Radial $\alpha$ Angle Using 3-dimensional Magnetic Resonance Image for the Evaluation of Cam Morphology in FAI and BDDH Patients

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Imaging diagnosis for femoroacetabular impingement (FAI) is based on morphologic evaluation, mainly by plain radiograph. Especially in cam-type FAI, the α angle is an important parameter commonly evaluated by plain X-ray.

In this study, we applied radial MRI and plain X-ray in FAI and Borderline Developmental Dysplasia of the Hip (BDDH).
Purpose

- To compare the $\alpha$ angle between radial MRI and plain X-ray, and
- To reveal the correlation between the radial $\alpha$ angle and the signal intensity of MRI.
A total of consecutive 42 hips from 39 patients (male, 19; female, 20) who underwent arthroscopic surgery were analyzed, including 22 femoroacetabular impingement (FAI) (mean age: 41) and 20 borderline developmental dysplasia of the hip (BDDH) (mean age: 43).

<table>
<thead>
<tr>
<th></th>
<th>FAI (α angle &gt; 55°)</th>
<th>BDDH (CEA 20° – 25°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Mean age</td>
<td>41 (14–60)</td>
<td>43 (19–63)</td>
</tr>
<tr>
<td>Male/Female</td>
<td>17/5</td>
<td>4/16</td>
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Methods

We adopted the method previously described by Bouma et al. (Acta Orthop. 2014)

Signal intensity ratio was calculated as A/B to compensate the individual value. ROI A was defined as the signal intensity in cam lesions. ROI B was defined as the reference intensity.
Results

Figure 3: Average radial α angle on each radial image

- The maximum alpha angle in BDDH was more anterior compared to FAI.
Table 1. Correlations between the maximum radial alpha angle on MRI and each radiographic alpha angle in FAI and BDDH

<table>
<thead>
<tr>
<th>Pearson’s correlation coefficient</th>
<th>FAI</th>
<th>BDDH</th>
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<tbody>
<tr>
<td>45° Dunn view</td>
<td>0.53</td>
<td>0.66</td>
</tr>
<tr>
<td>AP</td>
<td>0.29</td>
<td>0.40</td>
</tr>
<tr>
<td>Cross-table lateral</td>
<td>0.79</td>
<td>0.90</td>
</tr>
<tr>
<td>p-value</td>
<td>p &lt; 0.05</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>n.s.</td>
<td>p &lt; 0.05</td>
<td>n.s.</td>
</tr>
<tr>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
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</table>
When compared with radiographic and radial MRI, 45° Dunn view showed the smallest discrepancy in both FAI(A) and BDDH(B).
A significant negative correlation is present in the younger age group (A) \( (r = -0.36, \ p = 0.021) \), while a significant positive correlation exists in the older age group (B) \( (r = 0.33, \ p = 0.008) \).
Figure 6: Correlations between alpha angle and signal intensity ratio in younger-age male FAI patients (A) and older-age female BDDH patients (B)

There is a significant negative correlation in the younger-age male FAI group ($r = -0.48, p = 0.034$), and a significant positive correlation in the older-age female BDDH group ($r = 0.60, p = 0.0064$).
Discussion

Which is better, Dunn view, or cross-table lateral view?

- Dunn view had the best reproducibility with the maximum radial alpha angle.
- Cross-table lateral view had the highest correlation with the maximum radial alpha angle, particularly in BDDH.

The most appropriate radiographic position for evaluating the alpha angle may depend on the actual impingement location, which reveals a different distribution between FAI and BDDH.
Subchondral bone status at cam lesion

Is there any difference between FAI and BDDH?

Older female BDDH → Bone marrow edema

Younger male FAI → Bone sclerosis?
Conclusion

- We reconfirmed the utility of the 45° Dunn view, with it presenting the best reproducibility for the maximum radial alpha angle as an evaluation of cam morphology, while the cross-table lateral view revealed the best correlation with the maximum radial alpha angle in BDDH.

- A negative correlation was found between radial alpha angle and signal intensity on MRI in the younger age group, particularly in male FAI subjects, whereas a positive correlation was found in the older age group, particularly in female BDDH subjects.