Neuroimaging in Cerebral Palsy: A Reliable Biomarker For Predicting Motor And Cognitive Severity

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INTRODUCTION

Magnetic resonance imaging (MRI) can be used to analyze the location, nature and severity of brain damage in cerebral palsy (CP).

Few studies have investigated the contribution of MRI in predicting severity of CP in children.

OBJECTIVES

To analyze the neuroimaging findings and to establish a correlation between motor and cognitive severity and MRI patterns in children with CP.

MATERIALS & METHODS

- Retrospective study over a period of 10 years [2013-2023], including children with CP.
- We assessed the functional status using **Gross Motor Function Classification System (GMFCS)**. GMFCS was classified into mild-moderate (level I-III)/ severe (level IV-V) categories.
- We analyzed **neuroimaging patterns** and applied the **MRI classification system** (MRICS) of the Surveillance of Cerebral Palsy in Europe [1].
- The MRICS consists of **five main groups** [1] : maldevelopments (A), predominant white matter injury (B), predominant grey matter injury (C), miscellaneous (D), and normal findings (E).
- Results were considered statistically significant if **p<0,05**

RESULTS

CLINICAL AND RADIOLOGICAL FEATURES

- **218** children were included
- Sex-ratio (M/F) = **1.3**
- Median age = 7 years [1-18]
- Median age at time of brain MRI = 7 years [1-18]

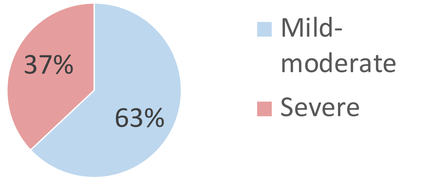

Figure 1. Distribution of motor severity

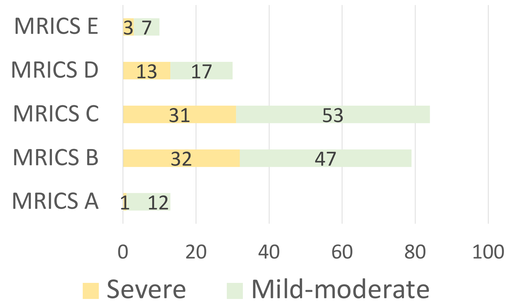

Figure 2. Severity distribution according to MRICS Classification

RADIOLOGICAL PATTERNS PREDICTING MOTOR SEVERITY

Table 1. Radiological patterns associated with motor severity : univariate study

Radiological features	Mild-moderate n (%)	Severe n (%)	p
CSAC	20 (24,4%)	11 (8,1%)	**0,001**
Grey matter abnormalities	30 (36,6%)	23 (17%)	**0,001**
Globus pallidus	13 (15,9%)	4 (3%)	**0,001**
Putamen	6 (7,3%)	3 (2,2%)	0,085
Thalamus	13 (15,9%)	4 (3%)	0,001
White matter abnormalities	43 (52,4%)	58 (43%)	0,175
Ischaemic stroke	4 (4,9%)	35 (25,9%)	**<0,001**
Porencephalic cavities	8 (9,8%)	35 (25,9%)	**0,004**
Ventricular abnormalities	6 (7,3%)	24 (17,8%)	**0,03**
Cerebral calcifications	2 (2,4%)	4 (3%)	1
Bilateral lesions	77 (51,7%)	72 (48,3%)	**<0,001**
MRICS A	1 (1,2%)	12 (8,9%)	**0,024**

CSCA: Cortical and subcortical atrophy ; **p**: p value

Table 2. Radiological patterns associated with motor severity: multivariate study

Radiological features	p	OR	CI95%
Cortical and subcortical atrophy	**0,006**	**6,098**	**1,694-21,953**
Grey matter abnormalities	0,142	2,046	0,787-5,317
Ischaemic stroke	0,057	0,212	0,043-1,048
Porencephalic cavities	0,11	0,326	0,082-1,291
Ventricular abnormalities	0,302	0,502	0,135-1,857

RADIOLOGICAL PATTERNS PREDICTING COGNITIVE SEVERITY

Table 3. Radiological patterns associated with cognitive severity

Radiological pattern		Intellectual disability		Learning difficulties		Writing difficulties		Speech impaire-ment		Neuro-sensorial impaire-ment		Behavioural disorders	
		p	OR	p	OR	p	OR	p	OR	p	OR	p	OR
MRICS	A												
	B									>0,05	-		
	C	>0,05	-	>0,05	-	>0,05		>0,05	-			>0,05	-
	D									**0,031**	**2,321**		
	E									>0,05	-		
Bilateral lesions		**0,025**	**2,39**	**0,009**	**4,78**	**0,000**	**7,23**	**0,000**	**4,943**	>0,05	-	>0,05	-
Ischaemic stroke		>0,05	-	>0,05	-	>0,05	-	**0,001**	**2,47**	>0,05	-	**0,018**	**2,69**
Basal ganglia involvement		>0,05	-	**0,041**	**2,38**	**0,005**	**4,12**	**0,016**	**2,376**	>0,05	-	>0,05	-
CSCA		>0,05	-	**0,038**	**3,56**	**0,003**	**3,23**	**0,003**	**4,731**	**0,000**	**4,05**	>0,05	-
Calcifications		>0,05	-	**0,04**	**2,12**	>0,05	-	>0,05	-	>0,05	-	>0,05	

p: p value ; **OR:** Odds Ratio; **CSCA**: Cortical and subcortical atrophy

CONCLUSIONS

Our study suggests that cerebral imaging can **predict motor and cognitive severity in children with CP**. A result consistent with the study by Himmelmann *et al.* is that **bilateral lesions**, **ischaemic strokes** and **porencephalic cavities** are more often associated with a severe phenotype [1]. Kulak *et al.* have also demonstrated that **cerebral atrophy** is a predictive factor of a poor prognosis for ambulation [2], which is in line with our results. Since severity is correlated with a number of other factors such as **genetics and therapeutic management** [3], brain MRI is not sufficient on its own to establish a prognosis of the CP. Further large-scale studies will be necessary to investigate structure–function relationships and may help in **predicting future impairments** and **improve therapeutic management**.

REFERENCES

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