MRI vs CT for Acetabular and Femoral Morphology in the Diagnosis and Surgical Planning for Acetabular Dysplasia

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INTRODUCTION: Computed tomography (CT) is considered the standard of care for three-dimensional modeling and surgical planning in acetabular dysplasia. However, CT poses significant radiation risks towards an at-risk young population, as well as inability to assess soft tissue pathology. As such, additional magnetic resonance imaging (MRI) is often necessary for complete workup. We hypothesize that MRI provides equivalent morphological measurements compared to CT, while offering the advantages of no radiation and concurrent evaluation of soft tissue pathology.

METHODS: Following IRB approval, we retrospectively analyzed 45 consecutive patients with acetabular dysplasia who underwent both CT and MRI as part of pre-operative planning ahead of hip preservation surgery. For both CT and MRI, imaging through the distal femur was required for femoral version measurement. All CTs included the entire pelvis, whereas some MRIs did not include the full pelvis. 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. Key measurements included Tönnis angle, lateral center-edge angle, acetabular version, femoral version (Reikeras and Murphy techniques), and femoral head coverage. CT was treated as the reference standard. Mean absolute differences between MRI and CT were calculated for each variable. Paired t-tests and non-inferiority testing (with a clinical margin of error set to 5° or 5%) were performed to assess agreement.

RESULTS: The generated 3D models from CT and MRIs were comparable (error <0.5mm; Figure 1A). The mean absolute differences between quantified hip anatomical measurements obtained from MRI and CT are shown in Figure 1B. MRI measurements were equivalent to CT across all variables. Mean differences were within ±5° or ±5%, including femoral version (bias +2.5° Reikeras; +1.8° Murphy), LCEA at 12:00 (bias +3.8°), acetabular version (bias +5.0°), Tonnis angle (+3.2°). Femoral head coverage differed by <0.1% overall. No differences were statistically significant ($p > 0.05$), and all MRI-derived metrics met non-inferiority criteria compared to CT. Acetabular measurements demonstrated slightly higher discrepancy; however, in patients where the full pelvis was included in the available MRI, the magnitude of discrepancy was lower (Figure 1C vs 1D).

DISCUSSION: MRI provides accurate, non-inferior 3D measurements of acetabular and femoral morphology that are comparable to CT in patients with acetabular dysplasia. In addition to eliminating radiation exposure, MRI allows for evaluation of soft tissues including labrum, cartilage, and capsule that CT cannot assess. These findings support the role of MRI that captures the full pelvis and extension to the knee as a standalone imaging modality for diagnosis and surgical planning in acetabular dysplasia.

CLINICAL RELEVANCE: This study supports substituting CT with MRI for preoperative assessment in acetabular dysplasia. MRI offers comparable accuracy for 3D bone measurements, with added soft tissue detail and no radiation exposure – potentially changing standard imaging protocols in this young and at-risk population.

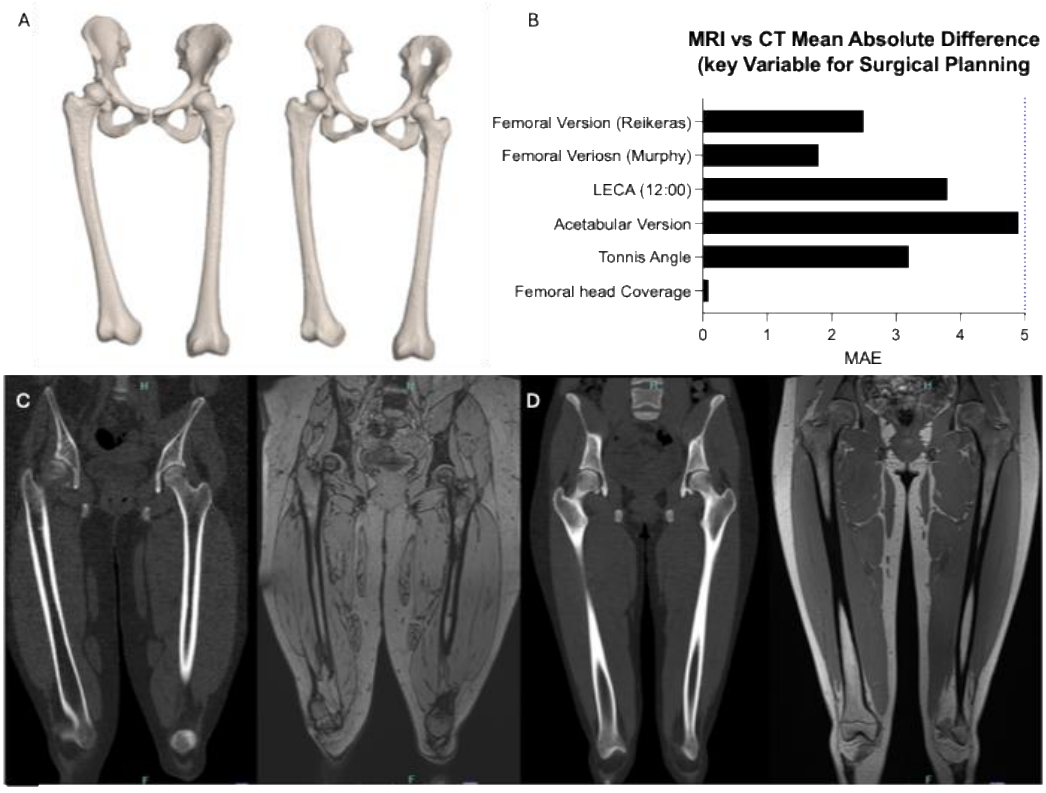

Figure 1. (A) Representative 3D models reconstructed from CT and MRI. (B) Mean absolute differences between 3D anatomical measurements obtained from MRI and CT. Clinical margin of error was set to 5° or 5%. (C) Lower discrepancies were noted in acetabular measurements for patients with MRIs that captured the complete pelvis compared to those with incomplete imaging of the pelvis (D).