Native Combined Anteversion Influenced Onset of Pain in Patients with Hip Dysplasia

Yusuke Kohno, MD, Yasuharu Nakashima, MD, PhD, Mio Akiyama, MD, PhD, Masanori Fujii, MD, PhD, Yukihide Iwamoto, MD, PhD.
Kyushu University, Fukuoka, Japan.


Introduction: Developmental dysplasia of the hip (DDH) is characterized by various morphological abnormalities such as acetabular dysplasia, decreased acetabular coverage of the femoral head, and excessive femoral anteversion. These features result in abnormal joint stresses, leading to subsequent labral tears, articular cartilage degeneration, and early development of secondary hip osteoarthritis. Severity of hip dysplasia is determined by the degree of subluxation and extent of acetabular dysplasia as determined by the lateral center-edge (CE) angle, Sharp angle, or acetabular roof obliquity (ARO) in the coronal plane.

Combined anteversion (CA) is the sum of femoral anteversion (FeAV) and acetabular anteversion (AcAV), and thus links femoral and acetabular morphologies in the axial plane. Recently, CA has been used to assess the overall alignment of the cup and stem as it contributes to joint stability in total hip arthroplasty. However, to our knowledge, few studies have evaluated the exact role of native CA on the development of osteoarthritis in dysplastic hips.

In the present study, we sought to examine: (1) the distribution of CA in dysplastic and control hips, and (2) the correlation between CA and age at pain onset in patients with dysplastic hips.

Methods: We reviewed 100 hips in 79 patients with dysplastic hips. Hip dysplasia was defined as a lateral center-edge angle of Wiberg less than 20 degrees. There were 11 hips in 8 male patients and 89 hips in 64 female patients. The average age of the patients at corrective osteotomy was 38.0 years (range, 16–59 years) and all patients were skeletally mature. The control group included 50 hips in 44 patients with osteoarthritis of the knee. This retrospective study was approved by our institutional review board.

Multiplanar reconstruction of pelvic CT images was performed using image analysis software. We measured the morphologic parameters including femoral and acetabular version (Fig.1). We used the anterior pelvic plane as a reference plane for the acetabulum, and the table top plane for the femur.

Due to the assumption of two different pathological hip dynamics, dysplastic hips were divided into two groups (the acetabular anteversion or retroversion groups) based on positive or negative cranial acetabular version which was measured on 5 mm distal to the acetabular roof. Correlations between radiographic and clinical parameters and age at pain onset were analyzed.

Results: FeAV and AcAV in dysplastic hips were significantly greater than those in control hips (14.3° versus 20.9°, p<0.0001 and 21.9° versus 23.9°, p=0.049, respectively; Table 1). The resultant CA in dysplastic hips was significantly greater than that in control hips (44.4° versus 36.3°, p<0.0001; Table 1). When the distribution of CA was examined, CA in dysplastic hips was significantly more widely distributed compared to control hips (range, 3.6°-76.5° versus 18.6°-64.6°, p=0.0015). Among the radiographic parameters in the dysplastic hip group, CA was not found to correlate with lateral CE angle (r=−0.095, p=0.40), Sharp angle (r=0.032, p=0.78), and ARO (r=0.032, p=0.78).
Of the 100 dysplastic hips, 83 hips (83%) had positive cranial anteversion angles (anteversion group), and the remaining 17 hips (17%) had negative cranial anteversion angles (retroversion group). The anteversion group showed significantly greater CA than the retroversion group (47.4° versus 30.2°, p<0.0001; Table 1) whereas no difference was noted between the retroversion and control hips (30.2° versus 36.3°, p=0.11).

The mean age at pain onset in the anteversion group was 36.7 years showing significantly later pain onset relative to the retroversion group (26.5 years) (p=0.0007). In the anteversion group, FeAV, CA, lateral CE angle, and Sharp angle were significantly correlated with age at pain onset (Table 2).

Multivariate analysis showed that CA (p=0.0001) and Sharp angle (p=0.011) were significantly and independently correlated with age at pain onset. The cutoff CA values in which pain developed less than 25, 35, and 45 years were 57.1°, 51.8° and 48.6°, respectively.

No correlation between CA and pain onset was noted in the retroversion group (r=−0.11, p=0.74).

**Discussion:** In the anteversion group, as the CA increases the mechanical condition of the hip is thought to worsen. As prosthetic FeAV increased, joint contact force was shown to increase with the decreased contact area in the truncated femoral head model. AcAV was shown to be negatively correlate with anterosuperior coverage, thus the stress in both the acetabular edge and contact area of femoral head would increase. Furthermore, a significantly positive correlation between FeAV and AcAV in dysplastic hips was reported, these morphological features in the anteversion group appear to result in a vicious circle.

In conclusion, our data showed that the greater value of native CA measured in the axial plane resulted in younger age at pain onset in the typical dysplastic hips (the anteversion group), suggesting the role of interaction between the acetabulum and femoral head for the development of osteoarthritis.

**Significance:** CA measured in the axial plane was not correlated with parameters measured in the coronal plane (e.g., lateral CE angle, Sharp angle, and ARO), and was significantly associated with age at pain onset in the anteversion group. Therefore CA would be another useful index used to represent morphological abnormalities of dysplastic hips.
Table 2. Correlation of age at pain onset with radiographic parameters in the Anteversion group

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Correlation coefficient</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeAV</td>
<td>-0.41</td>
<td>0.0008*</td>
</tr>
<tr>
<td>AcAV</td>
<td>-0.24</td>
<td>0.060</td>
</tr>
<tr>
<td>CA</td>
<td>-0.46</td>
<td>0.0002*</td>
</tr>
<tr>
<td>Lateral CE angle</td>
<td>0.33</td>
<td>0.0090*</td>
</tr>
<tr>
<td>Sharp angle</td>
<td>-0.33</td>
<td>0.0098*</td>
</tr>
<tr>
<td>ARO</td>
<td>-0.24</td>
<td>0.060</td>
</tr>
</tbody>
</table>

*Statistical significant (p value<0.05)