1.84
% FM[21]	18.975 (7.67-37.8)
% Adjusted FM	105.3 (46.0 a 234.6)
Total Brachial Area (cm²)	31.13 (13.86-58.01)
Brachial muscle area (cm²)	21.66 (10.98-48.7)
Brachial Fat Area (cm²)	9.35 (2.27-27.64)

#Variables expressed as Mean (SD) or Median (Rank) according to their distribution. BMI: Body Mass Index. BMI (%): Percentage of Brooks p50 = [(Real BMI/BMI p50[17]) x 100]. % FM 23: Fat Mass Percentage, calculated with sum of 4 skinfolds[23]. % Adjusted FM: [FM[23]/(FM p50 for weight and age) x100]. Reference OMS in under 5 years[22] and in older, reference CDC-NCHS[21].

Table 3. Characteristics of 81 children and adolescents with CP, according to nutritional risk (NR)

	With NR (n = 23)	Without NR (n = 58)	p (test)	
Age (months)	145.5 SD ± 62.1	132.7 SD ± 71.4	0.44	(Test T)
Age > 10 years (%) < 10 years	 14 (35) 9 (22)	 26 (65) 32 (78)	 0.19	 (Chi²)
Male sex (%)	61.9	60.0	0.29	(Chi²)
BMI (%)	74.9 SD ± 16.7	94,7 SD ± 16,8	0.0001	(Test T)
Z-score BMI	-3.3 (-9.7 a -0.76)	-0.37 (-7.5 a 2.7)	0.000	(MW)
Z-score Height/Age	-3.474 SD ± 1.8	-1.801 SD ± 1.64	0.000	(Test T)
Muscle Area (mm2)	17.14 (12.59 a 26.44)	20.96 (10.98 a 48.7)	0.0001	(MW)
FM (%)	83.57 (46 a 151.8)	116.29 (47.56 a 234.6)	0.0001	(MW)
Use of GT (%)	11 (47.8)	26 (44.8)	0.9	(Chi²)
Age of Installation GT (years)	8.0 (0 a 15)	4.5 (1 a 16)	0.144	(MW)
Year of GT use	3.5 (2 a 12)	5.0 (1 a 17)	0.435	(MW)
GMFCS IV (%) GMFCS V (%)	0 (0) 20 (87)	6 (100) 43 (74)	 0.11	 (Chi²)

#Variables expressed as Mean (SD) or Median (Rank) according to their distribution. BMI (%): Percentage of Brooks p50 = [(Real BMI/BMI p50[17]) x 100]. GT: Gastrostomy. % Adjusted FM: [FM[23]/(FM p50 for weight and age) x 100]. Reference OMS in under 5 years[22] and in older, reference CDC-NCHS21. SD: Standard Deviation. MW: Mann-Whitney test.

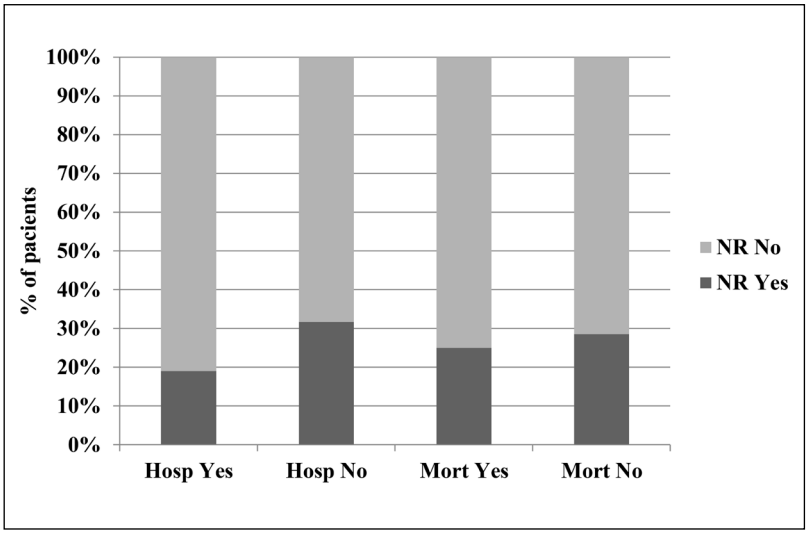

Figure 1. Distribution of 81 children and adolescents with Cerebral Palsy according to nutritional risk, regarding the need for hospitalization and mortality.

Discussion

This study describes the nutritional status of 81 children with CP, who underwent follow-up for a year, without finding an association between nutritional risk and morbidity and mortality, although GT intake was a factor that worsened the prognosis. This is the first study that investigates this important aspect in Chilean children with CP.

Regarding the characteristics of this sample, the prevalence of male gender, a non-preventable risk factor for PC, coincides with that published in the reports known in the medical literature[3,25,26]. Most of the patients had GMFCS V, coming from a referral center that serves patients with greater severity and comorbidity. This severity is greater than other studies and is the main determinant of survival in these patients[4,27]. The most frequent etiology reported was perinatal (asphyxia and prematurity), although it has been shown that the main one should be prenatal[26]. The absence of schooling was high (47%), probably associated with transportation difficulties, low supply of special schools or integration in the South-East sector, as well as overprotection by caregivers. No differen-

Table 4. Characteristics of patients according to use of GT

GT	No (43)	Yes (37)	p (test)
Age (months)	124.2 SD ± 50.9	147.6 SD ± 64.6	0.086 (Ttest)
BMI (%)	91.85 (51.48 a 138.7)	85.44 (42.79 a 139.1)	0.083 (Ttest)
Z-score BMI (WHO)	-0.760 (-8.11 a +2.7)	-1.86 (-9.68 a +1.79)	0.720 (MW)
Z-score Height (WHO)	-1.98 DE ±1.94	-2.80 DE ± 1.66	0.057 (Ttest)
BMA (mm2)	20.39 (10.98-48.7)	18.77 (13.53 a 37.95)	0.277 (MW)
% Adjusted FM	107.9 (46 a 234)	105.0 (51.64 a 234.5)	0.925 (MW)
Caregiver Age (years)	39.64 (20 a 59)	40.6 (24 a 59)	0.927 (Ttest)
Nutritional Status#			
Underweight (%)	8 (18.6)	10 (27)	
Normal (%)	32 (74.4)	26 (70.3)	
Overweight (%)	1 (2.3)	1 (2.7)	0.16 (Chi^2)

BMI (%): Percentage of Brooks p50 = [(Real BMI/BMI p50[17]) x 100]. BMA: Brachial muscle area. % Adjusted FM: [FM^{23}/(FM p50 for weight and age) x 100]. Reference OMS in under 5 years[22] and in older, reference CDC-NCHS[21]. Nutritional status according to Brooks Growth Charts[17]. Underweight < p10, Normal p10-90, Overweight > p90. SD: Standard Deviation. MW: Mann-Whitney test.

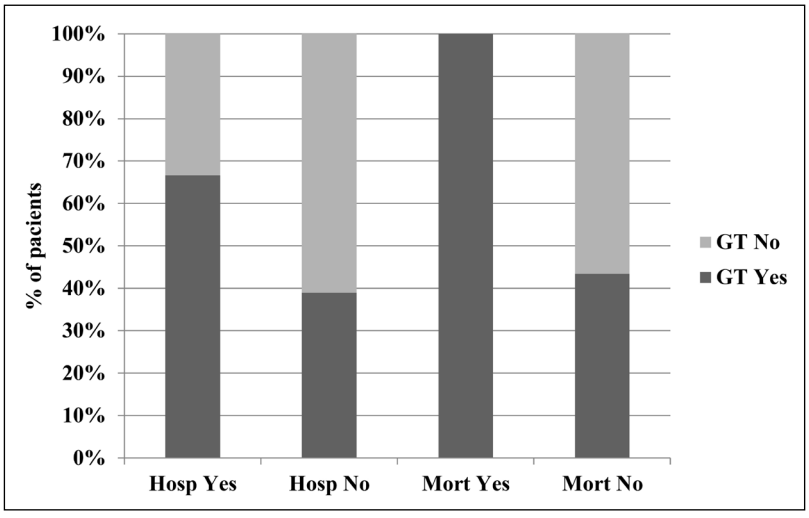

Figure 2. Morbidity and mortality in 1-year follow-up of 81 children and adolescents with Cerebral Palsy, according to the use of gastrostomy.

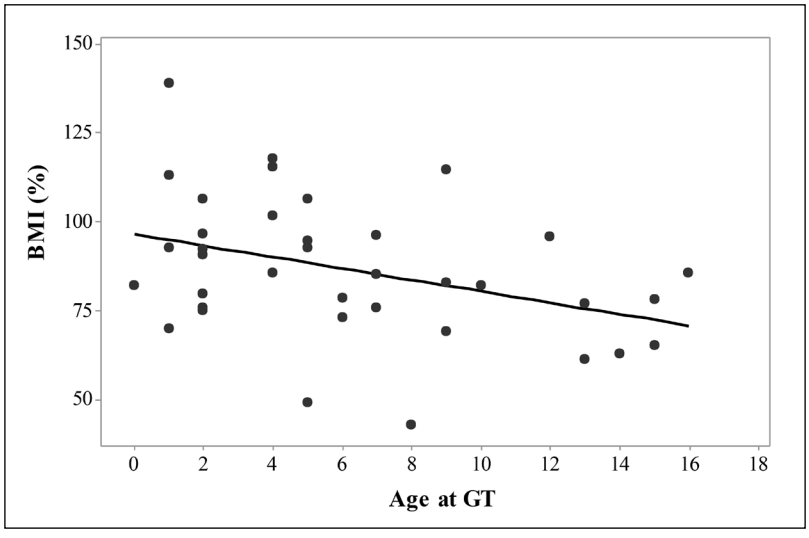

Figure 3. Body Mass Index according to the age of installation of Gastrostomy, in 37 children and adolescents with Cerebral Palsy.

ce was found in the socio-economic level, education or occupation of the primary caregiver, according to the child's NR, possibly due to the homogeneity of the population, low socioeconomic level and low, which are fully attended in the Public Service of Health. Only 22% of caregivers worked outside the home and most of them are dedicated exclusively to the care of these patients.

The high prevalence of malnutrition according to the specific curves[27] was composed mostly by children in the group with the greatest neurological damage, according to this study. Several authors support the use of this reference constructed with a large sample, balanced by gender and age, and categorized according to functionality. Besides, it allow us to make better decisions, especially in those patients with GMFCS IV-V[27]. In addition, we state in this sitdy that the use of CDC-NCHS overestimates malnutrition (45.7%), compared to the curves for CP (22.5%)[17]. In other studies, this prevalence varies between 29 and 51% with the first reference[28,29], according to the characteristics of the subjects. Using specific curves would allow focusing resources and nutritional interventions on those who are effectively malnourished[30,31]. The use of W/A to define NR is, moreover, more precise and applicable than the other indices that include size[31], difficult to measure in patients without full extension.

Patients with NR of this sample had a lower percentage of fat and lean mass than those without NR, as was expected. Although the estimation of FM with skinfolds has limitations and underestimation[32], it is useful for follow-up, especially when weight and height are difficult to measure, as in the prostrate and/or column deformities. This is important, because despite being weakened, the FM of CP patients may be similar to normal, by proportional decrease of body weight components[39].

The main cause of morbidity and mortality were respiratory infections in our study, according to what was published[4,33]. These patients have an increased risk of pulmonary aspiration, secondary to the coexistence of GER and dysphagia[6], and the presence of WB is an independent risk factor for recurrence of hospitalizations[34]. In our study, the majority of gastrostomized patients had anti-reflux surgery, despite which respiratory pictures were frequent. Moreover, three of the four deceased patients had fundoplication GT. According to the mentioned, the evidence is not conclusive, since the effectiveness of this in reducing pneumonias, and the GER is of 57%[35], without preventing the aspiration of saliva or high respiratory secretions[34]. However, if WG is late, prior establishment of chronic lung damage and associated nutritional compromise will allow new infections, which is frequently observed in gastrostomy patients.

The absence of association between NR and morbidity and mortality may be due to the fact that one year may be insufficient time to evaluate the validity of Brooks' suggested cut - off points[17]. These were defined in a large sample (25545 multicentre controlled patients between 1988 and 2002 in California, USA), with all functional groups represented and with a longer follow-up (3 years after the last recorded measurement).

We found higher morbidity and mortality in gastrostomy versus non-gastrostomy patients, although with the design of this study we can not attribute causality. This would only be possible if the follow-up will begin from before the WG was installed, knowing the conditions of the patients at that moment, as well as their accomplishment with homogeneous procedures. There was also an inverse association between the age of installation of the WG and the BMI, that is, the older the intervention, the worse the nutritional status, which could have increased morbidity and mortality due to the failure to receive the nutritional benefits of the intervention. GT for its late implementation. Taken in a timely manner, the insertion of a GT improves nutritional status and fat mass, decreases respiratory infections and hospitalizations in patients with CP[35,36]. However, patient heterogeneity and measurements, coupled with inadequate design studies make it difficult to demonstrate its benefits[37-39]. Moreover, it has been shown that survival at age 19 is greater in those without WG (72% versus 55%)[27], but this study suggests that the association between WG use and morbidity and mortality should be investigated prospectively , Considering the patient's condition at the time of the WG, in order to evaluate if the greatest risk is real or if it is only about patients with greater fragility and vital risk[5].

Dentro de las fortalezas de este estudio, está su diseño prospectivo, en una cohorte cautiva con cuidados homogéneos, controles periódicos y seguimiento completo. Las mediciones fueron realizadas por un mismo investigador, con método estandarizado, instrumentos adecuados, no invasivos y de bajo costo. En cuanto a debilidades, debe considerarse que los resultados son aplicables a niños con grado alto de limitación funcional y no a la población completa de pacientes con PC, así como se planteó antes, al tiempo insuficiente de seguimiento.

As a conclusion, in this group of children with severe CP and high prevalence of malnutrition, those in the nutritional risk category did not present higher morbidity and mortality at one-year of follow-up. From another factors which were analyzed, only the GT portation was associated with greater morbidity and mortality, which may be determined by being patients of greater severity and/or the late performance

of this procedure (this according to the patient's age). It is important to use specific curves for the nutritional assessment of patients with CP, and we strongly believe that possibly a longer follow-up could demonstrate the influence of low weight on morbimortality. Complementary, we hope to have helped in recommending the timely installation of GT in pediatric patients with Cerebral Palsy.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Financial Disclosure

Pontificia Universidad Católica de Chile, School of Medicine, Research Unit: "Grant for Postgraduated Thesis 2012" Programs of Master's and Doctorate School of Medicine.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Acknowledgements

Dr. Sotero del Río Care Center, Diagnostic and Therapeutic Center, NINEAS Assistance Unit (Children with Special Needs of Health Care) and its Director Dr. Ana María Cabezas Tamayo.

References

1. Colver A, Fairhurst Ch, O D Pharoah P. Cerebral palsy. Lancet. 2014; 383:1240-9.
2. Oskoui M, Coutinho F, Dykeman J, Jette N, Pringsheim T. An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. Dev Med Child Neurol. 2013;55:509-19.
3. Tosun A, Gökben S, Serdaroglu G, Polat M, Tekgul H. Changing views of cerebral palsy over 35 years: the experience of a center. Turk J Pediatr. 2013;55:8-15.
4. Reid SM, Carlin JB, Reddihough DS. Survival of individuals with cerebral palsy born in Victoria, Australia, between 1970 and 2004. Dev Med Child Neurol. 2012; 54:353-60.
5. Westbom L, Bergstrand L. Survival at 19 years of age in a total population of children and Young people with cerebral palsy. Dev Med Child Neurol. 2011;53:808-14.
6. Barja S. Enfermedades Neurológicas en niños: un adecuado apoyo nutricional, Neumol Pediatr. 2011;6(2):61-6.
7. Campanozzi A, Capano G, Miele E, Scuccinama G, Del Guidice E, Strisciuglio C, et al. Impact of malnutrition on gastrointestinal disorders and gross motor abilities in children with cerebral palsy. Brain&Development. 2007;29:25-9.
8. Tomoum H, Badawy N, Hassan N, Alian K. Anthropometry and body composition analysis in children with cerebral palsy. Clinical Nutrition. 2010; 29:477-81.
9. Schoendorfer N, Ujang, Sharp N, Boyd R, Vitetta L, Davies P, Di Geronimo M. Micronutrient intakes in enterally and orally fed children with severe cerebral palsy. E Spen Eur E J Clin Nutr Metab. 2011;6:e259-e263.
10. Kalra S, Aggarwal A, Chillar N, Faridi MMA. Comparison of Micronutrient Levels in Children with Cerebral Palsy and Neurologically Normal Controls. Indian J Pediatr 2015;82(2):140-4.
11. Uddenffeldt Wort U, Nordmark E, Wagner P, Düppe H, Westbom L. Fractures in children with cerebral palsy: a total population study. Dev Med Child Neurol. 2013;55(9):821-6.
12. Kuperminc M, Stevenson R. Growth and Nutrition Disorders in Children with Cerebral Palsy. Dev Disabil Res Rev. 2008;14(2):137-46.
13. Le Roy C, Rebollo MJ, Moraga F, Díaz X, Castillo-Durán C. Nutrición del Niño con Enfermedades Neurológicas Prevalentes. Rev Chil Pediatr. 2010;81(2):103-13.
14. Worley G, Houlihan CM, Herman-Giddens ME, O'Donnell ME, Conaway M, Stallings VA, et al. Secundary Sexual Characteristics in Children with Cerebral Palsy and Moderate to Severe Motor Impairment: A Cross Sectional Survey. Pediatrics. 2002;110:897-902.
15. Day S, Strauss D, Vachon P, Rosenbloom L, Shavelle R, Wu Y. Growth patterns in a population of children and adolescents with cerebral palsy. Dev Med Child Neurol. 2007;49:167-71.
16. Wood E, Rosenbaum P. The Gross Motor Function Classification System for Cerebral Palsy: a study of reliability and stability over time. Dev Med Child Neurol. 2000;42:292-6.
17. Brooks J, Day S, Shavelle R, Strauss D. Low Weight, Morbidity and Mortality in Children With Cerebral Palsy: New Clinical Growth Charts. Pediatrics. 2011;128:e299-e307.
18. Stevenson RD. Use of segmental measures to estimat estature in children with cerebral palsy. Arch Pediatr Adolesc. 1995; 149:658-63.
19. Amezquita V, Hodgson MI. Estimación de la talla en la evaluación nutricional de niños con Parálisis Cerebral. Rev Chil Pediatr. 2014;85(1): 2-30.
20. National Health and Nutrition Examination Survey (2011-2012). Anthropometry ProceduresManual(January2011). www.cdc.gov/nchs/data/nhanes_11_12/anthropometrics_procedures_manual.pdf
21. https://www-cdc.gov/growthcharts/. Accessed April 2015.
22. World Health Organization. Growth Charts. Available at: http://www.who.int/growthref/tools/en/ Accessed April 2015.
23. Webstrate JA, Deuremberg P. Body

Composition in children: Proposal for a Method for calculating body fat percentage from total body density or skinfold thicknees measumerents. Am J Clin Nutr. 1989;50:1140-15.
24. Frisancho AR. New Norms of upper limb fat and muscle áreas for assesment of nutritional status. Am J Clin Nutr. 1981;34(11):2540-5.
25. Germany L, Ehlinger V, Klapouszczak D, Delobel M, Hollódy K, Sellier E, et al. Trends in prevalence and characteristics of post-neonatal cerebral palsy cases: A European registry-based study. Res Dev Disabil. 2013;34:1669-1677.
26. Girona G, Aguilera R, Tosca R, Bea M, Cuello E. Factores de riesgo y etiología de la parálisis cerebral en nuestro medio. Rehabilitación (Madr) 2001;35(3):146-53.
27. Brooks J, Shavelle R, Strauss D. Survival in children with severe cerebral palsy: a further international comparison. Dev Med Chil Neurol. 2012;54:383-384.
28. Marchand V, Motil K. Nutrition Support for Neurologically Impaired Children: A Clinical Report of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition. J Pediatr Gastroenterol Nutr. 2006; 43:123-35.
29. Araujo L, Silva L. Anthropometric assessment of patients with cerebral palsy: which curves are more appropriate? J Pediatr (Rio J). 2013;89(3):307-14.
30. Rempel G. The Importance of Good Nutrition in Children with Cerebral Palsy. Phys Med Rehabil Clin N Am. 2015;26:39-56.
31. Stevenson R, Conaway M. Weight and Mortality Rates: "Gomez Classification" for Children with Cerebral Palsy. Pediatrics. 2011;128(2):e436.
32. Kuperminc M, Gurka M, Bennis J. Anthropometric measures: poor predictors of body fat in children with moderate to severe cerebral palsy. Dev Med Child Neurol. 2010;52:824-830.
33. Duruflé-Tapin A, Colin A, Nicolas B, Lebreton C, Dauvergne F, Gallien P. Analysis of the medical causes of death in cerebral palsy. Annals of Physical and Rehabilitation Medicine. 2014;57:24-37.
34. Proesmans M, Vreys M, Huenaerts E, Haest E, Coremans S, Vermeulen F, et al. Respiratory Morbidity in Children With Profound Intellectual and Multiple Disability. Pediatr Pulmonol. 2015;50(10):1033-8.
35. Ferluga E, Sathe N, Krishnaswami Sh, McPheeters M. Surgical intervention for feeding and nutrition difficulties in cerebral palsy: a systematic review. Dev Med Child Neurol. 2014;56:31-43.
36. Martínez-Costa C, Borraz S, Benlloch C, López-Saiz A, Sanchiz V, Brines J. Early decision of gastrostomy tuve insertion in children with severe developmental disability: a current dilema. J Hum Nutr. Diet 2011;24:115-21.
37. Gantasala S, Sullivan PB, Thomas AG. Gastrostomy feeding *versus* oral feeding alone for children with cerebral palsy. Cochrane Database Syst Rev 2013;31(7).
38. Nelson KE, Lacombe-Duncan A, Cohen E, Nicholas DB, Rosella LC, Guttmann A, et al. Family Experiencies With Feeding Tubes in Neurologic Impairment: A Systematic Review. Pediatrics. 2015;136:e140-51.
39. Kapadia MZ, Joachim KC, Balasingham C, Cohen E, Mahant S, Nelson K, et al. A Core Outcome Set for Children With Feeding Tubes and Neurologic Impairment: A Systematic Review. Pediatrics 2016;138(1):e20153967.