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The role of radiography and magnetic resonance imaging in diagnosis of slipped capital femoral epiphysis in children and adolescences

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Background Slipped capital femoral epiphysis remains a diagnostic problem despite numerous papers written on the subject. Radiographic imaging is important in the confirmation of the diagnosis. **Purpose** Explore changes in the proximal femur at early clinical manifestations of slipped capital femoral epiphysis (SCFE) to further study patterns and localisation of pathological process. **Material and methods** The imaging findings from the conventional radiological and magnetic resonance examinations are presented, patterns of displacements and structural abnormalities in the proximal femur described. **Results** MRI is the most informative imaging modality for detecting SCFE at early stages. **Conclusion** In our opinion MRI can be used to detect and predict a slip of the femoral head.

Keywords: slipped capital femoral epiphysis, hip joint, neck-to-shaft angle, radiography, magnetic resonance imaging

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) has been reported in association with endocrine disturbance and quantitative imbalance between growth hormones and sex hormones having an established role in epiphyseal cartilage functioning [1]. The reason for the weakened growth plate has been attributed to alterations in the hormonal balance with a combination of growth hormone excess and sex hormone deficiency [2]. The causal factors lead to the displacement of the capital femoral physis from the metaphysis [3].

It is important to recognise SCFE at early presentation but diagnosis of SCFE is often delayed because the symptoms are usually vague, often not located at the hip level and may not even involve pain. Sometimes SCFE patients experience pain in the groin, thigh or the knee area referred from the hip joint. Standard radiography is the primary imaging modality for evaluating SCFE and magnetic resonance imaging (MRI) can be a useful adjunct to radiographs in detecting early physeal changes [4, 5]. Awareness of these diagnostic possibilities and knowledge of subtle and early radiographic findings allows prompt diagnosis and treatment of SCFE. Our goal was to explore changes in the proximal femur at early clinical manifestations of SCFE to further study character and localisation of pathological process.

MATERAL AND METHODS

We report our study of structural and functional bone condition of the proximal femur in 32 patients (34 joints) with SCFE having different degrees of slippage (Table 1) performed at the department of adolescent orthopaedics of the Uzbekistan Republican Centre for Trauma and Orthopaedics. Left side, right side and bilateral involvement of the hip joint were diagnosed in 17, 13 and 2 adolescents, correspondingly. Patients were seen in a range of 2 weeks to 9 months from onset of the disease. LCPD was diagnosed in two cases, another two patients had periarthritis of the hip joint and one patient was diagnosed with arthritis of the knee at preadmission stage.

Table 1

Distribution of SCFE patients depending on degree of the slip and onset of the disease

Onset of the disease	Stage I	Stage II	Stage III	Total number of joints
Up to 1 month	6	3	1	10
Up to 3 months	3	5	3	11
Up to 6 months	1	4	5	10
Over 6 months	1	1	1	3
Total	11	13	10	34

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Radiological evaluation of the hip joint was produced for all patients using X-ray TUR-D-800 device. Anteroposterior and axial views were obtained. Radiographs of the contralateral side was included to rule out the bilateral involvement of SCFE. Posterior displacement of the femoral head was determined by measuring neck-to-epiphysis and antetorsion angles. Inferior displacement of the femoral head was determined by measuring neck-to-shaft angle (**Fig. 1**).

MRI of pelvic was produced to identify specific pathological changes in the proximal femur using Siemens Magnetom Aera 1.5T MRI system. Three-dimensional configuration was evuated comparing MRI images and conventional radiographs.

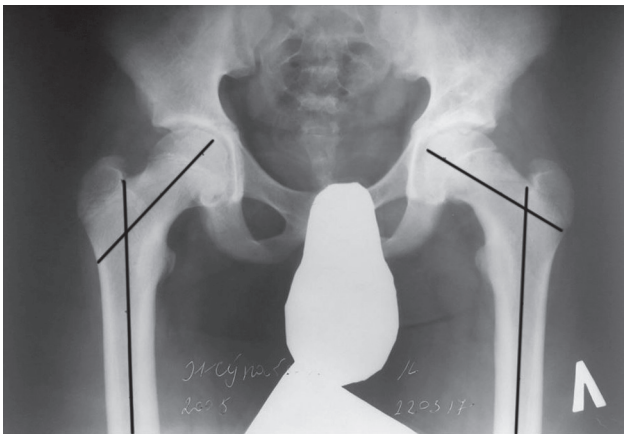

Fig. 1 Measurement of neck-to-shaft angle using survey radiograph

RESULTS AND DISCUSSION

Specific radiological features of displaced femoral head we identified included decreased neck-to-epiphysis angle to retroversion in Lauenstein view (**Fig. 2**), decreased neck-to-shaft angle (femoral neck inclination), decreased height of epiphysis, its crescent shape seen on AP view, flattened superior edge of the neck and head contour with the curve disappearing from head to neck. The line drawn along the superior edge of the neck did not cross the head, the decrease in trochantero-articular distance observed in comparison with intact side and clear superposition of greater and lesser trochanter seen on AP view. Epiphyseal displacement was measured with the capital distance along epiphyseal line.

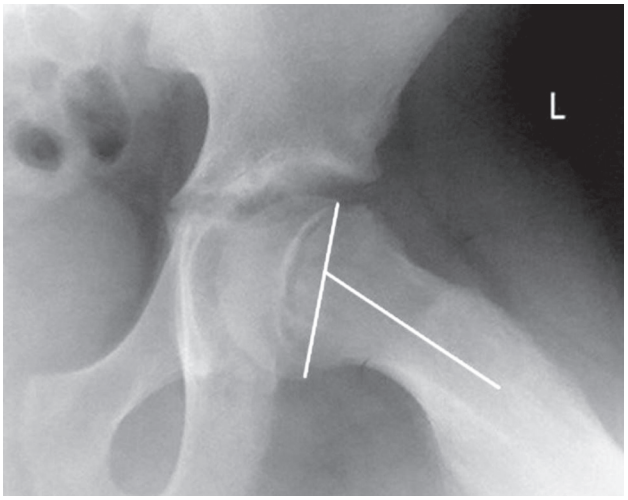

Fig. 2 Measurement of neck-to-epiphysis angle using Lauenstein view

Radiological measurements of the hip joint in SCFE are presented in Table 2.

In our series, neck-to-shaft angle measured 139.75° ± 1.61 in the involved side, 135° ± 2.47 in nominally healthy side that exceeded normal values by 7° and 11°, correspondingly, while the normal neck-to-shaft angle measures 128° ± 4.80 as reported by Kh.Z.Gafarov [6]. Angle of antetorsion measured 17.90° ± 1.70 in the involved side and 18.75° ± 1.68 in nominally healthy side while normal antetorsion is 12° ± 3.18 as reported by Kh.Z. Gafarov [6]. Antetorsion exceeded normal value by 6 % in SCFE. Neck-to-epiphysis angle was shown to increase with proximal and posterior displacement of the proximal femur.

We used the established classification in our series [7]. We subdivided the measurements into three groups: group I, neck-to-shaft angle decreased up to 30°, group II, from 31 to 50° and group III, more than 51°. Our findings are on par with the results reported by several authors [1, 2, 8, 9].

Diagnostically essential information was obtained with MRI examination of the hip joints with SCFE (**Fig. 3**). In addition to a slip all the patients showed signs of structural deviations in the epiphyseal and paraepiphyseal areas of the proximal femur on the involved side including enhanced bone transparency in the lower triangle of the femoral neck, thin

Table 2

Comparative radiological measurements of the normal and pathological hip joint

Degree of involvement	Neck-to-shaft angle	Antetorsion	Neck-to-epiphysis angle
Involved joint	139.75° ± 1.6	18.75° ± 1.68	50.67° ± 5.12
Nominally healthy joint	135° ± 2.47	17.90° ± 1.70	10.2° ± 1.85
Normal age related measurement	128° ± 4.80	12° ± 3.18	0–5°

cortical bone in the proximal femur, widening and twisting epiphyseal line, crescentic defect in the posterio-inferior portion of paraepiphysis and greater accentuation at the cortical edges.

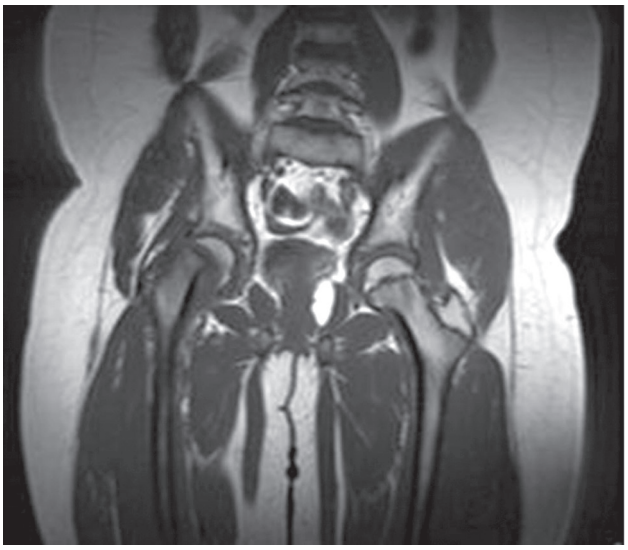

Fig. 3 MRI scan of pelvis of a 12-year-old male patient K., coronal view

Crescentic defect was observed in the posterio-inferior portion of paraepiphysis of the proximal femur on axial view [8]. The head was visualised as tilting distally and posteriorly at the area under static and dynamic load (**Fig. 4**). Capital location at a critical angle of more than 30–40° was considered as a launching mechanism for listhesis. Our findings are on par with the results reported by other authors [7, 10, 11].

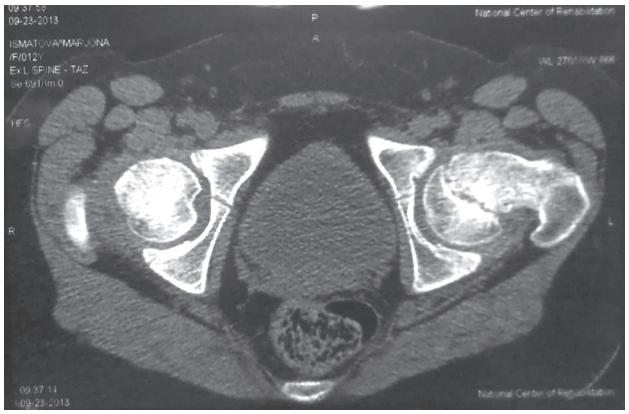

Fig. 4 MRI scan of pelvis of a 12-year-old female patient I., sagittal view

Therefore, MRI is well known for its ability to display soft tissue contrast and can be highly informative with regard to the detection of slipped capital femoral epiphysis at early stages. However, classical radiographic imaging is still an important tool for practicing orthopaedic surgeons.

CONCLUSION

Our findings showed the importance of MRI in detection of a character and location of pathological process, identification of structural changes in the proximal femur in SCFE for accurate diagnosis and prognosis of the pathological condition.

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