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## **Research Article**

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# Cerebral palsy: risk factors, comorbidities and associated MRI findings, a hospital based observational study

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#### **ABSTRACT**

**Background:** Cerebral palsy is a common pediatric disorder occurring in about 2-2.5/1000 live births. It is a chronic motor disorder resulting from a non-progressive static insult to the developing brain. There are various risk factors associated with it. Also it is accompanied with varied comorbidities and MRI findings depending on the etiology. Aims and objectives: To study the various risk factors, comorbidities and MRI findings in patients with cerebral palsy patients.

**Methods:** A hospital based observational study was undertaken in the post graduate department of pediatrics, GB pant hospital, GMC Srinagar, Northern India. The study was carried out over a period of one year from September, 2009 to August 2010. During this year 22036 patients were admitted in this hospital, of which 2077 (9.42%) were neurological cases. Of these 2077 neurological cases, 145 (6.98%) were cerebral palsy patients, however only 57 children were included in our study. Other 88 CP cases were excluded as they were not fulfilling the inclusion criteria. After thorough clinical history and examination relevant investigations were done including MRI brain.

**Results:** The commonest type of CP was spastic diplegia 28 (49.1%). Other types were spastic quadriplegia in 11 (19.29%), spastic hemiplegia 11 (19.29%), choreoathetoid 4 (7.01%) & mixed in 3 (5.29%). Seizures 27 (47.36%), aspiration pneumonia and bronchopneumonia 8 (14.03%) each were the commonest comorbidities associated. Most common risk factors for cerebral palsy in our study were prematurity and perinatal asphyxia in 7 (31.8%) each. Other risk factors in decreasing order of frequency were, pregnancy induced hypertension (PIH) in mothers 5 (29.41%), multiple gestations 5 (29.41%), neonatal meningitis 4 (18.18%), hypothyroidism in mothers 3 (17.64%), toxoplasmosis 2 (1.76%), rubella 2 (11.76%), maternal diabetes mellitus 2 (3.5%), neonatal hyperbilirubinemia 3 (13.6%) and neonatal seizure in 1 (1.75%). MRI was abnormal in 49 (85.96%) patients with PVL in 22 (38.59%), cortical atrophy in 7 (12.22%), post HIE changes in 4 (7.01%), followed by basal ganglion lesions, lissencephaly, porencephalic cyst, schizencephaly cortical dysplasia, dilated ventricles and infarctions.

Conclusions: The commonest type of CP was spastic diplegia 28 (49.1%), followed by spastic quadriplegia, spastic hemiplegia, choreoathetoid and mixed. Most common risk factors for cerebral palsy in our study were prematurity and perinatal asphyxia, followed by Pregnancy Induced Hypertension (PIH) in mothers, multiple gestations, neonatal meningitis, hypothyroidism in mothers, toxoplasmosis, rubella, maternal diabetes mellitus, neonatal hyperbilirubinemia and neonatal seizure. Seizures, aspiration pneumonia and bronchopneumon were the commonest comorbidities associated. MRI was abnormal in 49 (85.96%) patients with PVL, cortical atrophy, post HIE changes being the most common changes followed by basal ganglion lesions, lissencephaly porencephalic cyst, schizencephaly, cortical dysplasia, dilated ventricles and infarctions.

**Keywords:** Cerebral palsy, Seizures, Periventricular Leukomalacia

#### INTRODUCTION

The term Cerebral Palsy (CP) was coined more than a century ago and loosely translates "brain paralysis". However, a precise definition has remained elusive, because CP is not a single diagnosis but an umbrella term describing non progressive brain lesions involving motor or postural abnormalities that are not always present during early development.<sup>1</sup>

Sir William John Little (1810-1894), British orthopaedic surgeon gave description of the cerebral palsy in 1861 which was then known as cerebral paralysis. It was Sir William Osler who popularized the term cerebral palsy in 1887. The disease which was described as Little's disease for many years is now known as spastic diplegia.<sup>2</sup>

Cerebral palsy has been described as a group of disorders of the development of movement and posture causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, cognition, communication, perception and or/behaviour or/seizure disorder.<sup>3</sup> The brain lesions of CP occur from fetal or neonatal period upto age of 3 years. CP is restricted to lesions of brain only. Diseases specific to spinal cord, peripheral nerves or to muscles although causing early motor abnormalities are not considered CP.<sup>4</sup>

Incidence of CP in developed countries varies from 2-2.5/1000 live births. Male sex may be a risk factor for CP. Prevalence of CP among preterm infants is substantially higher.<sup>5-9</sup> Despite the reduction in the rate of birth asphyxia, prevalence of CP in USA has increased, likely related to the survival of the very low birth weight infants.<sup>10</sup>

Etiology of CP is multi-factorial. In 80 percent of cases features pointing to ante-natal factors were identified. <sup>11,12</sup> Including long menstrual cycle, previous pregnancy loss, maternal mental retardation, maternal thyroid disorder, especially iodine deficiency etc.

The peri-natal factors identified were prematurity, chorioamnionitis, non-vertex and face presentation of fetus, birth asphyxia. Post term pregnancy at 42 weeks or later has been associated with increased risk of CP. <sup>13</sup> The following post-natal factors may contribute to CP, Infections (e.g. meningitis, encephalitis), intracranialhaemorrhage, periventricular leukomalacia and kernicterus. <sup>11-14</sup>

# Associated manifestations of cerebral palsy

Mental retardation, epilepsy, <sup>15-19</sup> feeding nutrition and growth abnormality, <sup>20</sup> bladder dysfunction, <sup>21</sup> bowel dysfunction and sleep disturbances, <sup>22</sup> drooling, <sup>23</sup> hearing and visual abnormalities. <sup>24</sup>

MRI brain is the neuroimaging study of choice for diagnosis in children because it defines cortical and white matter structures and abnormalities more clearly than CT scan and USG cranium. Although precise role of MRI in the diagnosis and work up of children with CP or suspected CP has not been fully elucidated. Recent literature suggests that MRI should be strongly considered in all cases. MRI may have a role in predicting neuro-developmental outcome in preterm infants. Normal MRI does not exclude CP.<sup>25</sup>

#### Aims & objectives

To study the various risk factors, comorbidities and MRI findings in patients with cerebral palsy.

#### **METHODS**

A hospital based prospective study was undertaken in the department of pediatrics, GB pant hospital govt. medical college, Srinagar, Northern India

The study was carried out over a period of one year from September, 2009 to August 2010. During this year 22036 patients were admitted in this hospital, of which 2077 (9.42%) were neurological cases. Of these 2077 neurological cases, 145 (6.98%) were cerebral palsy patients, 57 children were included in our study. Other 88 CP cases were excluded because of:

- a) Inclusion criteria being age between 02 years to 16 years.
- b) Patient readmitted multiple times.
- MRI not done due to parental reluctance or patient's morbid condition.

All children enrolled in the study were subjected to the following protocol, after getting informed consent from their guardians,

History and clinical examination as mentioned in prestructured proforma was performed in every patient. Diagnosis of cerebral palsy was made clinically. MRI performed in these 57 cases was reported by radiologist.

## **RESULTS**

In all age groups males predominated in number over females. There were 37 males (64.91%) as against 20 females (35.08%) (Table1).

The commonest type of CP was spastic diplegia 28 (49.1%). Other types were spastic quadriplegia in 11 (19.29%), spastic hemiplegia 11 (19.29%), choreoathetoid 4 (7.01%) & mixed in the 3 (5.29%) (Table 2).

Table 1: Age and sex distribution of patients with cerebral palsy.

Age	Male		Female		Total	
(years)	No.	%	No.	%	No.	%
2-5	30	81.08	15	75	45	78.94
6-10	6	16.21	4	20	10	17.54
11-16	1	2.70	1	5	2	3.50
Total	37	64.91	20	35	57	100

Table 2: Distribution of type of cerebral palsy in studied patients.

Type of cerebral palsy	No.	%
Spastic diplegia	28	49.10
Spastic quadriplegia	11	19.29
Spastic hemiplegia	11	19.290
Choreoathoid	4	7.01
Mixed	3	5.26

Most common risk factors for cerebral palsy in our study were prematurity and perinatal asphyxia in 7 (31.8%) each. Other risk factors in decreasing order of frequency were, pregnancy induced hypertension (PIH) in mothers 5 (29.41%), multiple gestations 5 (29.41%), neonatal meningitis 4 (18.18%), hypothyroidism in mothers 3 (17.64%), toxoplasmosis 2 (1.76%), rubella 2 (11.76%), maternal diabetes mellitus 2 (3.5%), neonatal hyperbilirubinemia 3 (13.6%) and neonatal seizure in 1 (1.75%) (Table 3).

Table 3: Risk factors for CP in pregnancy and neonatal period.

Risk factor	No.	%
Disease during pregnancy		29.82
Pregnancy induced hypertension (PIH)		29.49
Hypothyroidism		17.64
Toxoplasmosis	2	11.76
Rubella	2	11.76
Urinary tract infections (UTI)	2	11.76
Diabetes mellitus	2	3.50
Admission during neonatal period		38.5
Perinatal asphyxia	7	31.8
Preterm with sepsis	6	27.2
Multiple births	5	22.72
Neonatal hyperbilrubenemia	3	13.6
Neonatal seizures		4.5
Preterm with Hyaline membrane disease		4.5

In our study most common cause of admission in patients of cerebral palsy was seizures 27 (47.36%). The other causes for hospitalization in these patients in decreasing order of frequency were: Aspiration pneumonia and bronchopneumonia 8 (14.03%) each; Acute gastroentritis and developmental delay in 3 (5.26%) each; Anemia 2 (3.50%); Acute laryngotracheobronchitis (ALTB),

wheezy bronchitis and generalized edema in 1 (1.75%) each (Table 4).

Table 4: Comorbidity conditions associated with hospitalization in patients of cerebral palsy.

Cause of admission	No.	%
Seizures	27	47.36
Aspiration pneumonia	8	14.03
Bronchopneumonia	8	14.03
Acute gastroenteritis	3	5.26
Developmental delay	3	5.26
Gastroesophageal reflux	2	3.50
Anemia	2	3.50
Wheezy bronchitis	1	1.75
ALTB	1	1.75
Generalized edema	1	1.75

MRI was normal in 8 (14.03%) cases. Which were all spastic diplegia cases. MRI was abnormal in 49 (85.96%) patients. Highest percentage of MRI abnormality was seen in spastic diplegia 20 (35.08%), followed by spastic quadriplegia & spastic hemiplegia 11 (19.29%) each. MRI was also abnormal in choreoathetoid 4 (7.01%) and mixed variety 3 (5.26%). The spectrum of MRI abnormalities in decreasing order of frequency was as under: PVL 22 (38.59%), cortical atrophy 7 (12.22%), post HIE changes 4 (7.01%), basal ganglion lesions 4 (7.01%), lissencephaly 2 (3.5%), porencephalic cyst 1 (7%), schizencephaly 1 (1.75%), cortical dysplasia 1 (1.75%), dilated ventricles 1 (1.75%) and infarctions 1 (1.75%). More than one abnormality was detected in 3 (5.26%) MRI scans (Table 5).

Table 5: Spectrum of MRI abnormalities in patients with cerebral palsy.

MRI findings	No.	%
Normal	8	14.03
Abnormal	49	85.96
Periventricular leukomalacia (PVL)		38.59
Cortical Atrophy		12.22
Basal ganglion lesions	4	7.01
Post H.I.E changes	4	7.01
More than one abnormality		5.26
Lissencephaly	2	3.50
Porencephalic cyst	1	1.75
Dilated ventricles		1.75
Calcifications	1	1.75
Shizencephaly	1	1.75
Cortical dysplasia	1	1.75
Infarction	1	1.75
Calcifications	1	1.75

Most common MRI findings in preterm born subjects were periventricular leukomalacia (PVL) in 8 (53.3%), cortical atrophy in 3 (20%), calcifications in 1 (6.6%), lissencephaly in 1 (6.6%), cortical dysplasia in 1 (6.6%)

& post Hypoxic Ischemic Encephalopathic (HIE) changes in 1 (6.6%) cases. Most common MRI findings in term born subjects were (PVL) in 16 (38.09%), cortical atrophy in 4 (9.52%), Post Hypoxic Ischemic Encephalopathic (HIE) changes in 4 (9.5%), basal ganglion lesions in 4 (9.5%) and lissencephaly in 1 (2.35%).

#### **DISCUSSION**

Cerebral Palsy (CP) is one of the common CNS disorders in children needing hospitalization. Patients get admitted either for comorbid conditions with CP like respiratory tract infections, feeding difficulties, gastroesophageal reflux and/or break through seizures with already existing seizure disorder.

In our study male preponderance over females was observed as 64.91% patients belonged to male sex against 35.08% females. Male preponderance has also been reported by Kulak W et al.<sup>26</sup> whose study had 67.27% males. However, Yamada K et al.<sup>27</sup> found female preponderance of 60.52% in their study of 38 cases of CP.

The commonest age group involved in our study was 2-5 years which accounted for 78.94% and the least involved group was 11-16 years (3.50%). However corresponding figures from other authors were not available regarding age distribution. In our study most common type of CP observed was spastic diplegia contributing to 49.10% of all cases. Similar observations have been made by Kwong K et al.<sup>28</sup> (50%) and Bax et al.<sup>3</sup> (34.4%) cases. However, Robinson et al.<sup>29</sup> have reported slightly lower (28.5%) spastic diplegic cases as against other forms of CP.

The next common types of CP in our study were spastic hemiplegia and spastic quadriplegia (19.29%) cases each. Study of Bax et al.<sup>3</sup> is in confirmatory with our study, who also had spastic hemiplegia (26.2%) and spastic quadriplegia (18.6%) as other common types of CP after spastic diplegia. In contrast to our study Robinson et al.<sup>29</sup> has reported spastic quadriplegia (37.5%) and spastic hemiplegia (33.5%) as common types of CP. The less common types in our study were choreoatheotoid (7.01%) and mixed (5.26%) types, similar to observations of Bax et al.<sup>3</sup> who had ataxic and mixed type of CP in 3.9% and 2.6% cases respectively.

In our study group risk factors for the development of CP during pregnancy were Pregnancy Induced Hypertension (PIH) (29.49%) followed by hypothyroidism (17.64%), intrauterine infections like toxoplasmosis and rubella (11.76%) each and Urinary Tract Infections (UTI) (11.76%).

Bax et al.<sup>3</sup> has also reported infection of mother during pregnancy as an important risk factor (39.5%) for CP.

Wu Yw Croen LA et al.<sup>30</sup> has reported maternal age >35 years as an independent risk factor for CP.

Out of all risk factors for CP during neonatal period, perinatal asphyxia contributed to 31.8%. Prematurity and multiple births contributed to 27.2% and 22.72% respectively. Neonatal hyperbilirubinemia was another important risk factor in 13.6% cases in our study. Prematurity with sepsis or hyaline membrane disease together contributed to 31.7% cases. All our multiple births were twins.

Prematurity and multiple births contributed to higher percentage (49.92%) of risk factors for CP in our study. BAX et al<sup>3</sup> had reported prematurity and multiple births as risk factors for CP in 34.3% and 12% respectively which is almost identical to our observations. Perinatal asphyxia contributed to 31.8% of all risk factors in neonatal period for CP.

Sugimoto T et al.<sup>31</sup> have reported perinatal asphyxia as a cause of CP in 12.8% cases only in their study. Higher incidence of perinatal asphyxia in our set up as the cause of admissions in neonatal period may be contributing it being as risk factor in large percentage of cases.

The commonest comorbid condition for which CP patients were admitted was seizures (47.30%). Aspiration pneumonia (4.03%) bronchopneumonia (4.03%), acute gastroenteritis (5.2%), gastroesophageal reflux (3.5%) and anemia (3%) were other reasons for hospitalization.

MRI was normal in 14.03% of studied subjects in our study. 85.90% CP patients had abnormal MRI which is almost similar to Bax et al.<sup>3</sup> study who had normal MRI in 11.76% CP patients and abnormal MRI in 88.24% cases. Similar observations were made by Kulak et al.<sup>26</sup> who had 4.7% normal MRI. Slightly higher percentages of normal MRI scans of CP patients have been reported by Robinson et al.<sup>29</sup> (16%) and Krageloh Mann et al.<sup>32</sup> (14%). Higher percentage of normal MRI scans has also been reported by Kwong K et al.<sup>28</sup> (25%) and Saginoya T et al.<sup>33</sup> (20%) in contrast to our study.

In our study group MRI of CP patients who had been born preterm were all abnormal (100%) as against 80.95% abnormality in term born CP patients. Though p value was not significant however, odds ratio was significant. Similar observations of higher MRI abnormalities in preterms have been reported by Krageloh Mann et al.<sup>32</sup> (75%).

The commonest MRI abnormality found in our study was periventricular leukomalacia (PVL) in 38.59% as has been reported by Bax et al. as well (42.25%). Higher percentage of PVL on MRI has been reported by Kwong et al. 28 (66%) and Gururaj et al. 34 (57%).

Basal ganglion lesions were observed in 7.01% cases, which is almost similar to Bax et al.<sup>3</sup> (12.08%). Kwong et

al.<sup>28</sup> has reported basal ganglion and thalamic lesions in 42% cases, which is far higher than our study.

Congenital malformations in the form of lissencephaly, schizencephaly, porencephalic cyst, cortical dysplasia was observed only in 5.45% of the abnormal MRI scans. However Robinson et al.<sup>29</sup> and Kulak et al.<sup>32</sup> have reported higher percentage of congenital malformations on MRI in 12% and 10% respectively. More than one abnormality was found in 5.26% cases. Similarly dual findings have been reported by Robinson et al.<sup>29</sup> (3%).

PVL was detected in 53.3% of the preterm born cases as against 38.01% of term born cases. Similar observation of higher PVL in preterm has been reported by Guraraj et al.<sup>35</sup> and Krageloh Mann et al.<sup>32</sup> In his study Krageloh Mann et al.<sup>32</sup> reported PVL in 90% of pre-terms as against 20% of term born cases. PVL on MRI correlated more with spastic diplegia (54.5%) and spastic quadriplegia (31.8%) as against other forms of CP in our study. Cortical atrophy and basal ganglion lesions correlated more with choreoathetoid type of CP (36.3%).

Significant PVL has been reported in 73.8% of spastic diplegia cases by Mei-Hou et al. St Kulak et al. has also reported higher percentage of PVL in spastic diplegia like us. However, Kwong et al. has reported higher PVL in (66%) tetraplegic cases in contrast to our study.

### **CONCLUSION**

The commonest type of CP was spastic diplegia 28 (49.1%), followed by spastic quadriplegia, spastic hemiplegia, choreoathetoid and mixed. Most common risk factors for cerebral palsy in our study were prematurity and perinatal asphyxia, followed by Pregnancy Induced Hypertension (PIH) in mothers, multiple gestations, neonatal meningitis, hypothyroidism in mothers, toxoplasmosis, rubella, maternal diabetes mellitus, neonatal hyperbilirubinemia and neonatal seizure. Seizures, aspiration pneumonia and bronchopneumon were the commonest comorbidities associated. MRI was abnormal in 49 (85.96%) patients with PVL, cortical atrophy, post HIE changes being the most common changes followed by basal ganglion lissencephaly porencephalic schizencephaly, cortical dysplasia, dilated ventricles and infarctions.

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