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ORIGINAL ARTICLE

Radiological Evaluation of Hip in Cerebral Palsy: A Randomized Cross-sectional Study

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ABSTRACT

Introduction: The incidence of hip abnormalities in cerebral palsy (CP) patients has been reported as low as 2.6% and as high as 28%. Hip displacement is the second most common deformity after equines. The objective of this study is to evaluate the radiological changes of hip in CP for detecting early features of hip instability.

Materials and methods: A total of 91 hips of 52 patients with CP who attended for rehabilitation management were randomly selected for the study. Hip surveillance was done in those cases where the clinical evaluation alone could not access stability. All the selected cases were evaluated radiologically with respect to acetabular angle, neck-shaft angles, degree of subluxation (migration percentage) and shape of femoral head.

Results: 38 hips showed grade I, 14 hips grade II, 6 hips grade III, and 2 hips grade IV stage of migration percentage. Flattening of femoral head was laterally seen in 16 cases, both medial and lateral flattening was seen in 8 cases of subluxated hip. Acetabular roof angle was increased in cases with grade III and IV migration percentage. Acetabular angle was within 12 to 75° with mean angle of 32°. The mean true neck-shaft angle was 145.5° ranging from 134° to 170°

Conclusion: Early detection of hip instability in Cerebral Palsy helps in timely intervention and that reduces or delays need for reconstructive surgery.

Keywords: Cerebral palsy, Diplegia, Hip, Migration percentage.

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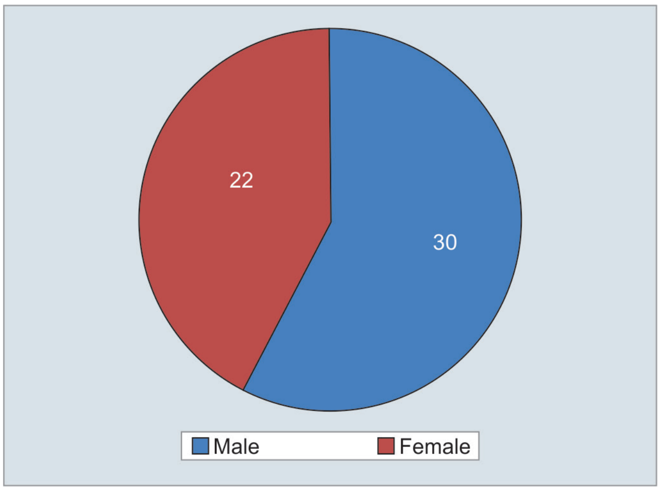
INTRODUCTION

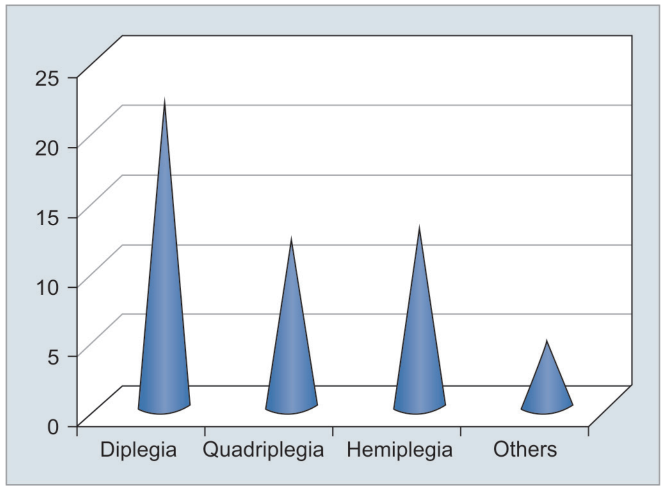
Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitations that are attributed to nonprogressive disturbances occurring in the developing fetal or infant brain. The damage of brain which occurs before, during, or after the delivery influences the musculoskeletal system.[1] Besides the delay in voluntary control, it is the variable spasticity of different agonist and antagonist muscles that cause deformities around different joints. Neuromuscular imbalances and abnormal ambulation change the biomechanical forces on the joints and result in characteristic osseous changes around different joints like hip, knee, and ankle.

The cause of hip displacement in CP is not completely clear, but the hip is usually normal at birth. High hip joint reaction forces and abnormal orientations of force vectors are relevant and place an abnormal force on the acetabulum, which may then begin to deform.[2] The role of spasticity remains unclear, but is probably overestimated, because hip dislocations occur in hypotonic as well as hypertonic conditions. Another factor may be positioning,[3] and many children with severe CP rest in the same position—particularly at night—in side-lying, where one hip remains in adduction. A further influence may be impaired proprioception, which results in inadequate muscle control.[4]

A saucer-shaped deformity develops in the acetabulum, usually in a craniolateral direction,[5] and the femoral head gradually migrates proximally and may also then become deformed. As the femoral head migrates proximally, it may be subjected to increasing forces on the medial side, which result in medial flattening of the head. The lateral side of the head may be subjected to pressure from the hip capsule and abductors, resulting in lateral flattening. The combination of medial and lateral flattening can produce a triangular or dunce cap appearance to the head as seen on an anteroposterior radiograph. Finally, direct force on the head from the reflected head of rectus femoris can produce a groove on the superior part of the head. The end result of the femoral displacement



Graph 1: Male and female ratio of study population



Graph 2: Topographic presentation

Table 1: Classification system

Age group (in years)	*No of patients*	*Gross motor function classification system*				
		I	*II*	*III*	*IV*	*V*
3–5	10	4	5	1	0	0
5–10	23	6	11	4	2	0
10–15	19	2	8	4	5	1

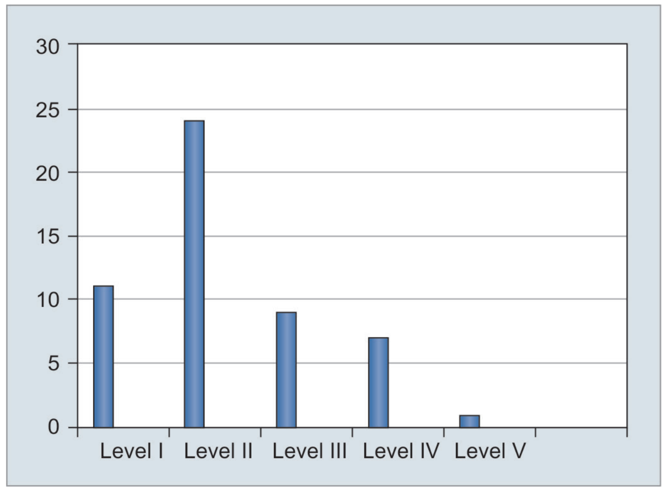
is often loss of articular cartilage and early osteoarthosis. The incidence of hip abnormalities in CP patients has been reported as low as 2.6% by Mathews et al[6] and as high as 28% by Samilson et al.[7] Hip displacement is the second most common deformity after equinus.[8] Recognition and proper treatment of these changes can significantly alter the clinical course of the disease.

The objective of this study is to evaluate the radiological changes of hip in CP for detecting early features of hip instability.

MATERIALS AND METHODS

A total of 91 hips of 52 patients with CP who attended for rehabilitation management were randomly selected for the study from all the CP children who attended the outpatient department of Physical Medicine and Rehabilitation at Swami Vivekanand National Institute of Rehabilitation Training and Research, Olatpur, Cuttack, India, from January 2014 to December 2016. There were 30 males and 22 females (Graph 1). Topographically 12 were quadriplegic, 22 diplegic, 13 hemiplegic, 5 cases are other category (Graph 2). Distribution of children with respect to Gross Motor Function Classification System (GMFCS) scale and age group is presented in Table 1.

A total of 11 patients are ambulatory with GMFCS level I, 24 children in level II, 9 children in level III, 7 children in level IV, 1 boy with severe limitation of mobility with GMFCS level V (Graph 3). Radiological



Graph 3: Gross motor function classification system level

hip surveillance was done in those cases where the clinical evaluation alone could not access stability. Basic recruitment criteria for the study were CP patients with severe spasticity, delayed walking or instability to walk by 30 months, limited abduction, shortening of thigh segments, and difficulty in personal hygiene by the parent or caregiver.

All the patients were subjected for radiological evaluation. Anteroposterior radiograph of pelvis was advised with patient position supine, pelvis horizontal, hip flexed to flattened lumber lordosis and neutralizing anterior pelvic tilt, patella facing upward and limb in neutral abduction limb in 20 to 25 degrees of internal rotation. All the X-rays were evaluated by drawing Shenton line, Hilgenreiner line—a horizontal line drawn across triradiate cartilage, Perkin line—perpendicular drop line from lateral most point of acetabular margin. The following parameters are recorded:

- Acetabular angle
- Neck-shaft angles (femoral neck valgus)

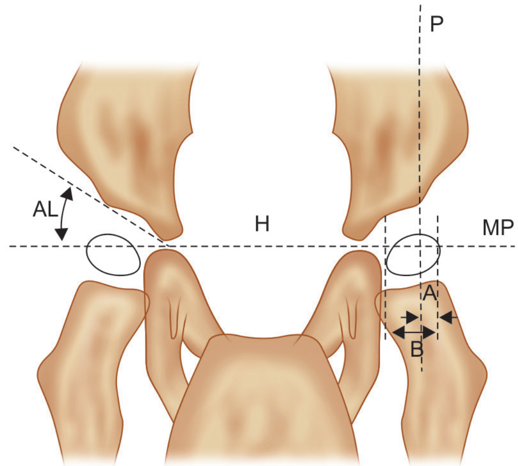


Fig. 1: Radiological parameters (acetabular angle and migration percentage)

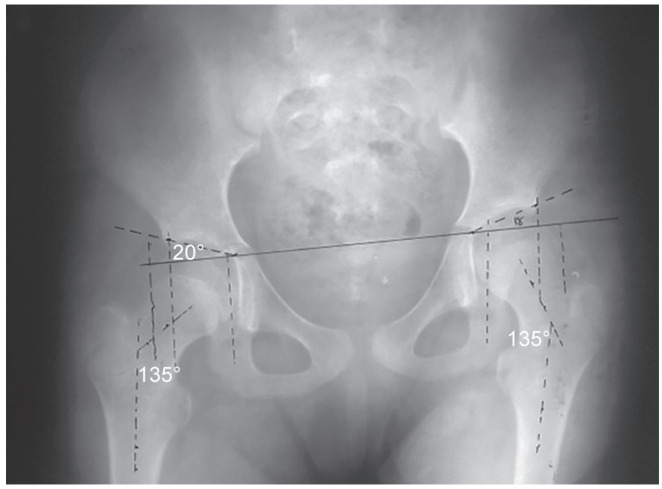
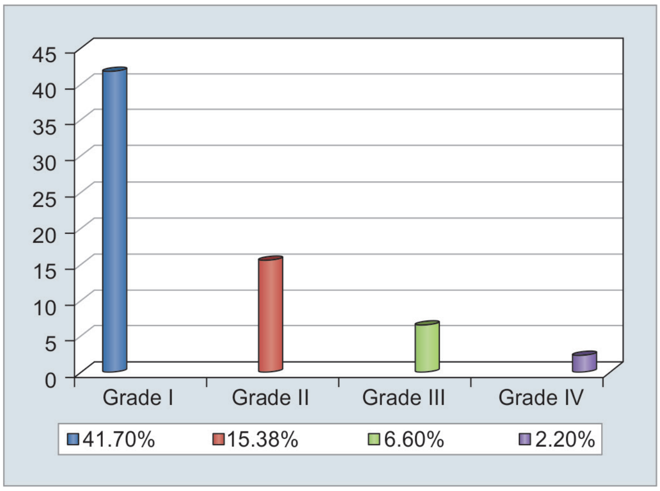


Fig. 2: Radiological evaluation: Neck-shaft angle



Graph 4: Migration percentage in different grades (17.5% of cases had concentric head)

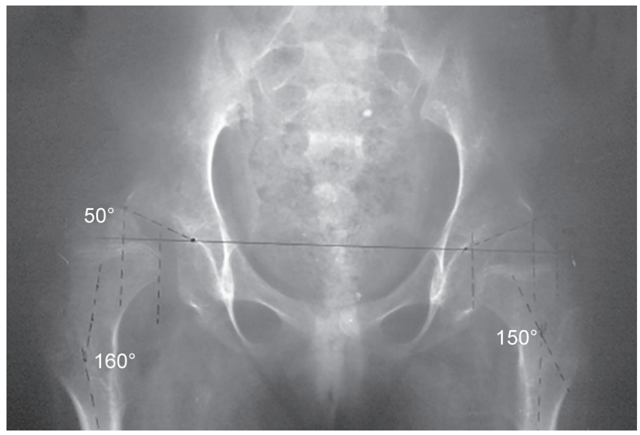


Fig. 3: Radiological evaluation: Acetabular roof angle

- Degree of subluxation (migration percentage)
- Shape of the femoral head

Acetabular angle is measured by angle formed between a line drawn through the roof of the acetabulum and the horizontal Hilgenreiner line (Fig. 1). With the method described by Reimers, the degree of malposition was graded I through IV, with grade I representing up to 33% migration percentage; grade II 33 to 67% migration percentage; grade III 67 to 100% migration percentage; and grade IV more than 100% migration percentage. Neck-shaft angle is measured by drawing axial lines along neck and shaft of femur (Fig. 2).

RESULTS

Concentric head placement was seen in 16 hips, 38 hips showed grade I, 14 hips grade II, 6 hips grade III, and 2 hips grade IV stage of migration percentage (Graph 4 and Fig. 3). Flattening of femoral head was laterally seen in 16 cases, both medial and lateral flattening was seen in 8 cases of subluxated hip. When both portions were flattened, a characteristic triangular deformity of the femoral head occurred. Medial flattening did not occur without subluxation of the femoral head. Acetabular roof angle was increased in cases with grade III and IV migration percentage (Fig. 3). Rest of the hip did not show any features of subluxation or dislocation of head. Acetabular angle was within 12 to 75° with mean angle of 32°. The mean true neck-shaft angle was 145.5° ranging from 134 to 170° (Table 2). Abnormalities including various degrees of superior lateral subluxation, dysplasia of the acetabulum, flattening of femoral head (Fig. 4) and functional increase in the neck-shaft angle were noted in all the CP children with GMFCS levels IV and V.

Table 2: Result

	Range	*Mean*	*SD*
Acetabular angle	12–75°	32°	3.1
Neck-shaft angle	134–170°	145.5°	7

SD: Standard deviation

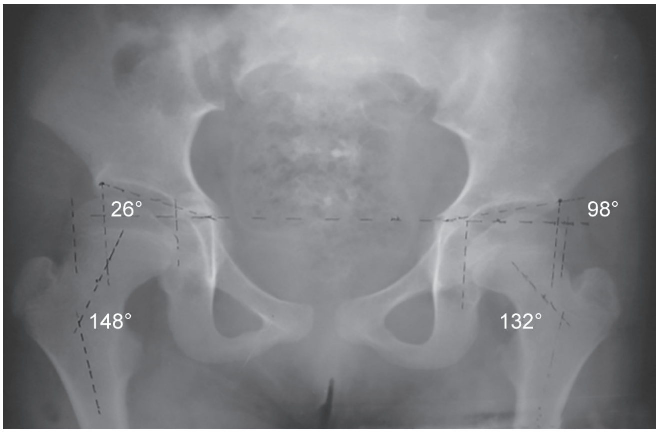


Fig. 4: Radiological evaluation: Flattening femoral head

DISCUSSION

During evaluation of a CP child, hip evaluation is often ignored as it appears silent externally. Since spasticity and deformity are more around knee and ankle, usually more concentration is given toward knee and ankle. Instability of hip is second most common deformity after equinus with prevalence rate of 2.6 to 28%.[9] Incidence increases with severity to an extent that 10 to 60% of spastic quadriplegia progresses to dislocation by 8 years of age.[10] There are two major hip problems in CP children, i.e., hip instability and gait abnormalities. Hip subluxation and dislocation develop in response to the muscle imbalance, due to contracture of hip abductors and flexors. Bony deformities occur later as a response to the spasticity. Approximately 75% of children with severe form of CP suffer from hip dislocations.[8]

Hip subluxation and dislocation develop in response to muscle imbalance, acetabular dysplasia, pelvic obliquity, excessive femoral anteversion, increased femoral neck valgus, lack of weight bearing, and maldirected resultant force vector across hip joint. Instability of hip with subluxation or dislocation leads to pain because of contracture or osteoarthritis of hip in 50% of adults with spastic quadriplegia and 49% of institutionalized adults with CP.[11] Limited range of motion interferes with dressing, perineal care, and diapering due to limited abduction. Sitting balance becomes poor. Pressure sore develops on bony prominences. Prolonged immobility leads to osteoporotic fractures of femur. Radiological evaluation is a cheap and effective method for early detection of hip abnormalities. Serial radiographs in standardized position at 18 months for all bilateral CP and 30 months if the child is still not walking are always advised.[12,13]

The history of the radiological methods for hip instability measurement goes back many years. In 1939, Wiberg proposed measurement of center edge (CE) angle, measured between a line through the center of the femoral head at right angles to the connecting line through the center of both the femoral heads and a line through the center of the femoral head to the acetabular edge. He stated that the CE angle more than 25 degrees was normal down to the age of 18 years and CE angle at least 20 degrees was normal for children between 6 and 14 years. The problem in determining the CE angle is that the edge of the acetabulum might be difficult to define. Perkins in 1928 described the line bearing his name drawn from anterior inferior spine at right angle to the horizontal line drawn between Y-shaped cartilage of the acetabulum. Heyman and Herdon in 1950 defined the acetabulum head index, where the portion of femoral head covered by acetabular roof was divided by the width of the head multiplied by 100. Snyder in 1975 used the percentage of subluxation measured by the proportion of the femoral head lying lateral to the lateral margin of the acetabulum.[14] Migration percentage developed from an idea suggested by Rang in 1975.

Based on these radiological parameters, different authors designed preventive strategies by setting up protocols of rehabilitation surgery for the management of hip instability in CP.[15,16] Shore et al[17] used migration percentage as a chief parameter for planning and follow-up surgery for hip instability. Robin et al[18] used radiological parameters to classify the hip in CP into six grades for strategic planning of hip instability.

CONCLUSION

Based on the findings of clinical and radiological evaluation, it can be presumed that the displacement of hip in patients with CP can be explained mainly by abnormal shape of proximal femur as a result of delayed walking, limited walking, or inability to walk. Evaluation of hip in CP should not be ignored to avoid complications like subluxation or dislocation of hip, which are very much resistant to conventional treatment. Reconstructive rehabilitation surgeries for hip instability is associated with grievous complications like high recurrence rate, infection, pathological fracture pressure sore, avascular necrosis, etc.[19] Radiological surveillance is essential when clinical examination alone cannot assess stability. Early detection allows for early intervention that reduces or delays need for reconstructive surgery, eliminates head salvage surgery, and early preventive strategies.[13] Hence, early detection of hip complications in CP facilitates rehabilitation process and improves quality of life.

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