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Hip Displacement in Children with Cerebral Palsy- A Clinico- Radiological Evaluation

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Abstract

Background: Children with cerebral palsy (CP) are at risk for hip subluxation due to the spasticity and contractures of the hip adductors, medial hamstrings, and hip flexors. Hip displacement is often asymptomatic in these children until the hip is particularly or fully dislocated resulting in pain, gait disturbances and impaired sitting balance. Hip surveillance is a process of actively monitoring a child for early identification of hip displacement. In India, the National Hip Surveillance Program was established to support surveillance in preventing dislocations and reducing the need for surgery. In light of this, the present study aims to determine the prevalence of hip displacement in children with CP in Belagavi.

Method: This descriptive, cross-sectional observational study was conducted at a tertiary care hospital and inclusive education schools. Children aged 2–18 years with CP, underwent clinical examinations followed by radiographic evaluation and the Migration Percentage (MP) was calculated to categorize hip displacement, the primary outcome measure of the study. Prevalence of subluxation and its association with gender, age, GMFCS E & R levels and CP subtypes were assessed.

Results: Out of 128 children with CP assessed, 104 had subluxation, with the majority (73.44%) showing bilateral involvement, while 7.81% had right-sided subluxation. The prevalence of subluxation varied by CP subtypes, with spastic type accounting for the higher prevalence. A statistically significant association between CP subtype and subluxation was found on the right side ($p = 0.003$).

Conclusion: The study identifies an 81.3% occurrence of hip subluxation in children with CP, with bilateral involvement being the most prevalent (73.44%). The likelihood of subluxation was notably impacted by CP subtype, especially in spastic CP. Timely detection through clinical assessment and radiographic monitoring is vital to prevent advancement to dislocation. Future investigations should prioritize extended follow-ups and therapeutic approaches to optimize outcomes.

Keywords: Hip subluxation, Cerebral palsy, Radiography, Migration percentage

Introduction:

Cerebral palsy (CP) is the most common childhood neurological disorders, with an incidence of 2.95 per 1,000 live births in India [1]. In the Belagavi district, the prevalence of different CP subtypes has been reported as dyskinetic (52.4%), spastic (29.1%), and mixed (5.8%) [2]. The incidence of hip displacement in India ranges from 0 to 2.6 per 1,000 live births and according to a study conducted in 2023, its prevalence in Karnataka is 54% [3, 4]. Among the various musculoskeletal complications associated with CP, hip displacement is a major concern, affecting 35% of children worldwide with a migration percentage (MP) greater than 30%, and rising to 90% in those classified at GMFCS Level V [5].

Children with CP frequently experience neuromuscular and musculoskeletal impairments such as spasticity, muscle contractures, incoordination, weakness, and loss of selective motor control. These primary impairments contribute to secondary complications, including joint pain, hip dislocation, and scoliosis, significantly

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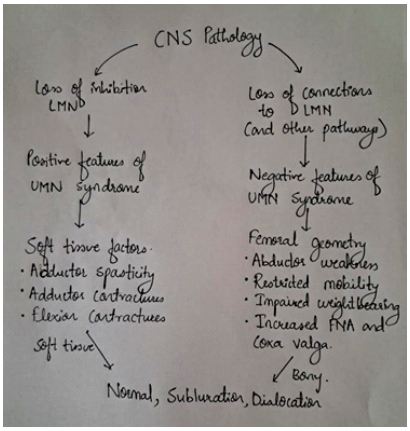

Figure1: Pathophysiology of hip dislocation in children with cerebral palsy.

impacting motor function and daily activities [6]. Spasticity and contractures of the hip adductors, medial hamstrings, and hip flexors create muscle imbalances around the hip joint, increasing the risk of hip subluxation [1]. Furthermore, recent studies highlight the influence of upper motor neuron (UMN) syndrome on proximal femoral geometry, exacerbating hip displacement in children with severe CP [5]. As the hip continues to grow under these pathological forces, the risk of progressive displacement increases, often leading to pain, gait disturbances, and impaired sitting balance if left undiagnosed (Fig. 1).

Despite the critical role of the hip joint in functional mobility, hip displacement in CP is often asymptomatic until partial or complete dislocation occurs. Early detection through regular clinical and radiographic evaluations is essential to prevent complications and optimize functional outcomes [1, 7]. Hip surveillance programs have been shown to effectively reduce the incidence of hip dislocation by enabling early intervention.

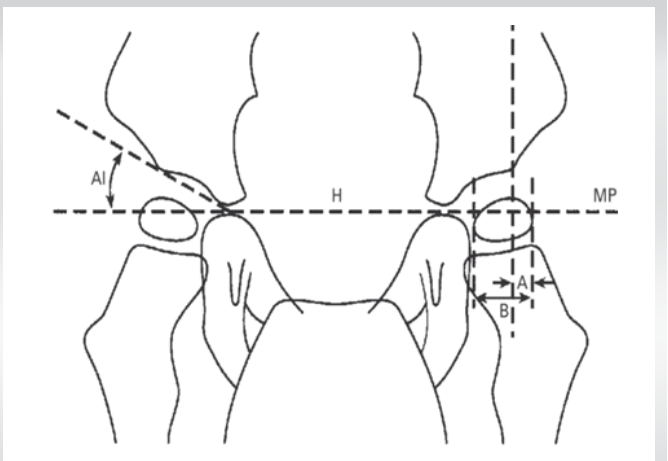

Figure 2: The migration percentage from X-rays is calculated (H for Hilgenreiner's line, P for Perkin's line, A for the maximum width of the ossified femoral head section lateral to Perkin's line, and B for the maximum width of the ossified femoral head). The formula for Migration Percentage (MP) is A/B * 100.

Hip dislocations in children with CP have significantly decreased, according to a population-based hip surveillance program and a systematic review conducted in Australia [8]. To aid in the early detection and treatment of hip dislocation, India launched the National Hip Surveillance Program. Following its implementation, a study in Hubballi, Karnataka, found that 51.7% of children with CP had hip subluxation, further reinforcing the importance of surveillance and functional classification in risk stratification [1].

There is no available estimate of prevalence of hip displacement in these children in Belagavi. The high risk of hip displacement in this population and its potential impact on functional abilities highlight the need for this study, which aims to determine its prevalence and examine its association with various risk factors. Finding these correlations will help children with CP have an early diagnosis, receive timely intervention, and have better mobility and quality of life.

Methodology:

This descriptive, cross-sectional observational study was conducted over a period of six months, from March 2024 to October 2024, in and around Belagavi. Participants were recruited from a range of settings, including urban and rural inclusive education schools, special schools, and a tertiary care hospital and those registered in District disability office to ensure diverse representation. The study population comprised male and female children aged 2 to 18 years diagnosed with CP, along with their parents who were willing to bring them to the tertiary care hospital for radiographic assessment. Children with developmental disabilities other than CP were excluded. Convenience sampling was used for participant selection. Ethical Clearance was obtained from the Institutional Ethical Committee of KAHER Institute of Physiotherapy; Belagavi and the study was registered under Clinical Trials Registry-India (CTRI/2024/03/064271).

Children were recruited based on the study criteria and a

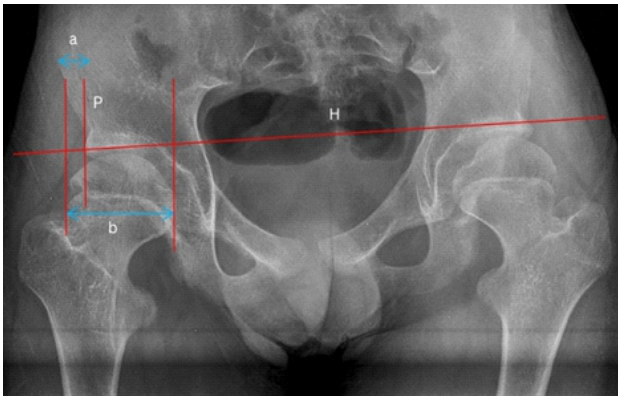

Figure 3: X-ray depicting calculation of migration percentage

written informed consent was obtained from the parent. The parents were given an appointment to visit the tertiary care hospital for detailed clinical examination and radiographic evaluation. During their visit demographic data was recorded and clinical examination was done by a paediatric physiotherapist. Spasticity of hip and knee muscles were assessed by the Modified Modified Ashworth Scale (MMAS) while the ambulatory status was recorded based on GMFCS-E & R.

This was followed by radiography of hip, based on guidelines of Indian Hip Surveillance at the radiology department [9]. The radiological evaluation included standardized anteroposterior pelvic radiographs taken in supine position. To ensure accurate positioning, the pelvis was aligned in a squared position, hips were maintained in neutral abduction and adduction, and both lower limbs were flexed to correct lumbar lordosis in cases with hip flexion deformity. Standard image magnification protocols, as outlined in the Indian Hip Surveillance Guidelines for Children with CP, were strictly followed, and all radiographs were appropriately magnified.

The Migration Percentage (MP) was calculated by measuring the extent of the ossified femoral head outside the acetabulum. After obtaining the radiographs, the lateral boundary of the acetabulum was marked using Perkin's (P) line perpendicular to the Hilgenreiner's (H) line, which was drawn horizontally between the triradiate cartilages. The MP was then determined after noting the area of the capital epiphysis that had laterally moved past the Perkins line. This provided a quantitative assessment of hip subluxation or dislocation, categorizing hip disorders as normal (MP < 30%), subluxated (MP ≥ 30% and < 100%), or dislocated (MP = 100) (Fig. 2, 3)

All radiographs were performed by a radiologist with over 10 years of experience, and the MP (Migration Percentage) measurements were carried out by a single therapist who was also trained in the procedure. Prior to the start of data collection, both the radiologist and the therapist reviewed the relevant guidelines and practiced on a few cases to ensure familiarity and accuracy in the procedure. Since only one therapist conducted the migration percentage measurements throughout the study, and the number of assessments per day was limited (1–2 per day), inter- and intra-rater reliability was not established separately. However, consistency was maintained by ensuring that the same trained individual performed all measurements to minimize variability.

The sample size was calculated based on an anticipated prevalence of 25% of children with CP in the Belagavi region. Using a significance level (α) of 5% and a precision of 7.5%, the estimated sample size was determined to be 128 participants. This calculation ensured sufficient statistical power to detect the expected prevalence with acceptable levels of accuracy and confidence.

Statistical analysis was done using SPSS software version 29.0.1. Frequencies and percentages were used to describe all continuous data, and means and standard deviations were used to describe all categorical data. Fisher's exact test and chi-square were used to search for correlations between the variables. All of the risk ratios' confidence intervals were established. A P value of less than 0.05 was considered statistically significant.

Results

The study evaluated 128 children and Table 1 represents the descriptive statistics of these children.

85.7% of males and 74.5% of females had subluxation on the right side, while 83.1% of males and 78.4% of females had subluxation on the left side (Table 2). Fisher's exact test showed

n=128	Range	Mean ± SD
Age (years)	2-16	7.66 ± 3.90
Height(m)	0.56 -1.67	1.13 ± 0.23
Weight (kg)	8-48	18.75 ± 9.21
BMI(Kg/m^2)	7.18 -38.27	14.08 ±3.91

Table 1: Descriptive statistics of participants

Gender	Migration percentage (Right hip)	.	Total n (%)	Migration percentage (Left hip)	,	Total n (%)
	Normal n (%)	Subluxation n (%)		Normal n (%)	Subluxation n (%)	
Male	11(14.30)	66 (85.70)	77(100)	13 (16.90)	64 (83.10)	77(100)
Female	13 (25.50)	38 (74.50)	51(100)	11 (21.60)	40 (78.40)	51(100)
Total	24 (18.80)	104 (81.30)	128(100)	24 (18.80)	104 (81.30)	128(100)

Table 2: Prevalence of hip subluxation according to gender

Age	Subluxation	
	Migration percentage (Right) n (%)	Migration percentage (Left) n (%)
<6	42 (89.40)	40 (85.10)
6/13.	54 (79.40)	56 (82.40)
>13	8 (61.50)	8 (61.50)
Total	104 (81.30)	104 (81.30)

Table 3: Prevalence of hip subluxation according to age

GMFCS E&R	Migration percentage (Right)	Migration percentage (Left)
	Subluxation n (%)	Subluxation n (%)
Level 1	38 (74.50)	39 (76.50)
Level 2	18 (78.30)	20 (87.00)
Level 3	7 (100)	7 (100)
Level 4	12 (85.70)	11 (78.60)
Level 5	29 (87.90)	27 (81.80)
Total	104 (81.30)	104 (81.30)

Table 4: Prevalence of hip subluxation across different GMFCS E&R levels

Type of CP	Migration percentage (Right)	Migration percentage (Left)
	Subluxation n (%)	Subluxation n (%)
Spastic Diplegia	28 (26.90)	26 (25.00)
Spastic Hemiplegia	14 (13.50)	16 (15.40)
Spastic Quadriplegia	28 (26.90)	28 (26.90)
Dyskinetic	28 (26.90)	28 (26.90)
Ataxic	2 (1.90)	3 (2.90)
Mixed	4 (3.80)	5 (3.80)
Total	104 (100)	104 (100)

Table 5: Prevalence of hip subluxation across CP subtypes

MMAS grading	Subluxation			
	Migration percentage (Right) n (%)		Migration percentage (Left) n (%)	
	Medial hamstrings	Adductors	Medial hamstrings	Adductors
0	1 (1.47)	0	1 (1.56)	2 (3.22)
1	44 (64.70)	40 (60.60)	38 (59.37)	31 (50)
2	18 (26.47)	19 (28.78)	21 (32.81)	22 (35.48)
3	5 (7.35)	7 (10.60)	4 (6.25)	7 (11.29)
Total	68 (100)	66 (100)	64 (100)	62 (100)

Table 6: Distribution of Hip Subluxation Based on MMAS Grading

Subluxation side	n	Percentage
Right	10	7.81
Left	0	-
Bilateral	94	73.4375
Total	104	81.24

Table 7: Distribution of sidewise subluxation between the children

no statistically significant association between gender and subluxation on either side (p = 0.088 for right and p = 0.33 for left).

In children aged 6–13 years, prevalence of 79.4% on the right and 82.4% on the left, while in those older than 13 years, the prevalence was 61.5% on both sides was found (Table 3). Despite this trend, Pearson's Chi-Square test found no statistically significant association between age and subluxation (p = 0.064 for the right, p = 0.147 for the left).

The distribution of subluxation across different GMFCS E& R levels showed that individuals at higher GMFCS levels had more prevalence of hip subluxation (Table 4). Pearson's Chi-Square test indicated no statistically significant association between GMFCS level and subluxation for either side (p = 0.354 for the right, p = 0.567 for the left).

Table 5 represents the prevalence of subluxation varied by CP subtypes, with spastic type accounting for the higher prevalence. A statistically significant association between CP subtype and subluxation was found on the right side (p = 0.003). However, on the left side similar distribution patterns were observed, the association was not statistically significance (p = 0.062).

Table 6 shows that hip subluxation increases with higher MMAS grades, with greater migration percentages in the medial hamstrings than in the adductors. Pearson's Chi-Square test found no statistically significant association between MMAS grading and subluxation medial hamstrings (p = 0.033 for the right, p = 0.168 for the left) adductors (p = 0.007 for the right, p = 0.420 for the left).

Subluxation laterality (Table 7) in the 104 individuals with

subluxation revealed that the majority (73.44%) experienced bilateral involvement; while 7.81% had subluxation on the right side, and none exhibited left-sided subluxation in isolation. This finding suggests that bilateral subluxation is the predominant pattern among affected individuals.

Discussion

Hip dislocation is a known risk in children with CP, with the likelihood increasing as severity progresses [10]. Following the implementation of the National Hip Surveillance Program, a study conducted in Hubballi, Karnataka, found that 51.7% of children with CP had experienced hip subluxation. This finding further reinforced the importance of surveillance and functional classification in risk stratification [1]. Our results support previous research suggesting, children with higher Gross Motor Function Classification System (GMFCS) levels are at greater risk of hip displacement. Although our study did not find a statistically significant association between GMFCS level and subluxation ($p = 0.354$ for the right, $p = 0.567$ for the left), the prevalence of subluxation was highest in children at GMFCS Level 3 (100%) and remained high at Levels 4 and 5 ranging from 85.7%–87.9%. This trend is consistent with the study by Larnert et al. that reported a 2.5–3 times higher risk of hip displacement in children with GMFCS level V compared to those at GMFCS III–IV. The higher prevalence in severe CP cases may be due to a combination of factors, including impaired weight-bearing, muscle imbalances, and spasticity-related contractures [11]. To avoid complications like high sacral sitting and challenges with perineal hygiene and transfers, early detection and intervention are essential in these groups [12].

Age also appears to influence subluxation risk. In our study, younger children (<6 years) had the highest prevalence (89.4% on the right, 85.1% on the left), which decreased with age, though the association was not statistically significant ($p = 0.064$ for the right, $p = 0.147$ for the left). This aligns with the understanding that hip displacement often begins within the first two years of life and can progress to dislocation over time [13].

CP subtype was the only factor significantly associated with subluxation ($p = 0.003$ on the right). Spastic diplegia, spastic quadriplegia, and dyskinetic CP accounted for the majority of cases (26.9% each), reinforcing findings by Kentish et al., who reported that most children with MP >30 were classified as GMFCS V, with spastic quadriplegia or dyskinetic CP. This highlights the role of muscle tone abnormalities and hip morphology in the progression of hip displacement [14].

Furthermore, our study found that subluxation most commonly presented bilaterally (73.44%), with only a small proportion having right-sided involvement (7.81%) and none showing isolated left-sided subluxation. This pattern supports previous evidence suggesting that nonambulatory children experience progressive bilateral hip displacement due to flexion-adduction contractures, acetabular dysplasia, and chronic femoral abnormalities [13].

In our study, although age, gender, and GMFCS levels did not demonstrate statistical significance and these findings differ from previous studies conducted in Australia, Sweden, and Karnataka (India), where a significantly higher prevalence of hip subluxation has been consistently associated with greater functional impairment, particularly in children classified at higher GMFCS-E&R levels [1, 11, 14]. One possible explanation for this discrepancy is that, although our sample was diverse, it may not have included a sufficient proportion of children with severe functional limitations (GMFCS Levels IV and V), who are typically at greater risk for hip displacement. Additionally, the cross-sectional design and relatively smaller sample size may have limited our study's power to detect statistically significant associations.

Early identification of hips at risk of progressive subluxation through clinical assessment and radiological evaluation, combined with timely initiation of a structured postural management program, plays a vital role in preventing hip dislocation. Effective postural management helps guide movement patterns, ensuring the maintenance of muscle length and joint mobility. Interventions aiming at maintaining proper alignment of the pelvis and lower extremities for a comfortable seated position, while supporting potential head and trunk weakness to facilitate easier handling, will help in enhancing postural stability, improving functional mobility and preventing secondary musculoskeletal complications [15].

Conclusion:

This study highlights a prevalence of 81.3% hip subluxation in children with CP, with bilateral involvement being most common (73.44%). Subluxation risk was strongly influenced by CP subtype, especially in Spastic CP. To stop the progression to dislocation, early diagnosis through clinical and radiological surveillance is essential. Future research should focus on long-term follow-up and intervention strategies to improve outcomes.

Limitation:

The limitations of this study include its cross-sectional design, which prevents establishing causality or tracking the progression of hip displacement over time. The sample size is limited to children within a specific geographic area, which may reduce the generalizability of the findings.

Future Scope:

Future research could explore a longitudinal design to track the progression of hip displacement in children with CP over time. Expanding the sample size and including diverse populations from different regions would improve the generalizability of the findings.

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Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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