The Location of the Physis 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

Reece Meyer Rosenthal, Ameen Z Khalil, Devin Louis Froerer, Natalya Elle McNamara, Allan Kenneth Metz, Joseph Featherall, Stephen K Aoki

University of Utah Department of Orthopaedics

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 physis 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 physis at the lateral and medial cortex of the femur to the apparent physis 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 physis and exclusion criteria were any visible hardware or pathology affecting the physis. 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 physis 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 physis appears to be on the lateral radiograph, to the true physis 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 physis 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 physis seen on DRR. The location of the true physis 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 physis seen on DRR (Table 1). At all points, the true physis was located significantly more proximally to the apparent physis on the medial cortex compared to the lateral cortex (p < 0.001). Additionally, the distance from the apparent physis to the actual physis increased as one moves posteriorly (p < 0.001) and the discrepancy between true physis and apparent physis 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 physis on the distal femoral cortical surface was, in all areas measured, proximal to the apparent location of the physis as seen on the digitally reconstructed perfect lateral radiograph. The distance from the apparent physis on the perfect lateral radiograph to the physis 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 physis on the distal femoral cortical surface, specifically as it relates to the physis visualized on the perfect lateral knee radiograph.