

## Femoral-Acetabular Impingement: 3-D Analysis of Hip Morphology and Association with Pathology

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**Purpose:** Femoral-acetabular impingement (FAI) is a condition in which morphology of the acetabular cup and femoral head results in osseous and soft tissue impingement at the extremes of hip range of motion [1-2]. FAI has been implicated in chronic hip pain in young adults, with formation and propagation of labral tear, cartilage loss and subsequent osteoarthritis [3-4]. We sought to create 3-D models of the acetabular cup and femoral head to depict femoral-acetabular morphology, and to measure volume and surface area to test for association with lesions of FAI.

**Materials and Methods:** MR arthrographic images of the hip of 42 patients with pain and suspected labral tear were acquired using a 1.5 T Unit (GE Medical Systems, Milwaukee, WI) and a phased array torso coil. Using 3-D analysis software (3D-Doctor, Able Software Corp., Lexington, MA) outlines of the acetabular cup and femoral head were drawn and shaded surface 3D reconstruction was performed (Figure 1A-D). Surface area (1A-B) and voxel volume (1C-D) were calculated. To control for differences in patient size, ratios were used for analysis: acetabular cup / femoral head volume (AFV) and acetabular cup / femoral surface area (AFA). A voxel dimension of 0.586 mm<sup>3</sup> was acquired using fat-suppressed 3D spoiled GRASS coronal images. Values for AFV and AFA were correlated with labral tear, tear location, cartilage loss location and synovial herniation pit. ANOVA analysis was used to test associations.

**Results:** 42 hip MR arthrograms (19 male, 23 female, age range 18-78, avg 39) were studied. Overall average AFV was 0.64 (range, 0.37-1.05) and AFA was 0.73 (range, 0.36-1.26). Mean AFV and AFA for labral tear, labral tear location, cartilage loss location and synovial herniation pit are listed in Table 1. Herniation pit was significantly associated with a small AFV (i.e., large femoral head volume relative to cup volume). Other findings were not statistically significant.

TABLE 1	Total Avg (N=42)	Labral Tear			Tear location				Cartilage Loss Location			Herniation Pit			
		Present (N=35)	Absent (N=7)	P	Anterior (N=15)	Lateral (N=16)	Posterior (N=4)	P	Anterior (N=12)	Lateral (N=20)	Posterior (N=11)	P	Present (N=7)	Absent (N=35)	P
AFV	0.64	0.62	0.70	<b>0.38</b>	0.64	0.64	0.55	<b>0.51</b>	0.57	0.64	0.69	<b>0.11</b>	0.55	0.67	<b>0.01</b>
AFA	0.73	0.72	0.79	<b>0.29</b>	0.73	0.72	0.69	<b>0.97</b>	0.70	0.75	0.80	<b>0.56</b>	0.86	0.70	<b>0.07</b>

### Discussion:

Femoral neck herniation pits are associated with low AFV. Gross volume and surface area ratios do not appear to correlate with labral tear or cartilage loss. However, this technique will enable more advanced analysis of morphologic variation associated with femoral-acetabular impingement.

- REFERENCES  
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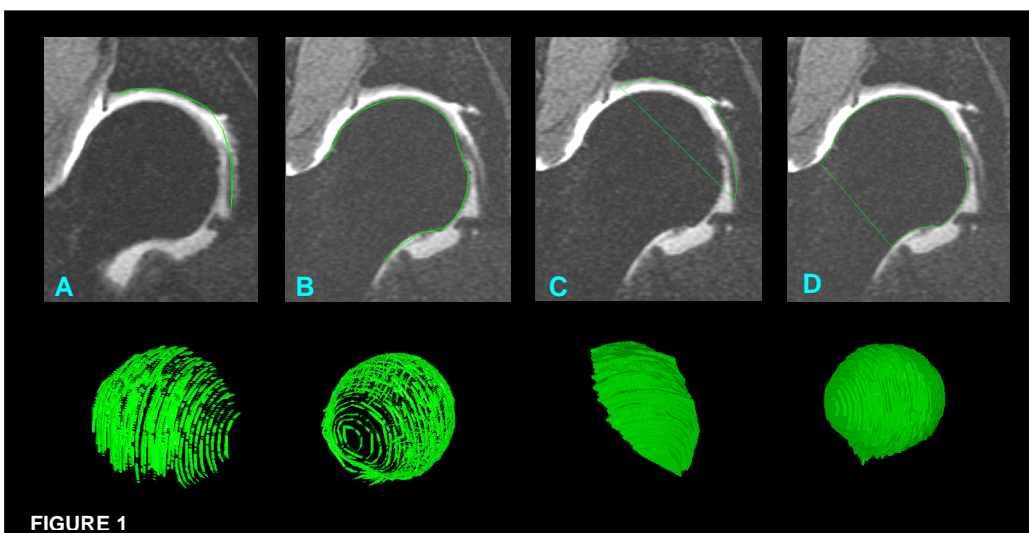


FIGURE 1