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THE S SIGN: A NEW RADIOGRAPHIC TOOL TO AID IN THE DIAGNOSIS OF SLIPPED CAPITAL FEMORAL EPIPHYSIS

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□ **Abstract—Background: Children with slipped capital femoral epiphysis (SCFE) are often seen by an array of medical professionals prior to diagnosis. Patients with mild slips, slips with knee pain, or bilateral slips can occasionally present a diagnostic challenge that increases the risk of a delay in diagnosis and associated complications. Objectives: This study introduces a new radiographic parameter, which we refer to as the S-sign, and analyzes its diagnostic utility on a frog-leg lateral radiograph. Methods: Twenty observers reviewed the radiographs from 35 patients with SCFE using Klein's line on anteroposterior pelvis radiographs and the S-sign on frog-leg lateral radiographs to diagnose an SCFE. Analysis included diagnostic outcomes and intraobserver and interobserver reliability. Results: The S-sign was more accurate at identifying an SCFE compared with Klein's line (92.4% vs. 79.2%, respectively). Sensitivity and specificity was greater for the S-sign compared with Klein's line (89.0% and 95.2% vs. 68.3% and 89.0%, respectively). A combination of the S-sign and Klein's line yielded a sensitivity of 96.5% and a specificity of 85.0%. The combination of tests was more diagnostic for an SCFE, compared with using the Klein's line, which was statistically significant ($p < 0.001$). Conclusions: With increased awareness of the S-sign and a usage of the combined test, clinicians can more reliably and accurately diagnose an SCFE. Clinicians are more likely to diagnose an SCFE using the combined test, compared with solely relying on Klein's line, which we found to be statistically significant.** © 2018 Elsevier Inc. All rights reserved.

□ **Keywords—slipped capital femoral epiphysis; SCFE; pediatric hip; Klein's line; Southwick head shaft angle**

INTRODUCTION

Children and adolescents with slipped capital femoral epiphysis (SCFE) occasionally present a diagnostic challenge to the evaluating physician. It is not infrequent that more than one provider may evaluate the child with an SCFE prior to arriving at an accurate diagnosis (1). A mild to moderate stable slip, a slip without hip or groin pain, and bilateral slips at presentation are all risk factors that can increase the risk of a delay in diagnosis (2–4). Consequences of a delay in diagnosis include an increased risk of adverse outcomes such as slip progression, hip impingement, avascular necrosis, and chondrolysis (3).

The standard assessment for diagnosing an SCFE includes clinical examination and both anteroposterior (AP) and frog-leg lateral pelvis radiographs (4). Several radiographic parameters have been described to aid in the diagnosis of an SCFE, including Klein's line, the modified Klein's line, the Southwick head shaft angle (SHSA), the Wilson percent epiphyseal displacement, and the metaphyseal blanch sign (4–7). Usually,

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minimal capital physis displacement is appreciated on AP pelvis radiographs, whereas frog-leg lateral pelvis radiographs are likely to show displacement (1).

Klein et al., in their original article, depicted a line drawn along the superior aspect of the femoral neck on an AP pelvis radiograph (5). Klein's line is abnormal when the line passes lateral to the epiphysis of the proximal femur. In a normal hip, this line will pass through the lateral aspect of the epiphysis of the proximal femur (Figure 1). The diagnostic utility of Klein's line has been scrutinized, and mild slips may still be missed (5). In comparison with the Klein's line, the modified Klein's line is a more sensitive test when employed on AP pelvis radiographs (4). The SHSA and Wilson percentage epiphyseal displacement have been credited with quantifying the amount of displacement, both of which are measured on frog-leg lateral pelvis radiographs (4). The SHSA has been heralded as the most sensitive measurement when diagnosing an SCFE, yet, in our experience, is infrequently utilized due to the cumbersome nature of calculating the angle as well as a lack of familiarity by primary care and emergency clinicians (8). Some authors have questioned the accuracy and reproducibility of the SHSA and Wilson percentage epiphyseal displacement, because a measurement difference in several degrees of head shaft angle or several percentage points for displacement could greatly affect the treatment and long-term prognosis for an SCFE patient (4).

This study introduces a new radiographic parameter, which we refer to as the S-sign, and analyzes its diagnostic utility on a frog-leg lateral pelvis radiograph. The S-sign is a curvilinear line drawn on the inferior margin of the proximal femoral head neck junction along the proximal femoral physis. The S-sign is created on frog-leg lateral pelvis radiographs by drawing a line that hugs the posterior-inferior cortical bone of the proximal femoral head neck junction starting at the level of the lesser trochanter, continuing the line along the femoral neck cortex passing the physis, and wrapping back around to the midpoint of the femoral head. Any broken continuity, asymmetry, or sharp turns of the S-sign was recorded as an abnormal test indicative of SCFE (Figure 2). We hypothesize that by combining the use of Klein's line on AP pelvis radiographs with the S-sign on frog-leg lateral pelvis radiographs, clinicians will be more likely to accurately diagnose an SCFE compared with solely relying on Klein's line.

MATERIALS AND METHODS

Approval was obtained, prior to embarking on this study, by our institutional review board. We retrospectively

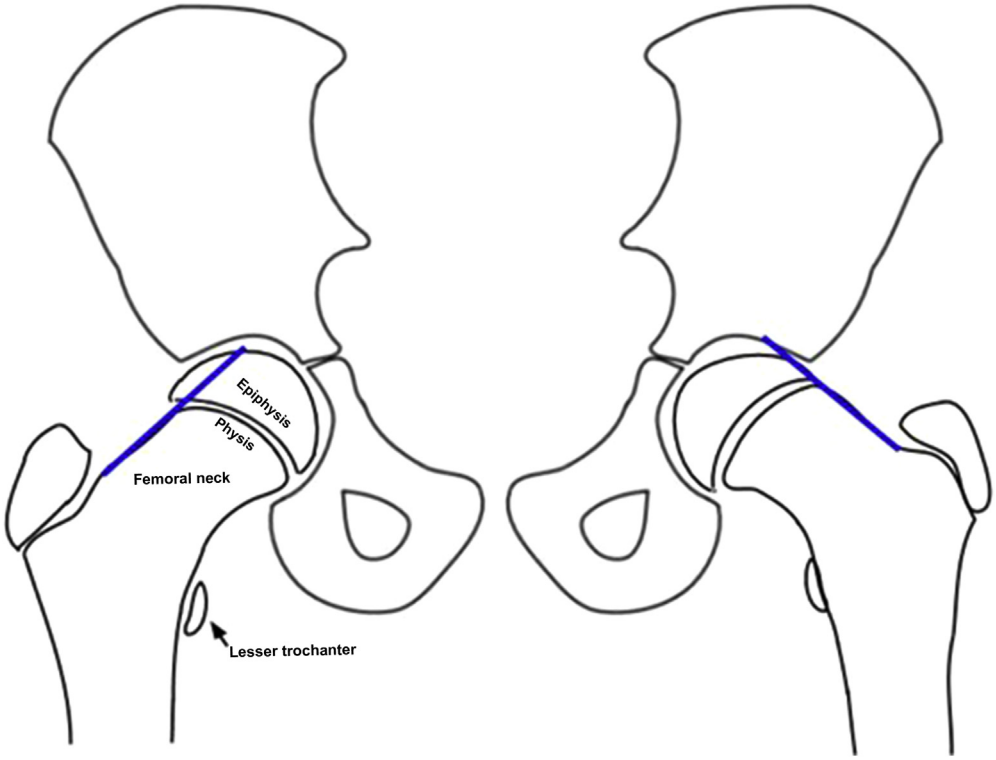

Figure 1. Anteroposterior pelvis graphic showing the cortical outlines of the pelvis and proximal femur. The Klein's line is normal on the right hip and abnormal on the left hip. A normal Klein's line will pass through the lateral proximal femoral epiphysis. An abnormal Klein's line will pass lateral to the proximal femoral epiphysis indicating a slipped capital femoral epiphysis.

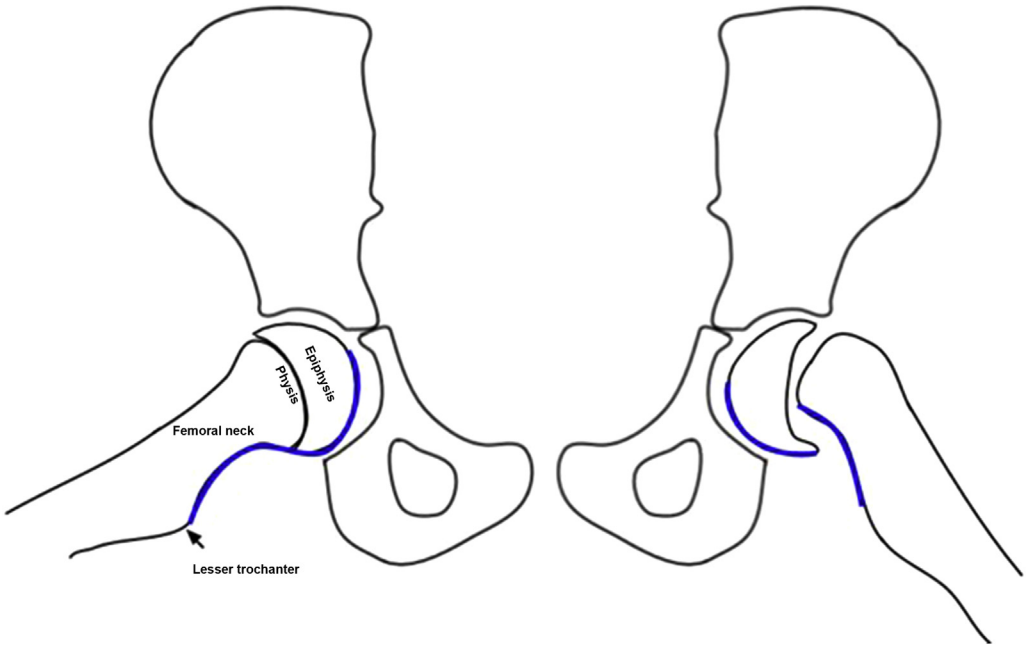

Figure 2. Frog-leg lateral pelvis graphic showing the cortical outlines of the pelvis and proximal femur. The S-sign is normal on the right hip and abnormal on the left hip with broken continuity. A normal S-sign will be symmetrical, without sharp turns, or broken continuity. An abnormal S-sign could be asymmetrical, have a sharp turn, or broken continuity.

reviewed the medical records and radiographs of patients who had undergone in-situ screw fixation for SCFE between 2005 and 2012; 66 hips with an SCFE were identified in 62 children.

Synapse (Fujifilm Medical Systems U.S.A., Inc., Stamford, CT) and Echoes (Medstrat, Inc., Downers Grove, IL) picture archiving and communication systems (PACS) were accessed to view radiographs. Patients were included if there was a preoperative AP pelvis and frog-leg lateral pelvis radiograph with no prior implants and of diagnostic quality. The radiographs were made in a standard manner, with the pelvis maintained flat on the table and the x-ray tube centered exactly in the midline between the hips. For the AP pelvis radiographs, the hips were maintained as close to neutral position as possible, with the patellae pointing straight up. For the frog-leg lateral pelvis radiographs, the hips were placed in maximum abduction and external rotation, with the knees flexed and the plantar surfaces of the feet facing each other while their lateral surfaces were resting on the table (6). Patients were included irrespective of the degree of slippage or chronicity of the slip. Patients were excluded from the study if the radiographs were incomplete, of poor quality, or orthopedic implants were present. Incomplete radiographs included single lateral hip radiograph, no AP pelvis radiograph, or no preoperative radiographs available. Six patients with normal AP and frog-leg lateral pelvis radiographs were included as controls. Thirty-two hips with an SCFE (29 patients) met inclusion criteria. Thirty-four hips with an SCFE (27 patients) were excluded: 13 SCFE (10 patients) did not have frog-leg lateral pelvis radiographs, one SCFE (1 patient) did not have an AP pelvis radiograph, six SCFE (4 patients) were felt to have had a preslip, 13 SCFE (11 patients) had poor-quality radiographs, and one SCFE (1 patient) had pelvic implants in place.

To grade the degree of the slipped epiphysis, the SHSA was measured on each hip using the frog-leg lateral pelvis radiographs (6). Using the SHSA, the slipped epiphyses were categorized as: mild (<30°), moderate (31–50°), and severe (>51°) (9). The SHSA was calculated using the angle measurement tool supplied with the PACS software. Twelve degrees was used as the control hip for a contralateral SCFE, and a $\geq$ 13° head shaft angle was considered a diagnosis of an SCFE (10,11). A head shaft angle under 13° was categorized as a preslip (11).

De-identified AP and frog-leg lateral pelvis radiographs were randomly arranged for the 32 hips with an SCFE (29 patients). Slip categories included 11 mild (10 patients), 15 moderate (14 patients), six severe (5 patients), and six normal control radiographs. Thirty-four percent of the hips were categorized as mild, 47% were categorized as moderate, and 19% were categorized as severe. Thirty-eight normal hips were present in the reviewed radiographs: 12 hips from the control patients and 26 contralateral hips on patients with unilateral SCFE.

For reviewed radiographs, the average SHSA was 33.5° (range of 8–77°), with a standard deviation of 20.4°. The 6 control patients were not included in the SHSA data analysis. The average age of the patients whose radiographs were reviewed was 11.7 years, with a standard deviation of 18.4 months. Sixteen male patients and 19 female patients were included in the review. The temporal classification for reviewed radiographs included seven acute, two acute on chronic, and 20 chronic slips (12). Outcomes were not differentiated based on temporal classification.

Twenty observers reviewed each of the radiographs in random order on two separate occasions at least 1 week apart. The observers were instructed on how to draw the S-sign on the frog-leg lateral pelvis radiograph and Klein's line on the AP pelvis radiograph.

Observers included a fellowship-trained pediatric orthopedic surgeon (n = 1), a fellowship-trained trauma orthopedic surgeon (n = 1), a fellowship-trained pediatric sports medicine primary care physician (n = 1), a pediatric fellowship-trained radiologist (n = 1), a musculoskeletal fellowship-trained radiologist (n = 1), primary care pediatric physicians (n = 2), orthopedic surgery resident physicians (n = 3), and pediatric resident physicians (n = 10). When analyzing the data, observers were categorized by attending radiologists (n = 2), attending orthopedic surgeons (n = 2), orthopedic surgery residents (n = 3), pediatric residents (n = 10), and attending pediatricians (n = 3).

Statistical analysis of the results included intraobserver and interobserver reliability using Cohen's kappa coefficient. The kappa values were evaluated according to Landis and Koch, who describe the relative strength of agreement with kappa ranges <0.00 as poor, 0.00 to 0.20 as slight, 0.21 to 0.40 as fair, 0.41 to 0.60 as moderate, 0.61 to 0.80 as substantial, and 0.81 to 1.00 as almost perfect (13). Accuracy, sensitivity, specificity, positive predictive value, and negative predictive value were reported for both radiographic parameters. Sensitivity was also reported for mild, moderate, and severe SCFE. Outcomes from Klein's line and the S-sign were combined as a parallel test in which an abnormal diagnosis was recorded if either test is abnormal, and a normal diagnosis if both tests are normal. The formula to calculate the combined test was: $\text{sensitivity}_{\text{combined}} = \text{sensitivity}_{\text{S-sign}} + \text{sensitivity}_{\text{Klein's line}} - [(\text{sensitivity}_{\text{S-sign}} \times \text{sensitivity}_{\text{Klein's line}})]$ and $\text{specificity}_{\text{combined}} = \text{specificity}_{\text{S-sign}} \times \text{specificity}_{\text{Klein's line}}$ (14).

Statistical significance was calculated by constructing receiver operating characteristic curves for sensitivity and specificity and analyzing the area under the curve (AUC) for the S-sign, Klein's line, and a combination of the parameters. AUC values were calculated for each different category of observer. A Bonferroni adjustment was used due to the number of statistical comparisons made for each category of observer. Overall study alpha of 0.05 was adjusted for the 20 comparisons; this resulted in an alpha of $p < 0.0025$ needed to declare significance.

RESULTS

The S-sign was able to identify an SCFE with an accuracy of 92.4%. The accuracy for Klein's line was 79.2%. The S-sign yielded a sensitivity of 89.0%, specificity of 95.2%, negative predictive value of 91.4%, and a positive predictive value of 94.6%. The Klein's line yielded a sensitivity of 68.3%, specificity of 89.0%, negative predictive value of 77.6%, and a positive predictive value of 86.9%. The sensitivity of the S-sign for mild, moderate, and severe SCFE were 70.2%, 98.6%, and 99.6% respectively. The sensitivity of the Klein's line for mild, moderate, and severe SCFE were 37.8%, 80.4%, and 93.9% respectively. A combination of the S-sign and Klein's line yielded an overall sensitivity of 96.5% (mild SCFE - 81.4%, moderate SCFE - 99.7%, severe SCFE - 100%) and a specificity of 85.0%.

The mean Cohen's kappa coefficient for intraobserver reliability for the S-sign was 0.881, showing almost perfect agreement (median 0.911, range 0.608–1); and for the Klein's line was 0.718, showing substantial agreement (median 0.748, range 0.487–1). Among the 20 intraobserver evaluations, 75% of the time the S-sign had an almost perfect agreement kappa vs. 30% of the time for the Klein's line. Observers had better individual agreement using the S-sign 80% of the time compared with 15% of the time using the Klein's line, with one observer having identical responses. The mean Cohen's kappa for inter-observer reliability for the S-sign was 0.820, showing almost perfect agreement; and for the Klein's line was 0.565, showing moderate agreement. The Cohen's kappa for interobserver reliability for the first set of observations was 0.815 for the S-sign and 0.547 for the Klein's line, and for the second set of observations, the Cohen's kappa was 0.825 for the S-sign and 0.582 for the Klein's line.

Statistical significance was identified when comparing the AUC of the combined tests with Klein's line using receiver operating characteristic curves. When comparing the AUC of the combined tests with Klein's line, the combined tests were more diagnostic for an SCFE for all categories of observers, which was statistically significant ($p < 0.001$). The AUC for the combined test when diagnosing an SCFE ranged from 0.844 for pediatric residents to 0.975 for attending orthopedic surgeons, compared with a range for Klein's line of 0.743 for pediatric residents to 0.860 for attending radiologist. Refer to Table 1 for a complete listing of AUC values.

Table 1. Observer Diagnostic Results

Observer Type	Area Under the Curve		*p* Value
	Klein's Line	Combined Test	
Attending radiologist (n = 2)	0.860	0.954	<0.001
Attending orthopedic surgeons (n = 2)	0.807	0.919	<0.001
Orthopedic surgery residents (n = 3)	0.822	0.975	<0.001
Pediatric residents (n = 10)	0.743	0.844	<0.001
Attending pediatricians (n = 3)	0.802	0.919	<0.001

DISCUSSION

SCFE is a common hip disorder in adolescents, with several known risk factors. A population study from 2013 showed that 6.6% of young adults have radiographic findings consistent with a prior SCFE, much greater than prior data reporting the incidence of SCFE from 4 to 80 per 100,000 (10).

Patients frequently present on a delayed basis, having been seen by several clinicians or facilities prior to an SCFE diagnosis being made. This delay in diagnosis was found to be 2.5 months, with 52% incidence of apparent missed diagnosis by the primary care system in 2005. These data advocated for increased orthopedic education for primary care providers (1). We believe this education is best done by offering easy-to-apply radiographic parameters such as the Klein's line on the AP pelvis and S-sign on the frog-leg lateral pelvis radiographs. Specifically looking at our results for primary care providers, we showed that attending pediatricians and pediatric residents, when combining Klein's line with the S-sign, are more likely to diagnose an SCFE, compared with only using Klein's line, which was statistically significant ($p < 0.001$).

The purpose of the S-sign is to aid clinicians when diagnosing an SCFE. Keen clinicians will, at times, order radiographs of the hip, even in absence of hip pain, when suspicion is high. The S-sign can help guide clinicians when viewing radiographs and more reliably diagnose an SCFE, especially when specialists such as pediatric radiologists or pediatric orthopedic surgeons are not always readily available in the community. Our experience has included children being referred to our center for a limp or hip pain with radiographs obtained from an outside institute. When viewing the outside radiographs and utilizing a combination of Klein's line and the S-sign, we have successfully diagnosed an SCFE, yet the corresponding Radiologist report is negative for pathology. Unfortunately, repeat radiographs have shown slip progression. Rahme et al., in 2006, similarly described slip progression when there was a delay in diagnosis, with the commonest pitfall being pain located to the knee or distal thigh, as well as mild slips being missed by inexperienced surgeons and radiologists (2). Our results show that attending radiologists, attending orthopedic surgeons, and orthopedic surgery residents, when combining Klein's line and the S-sign, are more likely to diagnose an SCFE, compared with using only Klein's line, which was statistically significant ($p < 0.001$).

Klein's line has a reported range of sensitivity from 39% to 68% (5–8). In our cohort, the sensitivity of Klein's line for the diagnosis of SCFE was 68.3%, similar to results from Klein et al. (5). In 2009, Green et al. described a modification of Klein's line in which a clinician should consider a diagnosis of SCFE if the epiphyseal width lateral to Klein's line differs by 2 mm or more between hips (4). The modified Klein's line is created on AP pelvis radiographs, with the maximum width of epiphyseal bone lateral to a line drawn from the superior outline of the femoral neck extending across the femoral neck, as described by Klein, being measured (4). Green reported a sensitivity of Klein's line and modified Klein's line as 40.3% and 79.0%, respectively. The overall sensitivity of the combined test in our study was better at 96.5%. Green et al. suggested that the modified Klein's line may provide an important complement to the gold standard of a strong clinical suspicion and lateral radiographic measurements in SCFE diagnosis (4). We agree with Green et al. in using a combination of parameters on both the AP and frog-leg lateral pelvis radiographs, and have shown that clinicians are more successful at diagnosing an SCFE when a combination of Klein's line and the S-sign is used. We speculate that by combining the usage of the modified Klein's line and the S-sign, there will be an increase in the sensitivity of diagnosing an SCFE, but further work is needed to confirm this.

The intraobserver and interobserver reliability analysis shows correlation to the work from Green et al., who found a median Cohen's kappa coefficient of 0.7 for the SHSA and 0.65 for the Wilson Class, which is characterized as substantial agreement for categorical data (4). We found almost perfect agreement for both intraobserver reliability and interobserver reliability for the S-sign with the mean Cohen's kappa coefficient of 0.881 and 0.820, respectively. For Klein's line, we found the mean Cohen's kappa coefficient of 0.718 for intraobserver reliability showing substantial agreement and 0.565 for interobserver reliability showing moderate agreement. Observers in our cohort were, on average, more consistent using the S-sign compared with Klein's line. Between observers, there was greater concordance using the S-sign compared with Klein's line, and this was maintained for two observations. Our work showed the S-sign is more consistent and had a greater

Figure 3. Frog-leg lateral pelvis radiograph of a 12-year, 2-month-old male patient with an acute left slipped capital femoral epiphysis (SCFE). The sensitivity of the S-sign for this frog-leg lateral pelvis radiographs was 10%.

concordance compared with Klein's line, the SHSA, and Wilson Class. Additionally, previous work has found the SHSA to have a reported range of measurement error from ± 5° to 12° (4). We believe these results highlight the potentially inaccurate and unreliable nature of calculating the SHSA. Even though the SHSA may have a greater reported sensitivity for diagnosing an SCFE, this radiographic parameter is not without flaw. Additionally, to our knowledge there has been no work comparing how successful clinicians are at diagnosing an SCFE with and without using the various radiographic parameters.

One difference in our study that may complicate direct comparison with published literature analyzing Klein's line is the proportion of mild, moderate, and severe slips. Our cohort of patients included 34% mild SCFE, 47% moderate SCFE, and 19% severe SCFE. Green et al. found a greater proportion of mild SCFE (78%), and

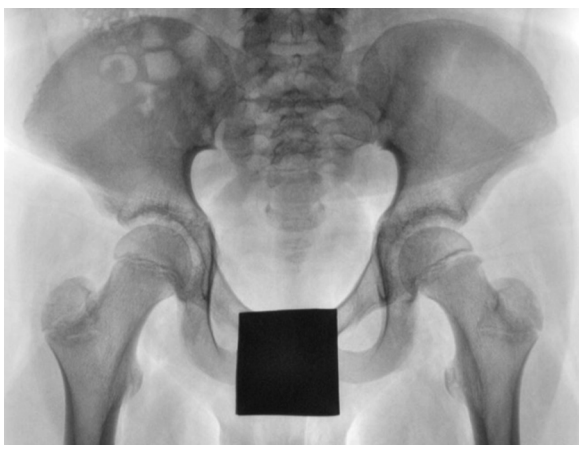

Figure 4. Anteroposterior (AP) pelvis radiograph of the patient in Figure 3 with an acute left slipped capital femoral epiphysis. The sensitivity of Klein's line for this AP pelvis radiographs was 90%. Southwick head shaft angle 19°.

Figure 5. Frog-leg lateral pelvis radiograph of a 9-year, 5-month-old female patient with an acute right slipped capital femoral epiphysis. Southwick head shaft angle 8°.

fewer moderate and severe SCFE (19% and 3%, respectively) (7). The proportion of slip severity found by other authors has varied, with Pinkowsky and Hennrikus finding 34.8% mild slips, 43.5% moderate slips, and 21.7% severe slips; Boyer with mild slips at 43.6%, moderate slips at 21.4%, and severe slips at 35.0%; and Rahme et al. with mild slips at 55.9%, moderate slips at 27.5%, and severe slips at 16.7% (2,8,9).

We believe the greater diagnostic utility of the S-sign compared with Klein's line is attributed to the majority of SCFE deformity being posterior epiphyseal displacement and then sometimes medial epiphyseal displacement (15). The common posterior epiphyseal displacement is best characterized on frog-leg lateral pelvis radiographs, as this radiograph is perpendicular to the plane of the deformity. As described by Rab, there is, at times, medial displacement of the epiphysis, which is best visualized on an AP pelvis radiograph, perpendicular to the plane of the deformity (15). An example of a child with a mild medially displaced SCFE is shown in Figures 3 and 4.

Figure 6. Frog-leg lateral pelvis radiograph of the patient in Figure 5 with an acute right slipped capital femoral epiphysis (SCFE) illustrating an abnormal S-sign (broken continuity) for an SCFE on the right hip and normal on the left hip.

Figure 7. Frog-leg lateral pelvis radiograph of a 12-year, 5-month-old male patient with a chronic left slipped capital femoral epiphysis. Southwick head shaft angle 31°.

The sensitivity of the S-sign for this patient was 10%, compared with a 90% sensitivity for Klein's line. We believe it is best to obtain orthogonal radiographs when evaluating a patient for an SCFE.

Limitations

A weakness of the S-sign as a radiographic parameter is related to the ability to diagnose a mild SCFE. The S-sign and combined test had a >90% sensitivity on moderate and severe slips, whereas Klein's line and modified Klein's line have been found to have a >90% sensitivity only for severe slips (8). A decline in the sensitivity of the various radiographic parameters for mild SCFE may be attributed to the subtle nature of the slip (3). To diagnose mild slips, one must rely on clinical examination as well as radiographic parameters. At times the combined test may prove not to be diagnostic in light of a strong clinical suspicion. In this situation, we recommend the SHSA to be measured, or advanced imaging should be pursued to most accurately make the correct diagnosis.

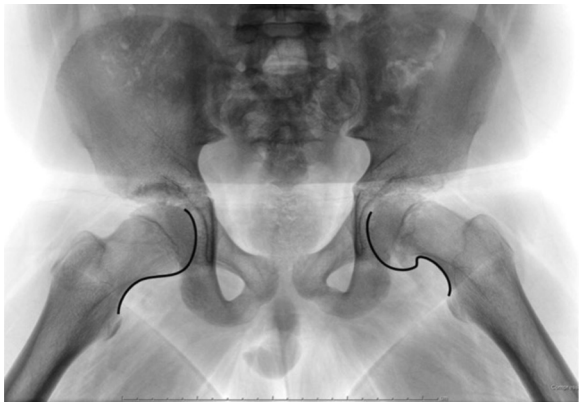

Figure 8. Frog-leg lateral pelvis radiograph from the patient in Figure 7 with a chronic left slipped capital femoral epiphysis (SCFE) illustrating a normal S-sign for an SCFE on the right, compared with an abnormal S-sign (asymmetrical and sharp turn) for the left hip.

The S-sign performance can be affected by the SCFE temporal classification. Chronic SCFE shows remodeling potential and callus formation on the posteromedial neck (16). Seventy-six percent of the patients in our reviewed cohort included chronic or acute-on-chronic slips per the temporal classification. Other authors have found cohorts of up to 91% of SCFE presenting as chronic in nature (17). Comparable literature from Green et al. and Pinkowsky and Hennrikus did not record temporal classification data (4,8). We believe the temporal classification can be appreciated when using the various radiographic parameters, but the radiographic parameters are intended to be used for all temporal classes. We did observe that broken continuity is more commonly encountered for an acute slip, whereas chronic slips more commonly had an asymmetric or sharp turn when the S-sign was used, which we have demonstrated in Figures 5–8.

CONCLUSIONS

With increased awareness of the S-sign and a usage of the combination of the S-sign and Klein's line, clinicians may more reliably and accurately diagnose an SCFE. The S-sign is an easy-to-apply parameter with little hassle that can diagnose even mild slips. When combining the S-sign with Klein's line to diagnose an SCFE, clinicians are more accurate at diagnosing an SCFE compared with solely relying on Klein's line, which we found to be statistically significant ($p < 0.001$). The S-sign can be drawn using the freeform line tool available with most PACS. The S-sign also encourages the use of and attention to frog-leg lateral pelvis radiographs, which are the radiographs that should be used to diagnose an SCFE (1). The utilization of the S-sign as a radiographic aid for the diagnosis of SCFE may lead to a more rapid diagnosis and referral for patients with SCFE, a lower rate of delayed or missed diagnoses, and overall better health care delivery for children and adolescents presenting with hip or knee pain, or both, secondary to a slipped epiphysis.

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ARTICLE SUMMARY

1. Why is this important?

Children and adolescents with slipped capital femoral epiphysis (SCFE) occasionally present a diagnostic challenge to the evaluating physician, and it is not infrequent that more than one provider may evaluate the child with an SCFE prior to arriving at an accurate diagnosis. The utilization of the S-sign as a radiographic aid for the diagnosis of SCFE will lead to a more rapid diagnosis and referral for patients with SCFE, a lower rate of delayed or missed diagnoses, and overall better health care delivery for children and adolescents presenting with hip or knee pain secondary to a slipped epiphysis.

2. What does this study attempt to show?

With increased awareness of the S-sign and a usage of the combination of the S-sign and Klein's line, clinicians can more reliably and accurately diagnose an SCFE. When combining the S-sign with Klein's line to diagnose an SCFE, clinicians are more accurate at diagnosing an SCFE, compared with solely relying on Klein's line, which we found to be statistically significant ($p < 0.001$).

3. What are the key findings?

Clinicians are more accurate at diagnosing an SCFE, compared with solely relying on Klein's line, which we found to be statistically significant ($p < 0.001$). Our work showed the S-sign is more consistent and had a greater concordance compared with Klein's line, the SHSA, and Wilson Class.

4. How is patient care impacted?

The utilization of the S-sign as a radiographic aid for the diagnosis of SCFE will lead to a more rapid diagnosis and referral for patients with SCFE, a lower rate of delayed or missed diagnoses, and overall better health care delivery for children and adolescents presenting with hip or knee pain secondary to a slipped epiphysis.