

# Postural Impairment of Adults and Adolescents Cerebral Palsy Inpatients at the Retaguarda Hospital of Ribeirão Preto-SP

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**Citation:** Lopes RRB, Mestriner T, Costa CSN, Pfeifer LI (2018) Postural Impairment of Adults and Adolescents Cerebral Palsy Inpatients at the Retaguarda Hospital of Ribeirão Preto-SP. J Neurol Neurol Disord 4(1): 104

**Received Date:** January 17, 2017 **Accepted Date:** February 26, 2018 **Published Date:** March 03, 2018

## Abstract

**Introduction:** Cerebral Palsy (CP) is a condition that described a group of permanent movement and postural development disorders, leading to activity limitations as a result of non-progressive distress during foetal or infant brain development. The non-progressive distress is frequently associated to sensation, perception, cognition, communication and behavioural disorders, by epilepsy or by secondary muscle distress. CP secondary musculoskeletal alteratons as a consequence of musculatura and tendon contrations, joint rigidity, hip dislocation and spinal deformities may lead to deficits in functional mobility. These alterations can develop with age and are related to physical growth, tone alterations, therapy submission or the use of orthoses. Most of the individuals with CP are in the care of institutions that are able to offer them special care, since they may develop several complexities. The philanthropic institution Retaguarda Cantinho do Céu Hospital (RCCH) was founded in 1983 in Ribeirão Preto (São Paulo state) with the objective of offering full time care to patients with CP or multiple, severe and irreversible sequelae.

**Objectives:** To analyse postural deviations in adolescents and young adults at the RCCH in Ribeirão Preto-SP and associate postural deviations to flexibility at the upper and lower limbs.

**Methods:** The Clinica's Hospital Ethics Committee at the Faculdade de Medicina of Ribeirão Preto, through the HCR n°14822/2012 process, approved this current transversal study. We evaluated a convenience sample of 28 inpatients. All the participants presented bilateral topographic distribution and were classified with Gross Motor Function Classific System-E&R (GMFCS-E&R) level V. The Gross Motor Function Classific System-E&R (GMFCS-E&R) and the Spinal Alignment and Range of Motion Measure (SAROMM) were chosen as classification tools to classify postural motor function and to analyse flexibility, respectively, in children and adolescents with CP. Moreover, the participant's photometric qualitative analysis was taken in order to describe postural misalignments. Descriptive statistics were analysed for all characteristics using the Statistical Package for Social Sciences, version 18.0 (SPSS; Inc, Chicago, IL, USA). A Pearson's Correlation test consisting of a linear correlation among the SPINE and HIP, KNEE, ANKLE and UPPER LIMBS variables.

**Results and Discussion:** The correlation of 0.707 ( $p < 0.001$ ) referring to the spine and upper limbs evaluation by SAROMM represents a strong correlation and show this clinical breakthrough. Inpatients adolescents and young adults with CP, classified as GMFCS E&R level V, presented severe spinal alignment implying to restrict joint extensibility and possible low motor performance. The spinal alterations presented significant high association with upper limbs hip, knee and ankle joints.

**Keywords:** Cerebral Palsy; Physiotherapy; Postural impairment; Spinal deformities

## Introduction

Cerebral Palsy (CP) is a condition that describes a group of permanent movement and postural development disorders, leading to activity limitations as a result of non-progressive distress during foetal or infant brain development. The non-progressive distress is frequently associated to sensation, perception, cognition, communication and behavioural disorders, by epilepsy or by secondary muscle distress [1]. According to the disorder and the individual's with CP clinical presentation, a 5-level classification system- *Gross Motor Function Classification System Expanded & Revised* (GMFCS E&R) has been used to classify the motor impairments of global motor functions. The 5-level classification system aims at the gross motor function enhancement emphasizing sitting,

transferring and mobility capabilities, which can vary from level I, indicating total independence to level V, indicating total dependence.

The anatomic distribution of the motor impairment can be classified as unilateral or bilateral [1,2]. From this intention, children with bilateral spastic cerebral palsy and motor impairment level V present with the most serious condition and the worst prognosis [3]. CP secondary musculoskeletal alterations as a consequence of musculature and tendon contractions, joint rigidity, hip dislocation and spinal deformities may lead to deficits in functional mobility. These alterations can develop with age and are related to physical growth, tone alterations, therapy submission or the use of orthoses [1-4].

It has been stated that 80% of the individuals with CP present atypical movements in such manner [5,6]. From this perspective, spinal deviations, such as cervical and/or lumbar hyper lordosis, thoracic and/or sacral hyper kyphosis and scoliosis are commonly found among this specific group [7]. According to Bruschini et al. (1998) [8] and Koman *et al.* (2001) [9-12], the most common upper limb spastic posture occurs due to adduction and inner shoulder rotation, elbow flexion, forearm pronation and wrist and fingers flexion. On the other hand, common lower limb postural deviations are equinus foot associated with rearfoot varus and forefoot adduction and supination, as well as, fallen arch (flat feet) and foot arches accentuation. Most common hip CP spastic deviations that may occur individually or simultaneously are adduction, flexion and medial rotation. In addition, knee flexion deviations are commonly observed and can be developed as a compensation strategy to ankle-foot deformities. On the other hand, hip flexion and knee valgus are characterized by medial deviation, which is associated to the hip's inner rotation, plano valgus foot (flat feet) and knee flexion.

The *Spinal Alignment and Range of Motion Measure* (SARROM) scale system was developed as a result of several postural deviations and musculoskeletal impairments observed in individuals with CP. The system evaluates the most common postural misalignments in addition to the muscular extensibility regions that are directly connected to the spine. The items that SAROOM evaluates were developed accordingly to the knowledge of posture deviations, as well as alignment and movement limitation in individuals with CP [9,10].

Most of the individuals with CP are in the care of institutions that are able to offer them special, since they may develop several complexities. The philanthropic institution Retaguarda Cantinho do Céu Hospital (RCCH) was founded in 1983 in Ribeirão Preto (São Paulo state) with the objective of offering full time care to patients with CP or multiple, severe and irreversible sequelae. The institution offers 24h multidisciplinary assistance to its patients, since they present high dependency levels. In order to better understand postural deviations in this specific study group, a research has been carried out along with the RCCH.

## Objectives

1. To analyse postural deviations in adolescents and young adults at the Retaguarda do Cantinho do Céu Hospital
2. To associate spinal alignment to joint extensibility at the upper and lower limbs

## Methods

The Clinica's Hospital Ethics Committee at the Faculdade de Medicina of Ribeirão Preto, through the HCR n ° 14822/2012 process, approved the current study. This work has a transversal perspective and was carried out under a quantitative analysis methodology at the Retaguarda Cantinho do Céu Hospital in Ribeirão Preto-SP.

## Population

All adolescents and young people inpatients of the Retaguarda Cantinho do Céu Hospital were invited to participate in the study. Adolescents and young people were eligible for the study if they had diagnosis of any clinical subtype of CP and were between 15 and 29 years of age. Inform consent will be sought from parents/carers because of participants' cognitive impairments. Potential participants will be excluded if they have had orthopaedic surgery in the last 6 months; Botulinum toxin therapy in the last 3 months; those too unwell to participate (although every effort will be made to accommodate these participants at a later date).

## Resources

The resources employed were validated specifically for the Brazilian population of children and adolescents with CP and widely used by clinical researchers for children, adolescents and young adults with CP. The *Gross Motor Function Classification System -E&R* (GMFCS-E&R) and the *Spinal Alignment and Range of Motion Measure* (SAROMM) were chosen to classify motor function level and to analyse spinal alignment and joint extensibility, respectively. Moreover, the participant's photometric data was performed in order to verify postural misalignments under a descriptive perspective and for better understanding about SAROMM findings in this population.

## Gross Motor Function Classific System-E&R (GMFCS-E&R)

The GMFCS E&R system is used to classify children's, adolescents' or young adults' with CP functional mobility and presents a 5-levels of classification system [8]. Level I: Walks without restrictions; Level II: Walks with restrictions; Level III: Walks with the assistance of a hand-operated mobility device; Level IV: Auto-mobility with restrictions, the individual can use a motorised

wheelchair and Level V: Wheelchair needed for transportation. Moreover, the system counts with an age group classification (0 to 2 years old, 2 to 4 years old, 4 to 6 years old, 6 to 12 years old and 12 to 18 years old) regarding expected motor development for each age range.

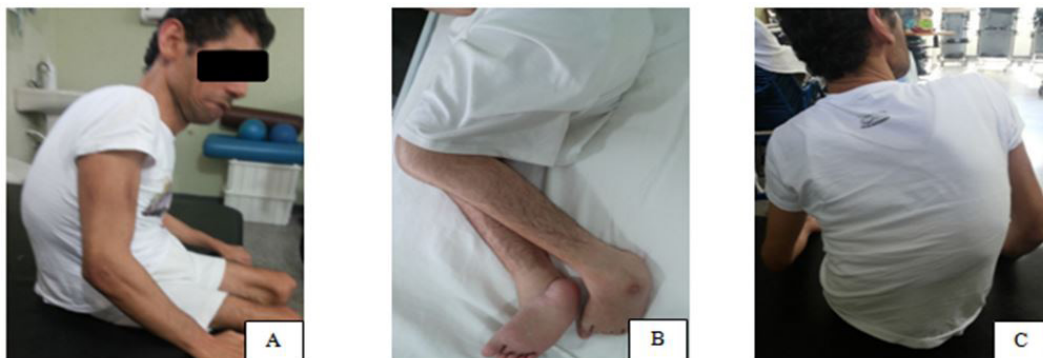
### Spinal Alignment and Range of Motion Measure (SAROMM)

SAROMM is a discriminative tool used to estimate limitations of spinal alignments and range of motion. Validity has been demonstrated by a significant contribution of GMFCS level and age to the total SAROMM score ( $R^2=0.44$ ) [10]. The manual for the SAROMM can be download from CanChild website (<https://www.canchild.ca/system/tenon/assets/attachments/000/000/088/original/SAROMM.pdf>).

The SAROMM consists of 26 items involved alignment and ROM within 5 joints: SPINE (cervical, thoracic, lumbar and lateral-items 1 to 4), HIP (extension/flexion; abduction/adduction; inner rotation/outer rotation -items 5 to 16); KNEE (hamstring - items 17 to 20), ANKLE (dorsiflexion and feet soles flexion-items 21-24) and UPPER LIMB (items 25 to 26). Each item is scored on a zero to four scales, where zero (0) consists of an optimal spinal alignment and complete movement amplitude. A score of four (4) indicates that despite the intensive professional assistance provided, spinal alignment will not occur, as well as the expected children's or teenager's minimum movement amplitude. Each joint was scored by average of all items from each joint respectively (possible range 0-4). The SAROMM mean score were obtained by average of the all joint scores (possible range 0-4). For that, for the SAROMM, we have the following quantitative variables: SPINE, HIP, KNEE, ANKLE, UPPER LIMB and SAROMM mean score.

### Photometric Data

The postural misalignments were described through a photometric qualitative description of the spinal misalignment [13]. Adolescents and young adults were photographed regarding their movement amplitude restrictions and motor development. Therefore, they were photographed in different positions (posteriorly, anteriorly and laterally) at the maximum postural alignment they could reach (Figure 1). After the photography session the researchers analysed the postural misalignments qualitatively, observing spinal curves enhancements or reductions along the hips, knees and ankles postural deviations



**Figure 1:** Postural deviations analysis applying photometric (A) Cervical and thoracic hyper kyphosis anterior projections. (B) Knee flexion pattern and open tibiotarsus angle (equinos foot). (C) Bent head and thoracolumbar scoliosis

### Procedures

Two physical therapists were trained to administer the *GMFCS-E&R*, the SAROMM, among other measures for photometric analysis. They achieved >80% item agreement with the criterion standard scoring of SAROMM items on individuals with a range of GMFCS levels before collecting data. All assessments of the inpatients adolescents/young adults were conducted at the Retaguarda Cantinho do Céu Hospital in Ribeirão Preto-SP.

### Statistical Analysis

Descriptive statistics were analysed for all characteristics using the Statistical Package for Social Sciences, version 18.0 (SPSS; Inc, Chicago, IL, USA). Continuous data (SAROMM) were summarized by average and standard deviation (SD) and categorical data (photometric) by number (percentages). A Pearson's Correlation test consisting of a linear correlation among the SPINE and HIP, KNEE, ANKLE and UPPER LIMBS variables. was applied A correlation of less than 0.25 was considered very low, 0.26 to 0.49 as low, 0.50 to 0.69 as modest to good; 0.70-0.89 was high and more than 0.90 as very high [14]. The statistical significance level was set at  $p<0.05$ , assumptions for the specific analyses were satisfied.

### Results

#### Population Studied

The convenience sample comprised of 28 out of 56 inpatients of the Retaguarda Cantinho do Céu Hospital. The inpatients that did not take part in this study had no authorization from the responsible to participate. It is important to stress that all the participants

presented bilateral topographic distribution and were classified as a GMFCS E&R level V. Demographic representation of the population studied is presented in Table 1.

Variables	CP (n=28)
Average age years/ months*	26 years 07 months
<b>Gender</b>	
Men	16
Women	12
<b>Topography</b>	
Unilateral	-
Bilateral	28
<b>Motor Classification**</b>	
Level I - IV	-
Level V	28

\*Average age, \*\*Level I -V according to the GMFCS E&R system

**Table 1:** Demographic representation of the population studied

Table 2 represents the results of SAROMM items' scores assessed for the spine and ROM joints for the right and left hips, knees, ankles and upper limbs. Average and standard deviations were also presented for the mean of all items for each segment/joint SPINE, HIP, KNEE, ANKLE and UPPER LIMB and score averaged for all segment/joints is represented by the SAROMM mean score.

SPINE ITEMS	CERVICAL	THORACIC	LUMBAR	LATERAL	SPINE
Average	3,17	3,53	3,67	3,67	3,51
*SD	0,81	0,57	0,54	0,47	0,50

HIP ITEMSS	RXTD	LXTE	RFLEX	LFLEX	RABD	LABD	RADD	LADD	IRROT	ILROT	ORROT	OLROT	HIP
Average	2,96	3,03	2,39	2,35	2	1,89	1,07	1,21	2,46	2,5	1,5	2,07	1,46
*SD	0,96	0,92	1,06	1,09	0,90	0,78	0,26	0,49	1,07	1	0,63	0,60	0,63

KNEE ITEMS	RXTD	LXTE	RHMT	LHMT	KNEE
Average	3,35	3,35	3,39	3,39	3,37
*SD	0,62	0,67	0,62	0,68	0,60

ANKLE ITEMS	RDSF	LDSF	RSFFLEX	LSFFLEX	ANKLE
Average	3,14	3,03	1,42	1,42	2,25
*SD	1,04	1,03	0,99	0,99	0,36

UPPER LIMBS ITEMS	RUL	LUL	UPPER LIMB
Average	3,53	3,53	3,53
*SD	0,69	0,69	0,69

SAROMM Mean Score	
Average	3,16
SD	0,48

\*SD: Standard Deviation, REXT: Right extension ; LEXT: Left extension; RFLEX: Right flexion; LFLEX: Left flexion; RABD: Right abduction; LABD: Left abduction; RADD: Right adduction; LADD: Left adduction; IRROT: Inner right rotation; ILROT: Inner left rotation; ORROT: Outer right rotation; OLROT: Outer left rotation; RHMT: Right hamstring; LHMT: Left hamstring; RDSF: Right dorsiflexion; LDSF: Left dorsiflexion; RSFFLEX: Right feet soles flexion; LSFFLEX: Left feet solar flexion; RUL: Right upper limbs; LUL: Left upper limbs. Average and standard deviations were also presented by the mean for all items for each segment/joint SPINE, HIP, KNEE, ANKLE and UPPER LIMBS and mean score for all segment/joints by the SAROMM mean score

**Table 2:** SAROMM scores assessed

The variables SPINE, KNEE, HIP and UPPER LIMB obtained scores close to 4, which means severe deviations in spinal alignment, limitations in joint ROM, or limitations in muscle extensibility. The lowest scores obtained was for the ANKLE, however scores from 2 (range 0-4) means that limitation is structural, static and not reducible.

Table 3 refers to the results after the statistical Pearson's Correlation analysis among spinal and upper/ lower limbs score obtained by the SAROMM.

SPINE	HIP	KNEE	ANKLE	UPPER LIMBS	SAROMM Mean Score
	0,724**	0,712**	0,750**	0,707**	0,821**

Pearson  $p > 0.70$  to  $0.9$  values indicate strong correlation and  $p$ -value  $< 0.05$ .

**Table 3:** Pearson's statistical analysis

Correlation between SPINE and all variables for upper/lower limbs obtained by the SAROMM was high ( $r > 0.70$ ) and significant ( $p < 0.05$ ).

Descriptive postural deviations analysis was carried out applying photometric resources. The main changes observed from a lateral perspective were 48.27% of cervical misalignments with an anterior head projection and 44.82% of excessive lordosis curve. Observed, in the thoracic region were a 41.37% hyper kyphosis condition and a 24.13% thoracic rectification. Observed, in the lumbar region, a 20.68% hyper lordosis condition and a 68.96% lumbar rectification. In terms of lower extremities, there were observed a 44.82% pelvic retroversion, 96.55% flexed knees and 58.62% equinus deformity. The postural analysis from a posterior perspective presented a 55.17% oblique head and 41.38% rounded head. Scoliosis was observed in 82.75% of the participants.

## Discussion

Postural misalignments developed throughout CP may result in several complications, which leads to severe pain, social exclusion and deformities, among others. From this perspective, postural evaluation is extremely relevant in order to develop therapeutic methods and prevention strategies for further complications. For that, the objectives of this study were to analyse postural deviations in adolescents and young adults inpatients at Retaguaarda do Cantinho do Céu Hospital and associate spinal alignment to joint extensibility at the upper and lower limbs.

The population studied in this research was composed by inpatients adolescents and young adults with CP bilaterally affected and greater motor impairment (GMFCS E&R level V). Children with CP present tone dysregulations, which might lead to belated motor development. On the other hand, children classified with GMFCS E&R level V during the clinical analysis presented severe motor deviations, as well as musculoskeletal impairments due to incorrect musculature activation resulting in postural misalignments. Givon (2009) [15] and HIROSHIMA *et al.* (1979) [16] showed, the relationship among muscle weakness influence, spasticity or ROM reduction and postural impairments in the population studied. For that, the motor development, every day activities and social inclusion might be influenced by ROM and muscle strength reduction. Our results showed that 48% of the participants presented anterior head projection and 44% presented excessive cervical lordosis. Lumbar lordosis is belatedly formed during the children's crawling period, which leads to the activation of the lumbar antigravity musculature. According to Abreu *et al.* (2014) [17], children with severe CP present relevant deficit at first level postural control, which can be influenced by tone dysregulations, as well as musculoskeletal system impairments. From this intention, research development that approaches postural misalignments in CP is extremely necessary. The forward head movement starts during the first week of life as a result of neck's antigravity musculature activation and development of the cervical lordosis.

Unconsistently with previous studies, our results demonstrated a much higher prevalence of 68% for pelvic retroversion found in Abreu *et al.* (2014) [17]. The main reason for such difference might be related to the participant's GMFCS E&R level (level V), which have more severe motor impairments than those described in the literature. The results showed that the pelvic retroversion is intensified when the individuals are seated, leading to offsetting postural misalignments for example, increases in thoracic kyphosis accompanied by shoulder's ROM decreases. The  $r$  correlation 0.707 referring to the spine and upper limbs evaluation by SAROMM represents a strong association and show this clinical breakthrough.

Frequently, individuals with CP demonstrate movement amplitude restriction of relevant body joint (hip, knee, ankle and shoulder) in addition to important postural misalignments like scoliosis. Abreu *et al.* (2014) [17] study verified that two thirds of the GMFCS E&R level V adolescents with CP presented scoliosis, whereas this present study showed 82.75%, which is considered a higher representation of this condition. Spinal misalignments demonstrated extreme impairment since it achieved a 3.67 score according to the SAROMM evaluation, which is closest to the maximum score (4). It is expected that soft tissues are used in the movement execution or joint stability impairments under ROM reduction condition. It is also important to emphasize that this joint stability impairment promotes atypical posture misalignments and deformities.

We found strong association among important joints, such as, hip, knee or ankle and the spine. According to Martinello *et al.* (2010) [18], optimal posture is essential to promote voluntary movements. The spinal misalignments development are associated with or even may lead to impairments of adjacent areas, resulting in motor restrictions, as well as alterations in the respiratory, digestive, musculoskeletal system, among others.

## Conclusion

In summary, inpatients adolescents and young adults with CP, classified as GMFCS E&R level V, presented severe spinal alignment implying to restricted joint extensibility and possible low motor performance. The spinal alterations presented significant high



association with upper limbs hip, knee and ankle joints. However, studies with a bigger sample size and heterogeneous population are still required in order to understand the cause/ effect between postural deviations and motor performance.

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