

# Hand Preference in Cerebral Palsy with Special Reference to Prematurity

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## Abstract

**Introduction:** Cerebral palsy (CP) is a static encephalopathy primarily causing impairment of movement and of posture. Handedness may be defined as the preferential use of one hand for performing unimanual tasks. Patients with CP develop early hand preference.

**Purpose:** To determine if the incidence of left handedness is high in children with CP and to investigate the association between prematurity, CP and hand preference.

**Design:** Case-control study.

**Materials and Methods:** A total of 129 children aged 6-15 years with CP and 516 age and gender matched controls were enrolled for the study. The handedness was assessed based on responses to questions on hand preference for writing/drawing, feeding, and throwing a ball. The data were analyzed by conditional logistical regression and calculating the odds ratio (OR) and 95% confidence intervals (CI) for left handedness.

**Result:** The mean age of cases was 9.1 years (standard deviation [SD] = 2.58) and that of controls was 9.6 years (SD = 2.72). Male female ratio was 1.22:1 for cases and 1.3:1 for controls. Spastic diplegia (79.07%) was the most common type of CP followed by hemiplegia (13.18%), quadriplegia (6.97%), and extrapyramidal CP (0.77%). Of the 129 children with CP, 49 (37.98%) were left-handed, while 21 (4.06%) of the 516 normal controls were left handed. The OR for left handedness in children with CP as compared with normal children was 14.43 (95% CI = 8.22-25.35). Nearly one-fifth (20.16%) of the study cases were preterm and out of these 57.69% cases were found to have left hand preference ( $P = 0.0204$ ).

**Conclusion:** The study shows that left handedness is very frequently encountered in children with CP. A significant association exists between preterm CP children and left handedness.

**Key words:** Cerebral palsy, Left handedness, Preterm

## INTRODUCTION

Cerebral palsy (CP) is a static encephalopathy and comprises a heterogeneous group of non-progressive motor impairment syndromes primarily causing impairment of movement and of posture. The cause is a brain insult occurring either prenatally, perinatally or postnatally and affecting areas of the brain which control muscle tone, power and coordination.<sup>1</sup>

Spastic diplegia is bilateral spasticity of lower extremity which is greater than the upper extremity. Periventricular leukomalacia (PVL) and prematurity are the most common associations with spastic diplegia.<sup>2</sup>

Handedness may be defined as preferential use of one hand for performing uni-manual tasks.<sup>3</sup> About 90% of humans are right handed.<sup>4</sup> Most left-handers are males.<sup>5-7</sup> Prematurity has been associated with left handedness.<sup>8</sup> Normally, infants do not show hand preference. Babies with hemiparetic CP may develop hand preference, using the unaffected arm to reach out for toys even when they are closure to the opposite affected hand. Even though, there is no clear-cut consensus as to the age at which adult-like handedness is achieved, it is only after age of 6 years that a clear hand preference can be observed.<sup>9</sup>

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The aim of this study was to ascertain the correlation between left handedness and various types of CP. The objective was to study the prevalence of left handedness among patients with CP and also to investigate the correlation between prematurity-related CP and hand preference.

## MATERIALS AND METHODS

This case-control study was conducted in the Department of Pediatrics, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India. The duration of the study was from September 2014 to December 2015. About 129 children with CP, attending the pediatric outdoor, between the ages 6-15 years were selected by convenience sampling. Detailed birth history, past history, family history, and relevant demographic information were taken. Each child was evaluated by a trained physiotherapist who classified each child's handedness on the basis of parental interview regarding which hand the child preferred while writing/drawing, feeding and throwing a ball. The handedness was also confirmed by direct visualization.

Age and gender matched controls ( $n = 516$ ), in the ratio of four control per patient, were selected from the outdoor patients who had no apparent congenital or neurological anomaly affecting the upper or lower extremities. The parents of the control subjects were asked to fill out a questionnaire in which the same three hand performance activities were asked.

### Statistical Methods

The SPSS Statistics 17.0 (SPSS Inc., Chicago, IL, USA) was used. Power calculations before the study (with a  $\beta$  of 0.10 and a two-sided  $\alpha$  of 0.05) showed that it would be possible to detect a three-fold higher prevalence of left handedness among cases than controls (assumed to be 8-10%). The association between diplegic CP and left handedness was assessed by odds ratio (OR) as a measure of relative risk. The precision of OR was taken as 95% confidence interval (CI), calculated from Mantel-Haenszel Chi-square test.

## RESULTS

The mean age of both cases and controls was 9.1 years (standard deviation [SD] = 2.58) and 9.6 years (SD = 2.72), respectively. Male female ratio was 1.22:1 (cases) and 1.3:1 (controls). Of the 129 children with CP, 37.98% ( $n = 49$ ) were left handed, while 4.06% ( $n = 21$ ) of the 516 controls were left handed. Table 1 shows the frequency of hand preference among the cases and the controls documenting a propensity of male CP children toward left handedness.

The OR for left handedness in children with CP as compared with normal children was 14.43 (95% CI = 8.22-25.35).

Out of 129 cases, 102 (79.07%) were diplegic, 9 (6.97%) were quadriplegic, 17 (13.18%) were hemiplegic, and one (0.77%) was ataxic. Among the different types of CP, left handedness was noticed in 53.92% cases of spastic diplegia, 52.94% of hemiplegic CP, and 33.33% of quadriplegic CP patients (Figure 1).

In the study group, 20.16% ( $n = 26$ ) cases were delivered preterm. Among the preterms, a significant percentage 57.69% ( $n = 15$ ) ( $P = 0.0204$ ) demonstrated a left hand preference whereas 33% ( $n = 34$ ) of term CP children showed a left hand preference (Figure 2).

In the control group, 3.29% ( $n = 17$ ) cases were delivered prematurely. In these normal preterm babies, 17.65% ( $n = 3$ ) showed left hand preference, whereas only 3.61% ( $n = 18$ ) of term CP children showed a left hand preference (Figure 3).

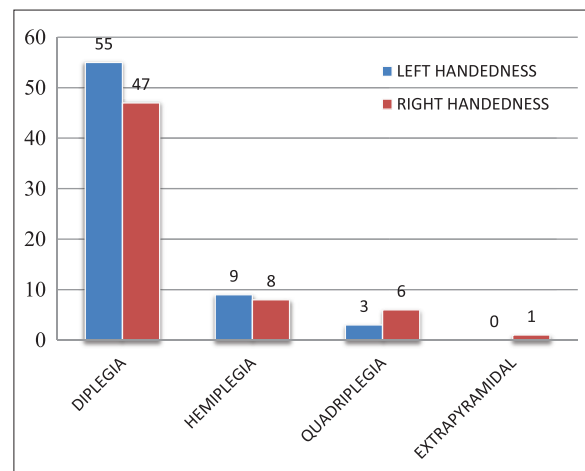
## DISCUSSION

In this study, handedness was judged by assessing three functions (writing/drawing, feeding and throwing

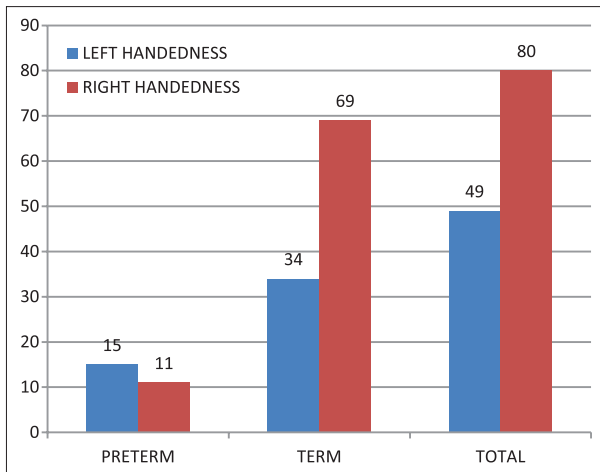
**Table 1: Frequency of left hand and right dominance among children with cerebral palsy and controls**

Gender	Hand dominance	Normal control $n=516$ (%)	Cerebral palsy cases $n=129$ (%)
Female	Left	6 (2.68)	16 (27.59)*
	Right	218 (97.32)	42 (72.49)
Male	Left	15 (5.14)	33 (46.48) <sup>§</sup>
	Right	277 (94.86)	38 (53.52)

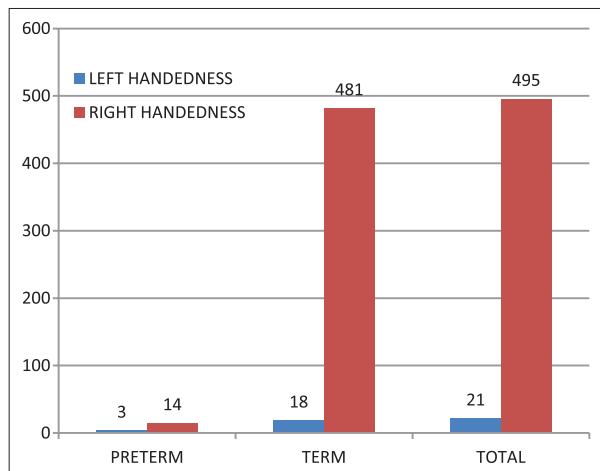
\* $P=0.0330$ , <sup>§</sup> $P=0.0094$



**Figure 1: Handedness among different types of cerebral palsy**



**Figure 2: Handedness and gestational age in cerebral palsy cases**



**Figure 3: Handedness and gestational age in control cases**

a ball). Interviewing and handedness questionnaire (e.g., Edinburgh inventory) are the two common methods for assessing hand preference.<sup>7,10-12</sup> Interviewing is done by asking the individual/parent which hand they prefer to use to perform a task; whereas, questionnaires inquire as to how frequently one hand is preferentially employed to perform a given set of activities. Since quite a few of these activities are not performed by normal Indian children, on account of cultural differences, hence, using the inventory would have necessitated several modifications.<sup>13,14</sup> Furthermore, a proportion of study cases may not have been able to understand or cooperate appropriately tasks included in these inventories. Although such inventory could have been given to normal controls, this was not done for the sake of uniformity. In spite of this limitation, it is very unlikely that the significant differences in handedness between normal and children with CP are due to inaccuracies in ascertaining the handedness. Similar results have reported in the previous studies from this country.<sup>15,16</sup> Lin *et al.* reported a high prevalence of left handedness in children

with diplegia.<sup>13</sup> Yokochi *et al.*<sup>17</sup> noted high prevalence of left handedness in athetoid CP patients and Dubey *et al.* reported high proportion of left handers among CP patients.<sup>18</sup>

This study reflects that a large number of children with CP are left handed. The study shows that approximately one-fifth of the patients with CP were born prematurely. Out of these a significant proportion of children demonstrated left hand preference. These findings are in agreement with the previous study by Dubey *et al.*<sup>18</sup> The reason is unclear. An explanation could be that damage to the dominant left cerebral hemisphere causes a mild hypofunction of the right hand leading the child to switch to left hand for daily activities.<sup>19</sup> The extent and site of brain damage differs on the basis of timing of insult (gestational age) and the cause of insult. Subcortical white matter damage and PVL are the more common in preterm babies.<sup>20,21</sup> Further *in vivo* studies including the use of magnetic resonance imaging is suggested to evaluate this propensity toward left handedness.

In several ethnic groups and cultures, forced hand conversion is practiced as it is considered socially inappropriate to use left hand for eating, accepting gifts or performing rituals.<sup>22-24</sup> Studies show that forced change in handedness leads to cortical re-organization in normal children<sup>25,26</sup> but no such studies have been reported in children with CP.

Knowledge of the fact that a child with CP has a high likelihood of being left handed will help the pediatrician counsel the parents to refrain from forcing the child to perform routine activities with the right hand. Furthermore, functions performed by non-dominant hemisphere such as visuo-spatial information, and music should be reinforced by vocational training.

## CONCLUSION

The study shows that left handedness is very frequently encountered in children with CP. A significant association exists between preterm CP children and left handedness.

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