

The Location of the Pysis on the Distal Femoral Cortical Surface is Consistently Proximal to its Apparent Location on the Perfect Lateral Radiograph: A 3-Dimensional Digitally Reconstructed Radiographic Study

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INTRODUCTION: The perfect lateral radiograph is utilized both clinically and scientifically to visualize anatomic structures and ligamentous attachment sites in the distal femur. Recent literature has suggested that the lateral radiograph may be imprecise at identifying and localizing anatomic structures because it is a 2-dimensional representation of complex 3-dimensional (3D) anatomy. The purpose of this study was to utilize digitally reconstructed perfect lateral radiographs to characterize the location of the pysis on the lateral and medial cortex of the femur. Using 3D computed tomography (CT) reconstruction software, the aim of this study was to determine the distance from the true pysis at the lateral and medial cortex of the femur to the apparent pysis seen on the digitally reconstructed lateral radiograph (DRR).

METHODS: Pediatric patients from a single center were analyzed from a cohort of CT scans queried from the institutional picture archiving and communication system (PACS). Inclusion criterion was an open pysis and exclusion criteria were any visible hardware or pathology affecting the pysis. CT data were imported into an open-sourced 3D imaging processing software and a rotational transformation was applied to create true lateral DRRs and 3D renderings of the distal femur. Fiducial markers were placed on the pysis at the midpoint in the anterior-posterior plane, as well as at points halfway between this middle point and the anterior (anterior point) and posterior (posterior point) cortices (Figure 1). These markers were transformed into lines that were subsequently extended perpendicular to the sagittal plane. The vertical distance from these lines, which represent the location that the pysis appears to be on the lateral radiograph, to the true pysis as seen on 3D reconstruction was measured at both the lateral and medial cortex of the femur (Figure 2).

RESULTS: Thirty-one patients were included for analysis. Mean age was 13.57 ± 1.66 years and the cohort was 74.2% male. The location of the true pysis on the medial cortex at the anterior, center, and posterior points was, respectively, 6.64 ± 1.74 mm, 11.95 ± 1.67 mm, and 14.30 ± 1.75 mm proximal to the apparent location of the pysis seen on DRR. The location of the true pysis on the lateral cortex at the anterior, center, and posterior points was, respectively, 2.19 ± 1.13 mm, 3.71 ± 1.19 mm, and 6.74 ± 1.25 mm proximal to the apparent location of the pysis seen on DRR (Table 1). At all points, the true pysis was located significantly more proximally to the apparent pysis on the medial cortex compared to the lateral cortex ($p < 0.001$). Additionally, the distance from the apparent pysis to the actual pysis increased as one moves posteriorly ($p < 0.001$) and the discrepancy between true pysis and apparent pysis was greater at the medial cortex compared to the lateral cortex at all locations measured (Table 2). A representative DRR and 3D reconstruction can be seen in Figure 3.

DISCUSSION AND CONCLUSION: The true location of the pysis on the distal femoral cortical surface was, in all areas measured, proximal to the apparent location of the pysis as seen on the digitally reconstructed perfect lateral radiograph. The distance from the apparent pysis on the perfect lateral radiograph to the pysis on the cortical surface seen on the 3-dimensional reconstruction was greater at the medial cortex compared to the lateral cortex and was greater in the posterior femur. These findings improve our knowledge of the approximate location of the pysis on the distal femoral cortical surface, specifically as it relates to the pysis visualized on the perfect lateral knee radiograph.

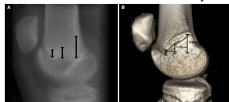


Figure 4. Digitally reconstructed lateral radiograph and 3D reconstruction of the distal femur showing the pysis location.

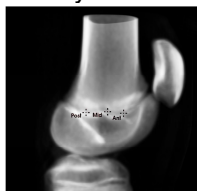


Figure 1. Representative digitally reconstructed lateral radiograph of distal femur demonstrating distal femoral pysis (black crosshair) placed on the anterior (anterior point), midpoint (black), and posterior (posterior point) of the apparent pysis as visualized on the lateral radiograph.



Figure 2. 3D reconstruction of distal femur demonstrating measurement of the vertical height (black line) between the location of the apparent pysis on the DRR to the actual pysis shown on 3D reconstruction. Vertical distance from the pysis to the apparent pysis is represented by purple values.

Location	Vertical Distance from Apparent Pysis to Actual Pysis, mm (SD)	Comparison to Anterior Point	Comparison to Middle Point
Medial Cortex			
Anterior Point	6.64 (1.74)	—	p = 0.001
Middle Point	11.95 (1.67)	p < 0.001	—
Posterior Point	14.30 (1.75)	p < 0.001	p = 0.007
Lateral Cortex			
Anterior Point	2.19 (1.13)	—	p = 0.001
Middle Point	3.71 (1.19)	p < 0.001	—
Posterior Point	6.74 (1.25)	p < 0.001	p = 0.001

Table 1. The vertical distance from the apparent pysis on DRR to the actual pysis shown on 3D reconstruction. Vertical distance from the pysis to the apparent pysis is represented by purple values.

Location	Medial Cortex, mm (SD)	Lateral Cortex, mm (SD)	p-value
Anterior Point	6.64 (1.74)	2.19 (1.13)	< 0.001
Middle Point	11.95 (1.67)	3.71 (1.19)	< 0.001
Posterior Point	14.30 (1.75)	6.74 (1.25)	< 0.001

Table 2. Comparison between the distance between apparent pysis on DRR and true pysis visualized on 3D reconstruction at the lateral and medial cortex.