

Age- and Sex-Related Developmental Changes in Lesser Trochanteric Version and Its Relationship to Femoral Anteversion in Normal Patients

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INTRODUCTION: A great deal of attention has been given to femoral anteversion, in particular with regards to its role in femoroacetabular impingement (FAI) and hip instability. Femoral anteversion is increased in childhood and remodels toward 15-25° at skeletal maturity. While segmental contributions to the overall femoral torsion have been previously described, the orientation of the lesser trochanter, an important biomechanical landmark serving as the insertion of the iliopsoas tendon, relative to the posterior condylar axis has not been previously quantified. We aimed to define normative lesser trochanteric version across age and examine its relationship to femoral anteversion in males and females. We hypothesized that lesser trochanteric version and femoral anteversion are highly correlated and they both significantly decrease by age.

METHODS: Following IRB approval, New Mexico Decedent Image Database (NMDID) was queried to identify CT scans with full coverage of the hip and femur from subjects with no documented bone and joint pathology (n=1,222 hips, 611 subjects, age: 30.4 ± 8.8; 67% males). A custom-developed and validated program (VirtualHip, Boston Children's Hospital) was used to automatically segment bones, identify landmarks, define anatomical coordinate system based on ISB recommendations, and then measure anatomical features of the hip joint. Femoral anteversion and lesser trochanteric version relative to the posterior condylar axis were measured (Figure 1A). Associations with age were evaluated using generalized additive models (GAM), stratified by sex. Relationships between femoral anteversion and lesser trochanteric version were assessed using linear regression.

RESULTS: Femoral anteversion decreased with age until adolescence (P<0.01 both sexes), after which no further change was observed (Figure 1B). There was no significant difference in femoral anteversion remodeling when comparing males and females (Figure 1B). Lesser trochanteric version increased (more anteversion) in both males (P=0.013) and females (P=0.015; Figure 1C). Males had a significantly larger trochanteric version (more anteverted) than females, after adjusting for age (P<0.001). Across the cohort, femoral anteversion and lesser trochanteric version were strongly positively correlated for both males (R²=0.36; p<0.001) and females (R²=0.41; p<0.001) – Figure 1D.

DISCUSSION: This is the first study to describe the change in lesser trochanteric version with age in normal patients. While it is well described that femoral anteversion decreases with skeletal maturity, our data demonstrates that lesser trochanteric version does not significantly change in males but dramatically increases in females until skeletal maturity. Both femoral anteversion and lesser trochanteric version are strongly correlated, supporting the theory that femoral anteversion is not the only contributor to rotational alignment between the hip and knee. Further studies are needed to evaluate these parameters in patients with pathologic versional abnormalities.

SIGNIFICANCE/CLINICAL RELEVANCE: Defining the developmental course of lesser trochanteric version may inform the evaluation of patients with pathologic versional abnormalities. ultimately serving as a guide for selecting the appropriate level of osteotomy (intertrochanteric versus subtrochanteric) to optimize rotational correction.

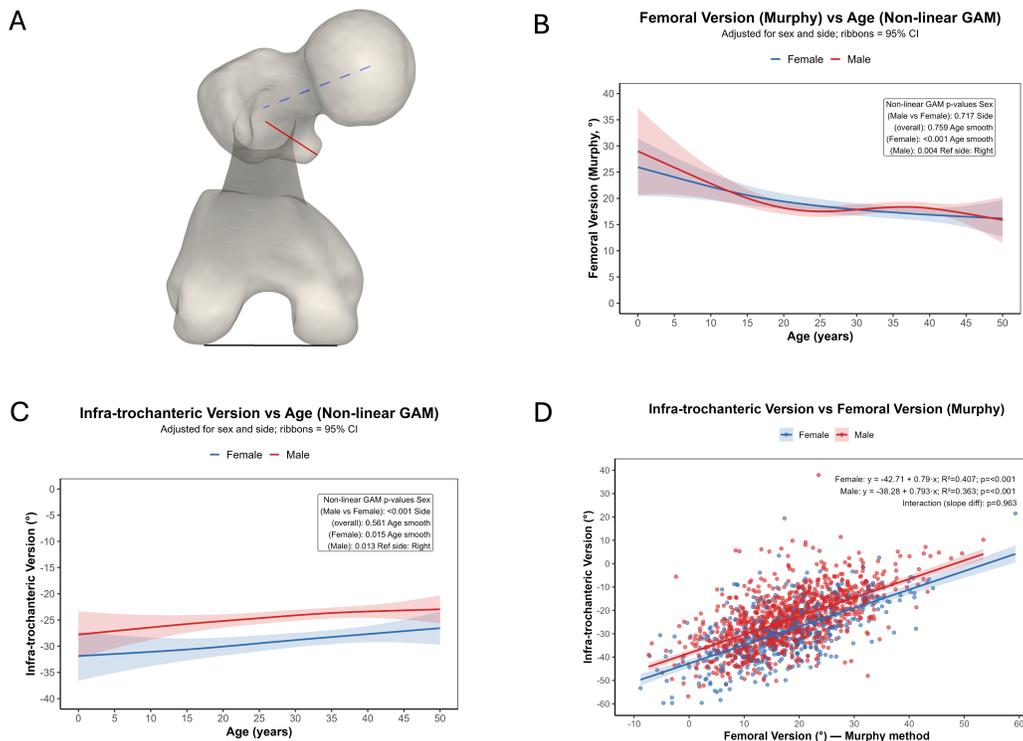


Figure 1. (A) 3D Measurements of femoral and trochanteric versions. Changes in (B) femoral anteversion and (C) lesser trochanteric version with age in males and females with normal hips. (D) orrelation of femoral version and lesser trochanteric version in males and females with normal hips.