Clinical

Femoral Acetabular Impingement: the sex- and age-linked distribution of alpha angles in 146 patients of service age without pre-existing osteoarthritic or other hip pathology

K M Heil, A M Wood, J Penn-Barwell, A C M Keenan, S McKie

Abstract

The use of the alpha angle to help the diagnosis of Femoral Acetabular Impingement (FAI) is common. However, there is currently no standard value available across an asymptomatic pre-arthritic population. We present the first large cohort of Computerised Tomography (CT) based alpha angles in patients with no history of hip pathology, including intra- and inter-observer validation. We carried out a retrospective analysis of 73 consecutive individuals (146 hip joints) with ages ranging from 18 to 39 years. The age range 18-39 represents 82.4% of those currently serving in the UK Armed Forces. The cohort was drawn from those patients who had received a CT scan in the Lothian Region between 1 Jan 2011 and 31 Dec 2011 due to abdominal pathology. These patients had their electronic patient record checked to rule out any hip-related problems. The alpha angle of Nötzli was measured on the axial view bilaterally. The mean value for the 18-39 age range was found to be 51.89° for the left hip and 52.53° for the right.

Femoral alpha angle is a reproducible measurement for assessing the femoral neck. However, there is wide variability in the alpha angle for patients, irrespective of the presence of symptoms. Our results would suggest that the alpha angle alone should not be used to diagnose FAI in service personnel, as even large angles may be normal.

Introduction

Over the last fifteen years the emerging clinical entity of Femoral Acetabular Impingement (FAI) in the young pre-arthritic hip is increasingly being recognised. Armed Forces personnel are predominantly young (1) and as a result there is a disproportionate increase in the diagnosing of this condition amongst service personnel when compared to the standard population.

FAI was described by Ganz et al 2003 (2) as being an important cause of early osteoarthritis (3). It is believed that FAI results from an impaction of the femoral neck with the labrum and acetabular rim; it is postulated to occur as a result of either an acquired or developmental abnormality of the femoral head or acetabulum (2,3). Predominantly, but not exclusively, it is during flexion and internal rotation of the hip that these bony abnormalities can produce the symptomatic pain of “impingement” (2,4).

As FAI is a relatively new condition there have been a number of attempts to formalise its diagnosis with radiological imaging (5,6,7,8). Some radiologists believe that every patient between the age of 18-50 with atraumatic hip pain should be diligently assessed for potential FAI (9). Whilst previous studies have attempted to determine the values of alpha angle for diagnosis they have often suffered from small numbers (10), or focused on symptomatic patients (11), rather than the general population. Those papers that have concentrated on the general population have predominantly used patient numbers which were too small to give normal variations across age groups (10) and have often focussed on an older osteoarthritic age group rather than the younger individuals which FAI is reported to affect (12,13,14).

Laborie et al 2011 (15) identified the prevalence of radiographic findings in 2081 young adults on plain x-rays; however, this cohort was overwhelmingly at the younger end of the spectrum (between the ages of 17 and 20) and as such do not reflect the full range of patients affected by FAI. This study reported that up to 35% of asymptomatic males had signs of FAI impingement on plain films, and therefore concluded that plain x-ray alone is not a reliable way to assess for FAI.

Nötzli et al (4) described the femoral alpha angle on axial MRI scans on symptomatic and asymptomatic patients as an accurate and reproducible way of diagnosing
femoral acetabular impingement. Despite the theoretical shortcomings of using the alpha angle to predict cam-type FAI (11), it is believed by many that patients with an alpha angle of greater than 55 degrees are likely to have cam impingement, and this is used by a number of institutions (9) to diagnose FAI. We have therefore examined the alpha angle in a normal population to better understand the validity of this value for positive diagnosis of FAI.

We present a series of alpha angles measured on Computerised Tomography (CT), in an adult, pre-osteoarthritic population, of an age-range representative of the UK Armed Forces, in order to better describe the standard values, and aid in the diagnosis of FAI.

Method
A retrospective study on an opportunity sample was performed on 73 patients between the ages of 18-39 who had a CT scan performed for abdominal pathology between 2 April 2011 and 29 November 2011. The electronic notes of each patient were interrogated to ensure that there was no history of hip pain; those with a history of hip pain were excluded. Any historical or radiological features of previous hip surgery, hip or femoral fractures, congenital hip dysplasia, Perthes, slipped capital femoral epiphysis or arthritis were exclusion criteria. The alpha angle as described by Nötzli (4) was measured on the oblique axial views.

Results
Alpha angles were recorded in 146 hips in 73 male and female patients as shown in table 1. The alpha angles were consistent across various age groups as shown in figure 1 and table 1. The distribution of alpha angles in this study was skewed, as shown in figure 2, with the mean not equalling the median. The range of 2 standard deviations either side of the mean of all alpha angles lay between 35.4 and 69.7 degrees.

Discussion
This study presents the normal distribution of alpha angle measurements in an asymptomatic population Figure 3, and finds that the mean for service personnel (18-39 years of age) will be between 50 and 55 degrees.

In the last 15 years there has been an increasing interest in a new diagnosis for the cause of hip pain and early

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>Mean Alpha Angle Left Hip</th>
<th>Mean Alpha Angle Right Hip</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>10</td>
<td>47.9 (SD 5.35)</td>
<td>50.4 (SD 5.44)</td>
</tr>
<tr>
<td>25-29</td>
<td>18</td>
<td>53.8 (SD 9.56)</td>
<td>53.0 (SD 10.63)</td>
</tr>
<tr>
<td>30-34</td>
<td>15</td>
<td>51.7 (SD 8.34)</td>
<td>54.8 (SD 9.63)</td>
</tr>
<tr>
<td>35-39</td>
<td>30</td>
<td>54.1 (SD 10.15)</td>
<td>51.9 (SD 8.03)</td>
</tr>
<tr>
<td>18-39</td>
<td>73</td>
<td>51.9 (SD 8.88)</td>
<td>52.6 (SD 9.06)</td>
</tr>
</tbody>
</table>

Table 1. Age groups and mean alpha angles for left and right hips

Figure 1: Alpha angles in degrees as recorded in right and left hips in each age group. Mean and standard deviations shown.

Figure 2: Frequency distribution of alpha angles with idealised line of best fit for a normalised distribution. 2 Standard deviations above and below the mean (not median) also shown.

Figure 3: Measuring Alpha Angle on CT.
FAI typically presents with deep groin pain which is exacerbated by athletic or occupational activities which require deep hip flexion, or prolonged periods of walking or sitting (15). In the UK Armed Forces, these characteristics make FAI a condition which is likely to be far more common than in the general population due to the physical nature of both training and active service.

The actual incidence of FAI has not been identified (16) although in the Copenhagen Osteoarthritis study, the incidence of cam malformation was believed to be 6% in men and 2% in women: but these patients had a mean age of 62 and the estimation of alpha angle was on an AP radiograph not, as described by Nötzli et al (4), using the coronal view on an MRI scan.

The diagnosis of FAI is a combination of clinical and radiological findings. Unfortunately there is frequently a delay in diagnosis (17), which can result in significant chondral injury before definitive treatment (18). The “impingement test” of flexing and internally rotating the hip to trigger pain has been reported by Troelsen et al 2009 (19) to have a sensitivity of only 59%, although it had a specificity in this series of 100%. These findings were similar to the findings of Leibold et al 2009 (20) who reviewed clinical tests in the literature and found that the positive predictive value of these ranged from 0.62-1.0.

Radiological investigations therefore have a role in supporting the clinical diagnosis. Plain radiographs are useful for the diagnosis of degenerative changes, bony lesions and bony prominences that predispose to FAI (21), with Laborie et al 2011 (15) identifying that it was possible to identify pistol-grip deformities, focal femoral neck prominence, flattening of the femoral head and a number of other pathologies on two plain x-ray views.

However, Leunig identified that even slight alterations in the rotation and inclination of the pelvis can lead to inaccurate assessment of acetabular coverage. We have not reported on the incidence of associated radiographic features in our paper, as Laborie et al 2011 (15) found that 35% of asymptomatic males had signs of FAI impingement on plain films: with over one third of asymptomatic patients having these signs, we did not believe that reporting their occurrence would be of any use in improving the diagnosis of FAI.

In our study we elected to use the alpha angle as described by Nötzli et al 2002 (4), as this was demonstrated to be accurate and reproducible in his original paper, which reported that in patients with an alpha angle >50 or >55 degrees cam impingement is likely (9). In contradiction to the paper by Nötzli (4), we do not believe that an angle >55 degrees necessarily means that a patient may be diagnosed with FAI. We believe the relevance of this angle needs to take into account the age and sex of a patient, as in our series the alpha angle ranged from 33.32-79.75 degrees and there was variability as to the normal distribution of alpha angle in different age groups, which we defined as within two standard deviations of the mean.

Aside from the Copenhagen study, previous literature suggests that the prevalence of bony anatomy which causes FAI ranges between 5-95% (22,23) and depends upon the population studied and the radiological feature being measured. Hack et al 2010 (24) looked at 200 volunteers and found that 53% had an alpha angle >50 degrees, and that the alpha angle was greater in the male hips. The average age of the patients was 29.4, which is similar to our study group of 31.7. Our mean alpha angle remained relatively consistent between different groups, which demonstrates that a value >55 degrees in a younger population group is possibly more clinically significant than one in an older pre-arthritic patient, and may represent a change to the morphology of the femoral neck secondary to abnormal loading.

We present the first study describing the normal distribution of alpha angle in a pre-osteoarthritis population similar to that of the UK Armed Forces. We believe that our results can be used to help guide the diagnosis of FAI in symptomatic patients and give a better understanding of the normal distribution of alpha angles over different age groups. Accurate diagnosis of FAI is of particular value in the UK Armed Forces due to the propensity for exacerbation through the nature of military service. Additionally, a diagnosis of FAI is likely to have a detrimental impact on the future service and employability of an individual. As such, it is essential that the diagnosis of FAI is as fast, specific and sensitive as possible.

Currently FAI surgery in the military is controversial, with the Defence Medical Rehabilitation Centre predominantly managing the access to this type of surgery. There is a push to increase the number of practitioners providing FAI surgery, with the referral pathways being less centrally controlled. It is therefore imperative that information about the clinical value of the radiological measurements in service personnel be available, so that practitioners unfamiliar with FAI diagnosis may refer patients with confidence.

Level 4 opinion from the president of NSMBOs (25), is that a “number of Royal Navy personnel have had FAI surgery. However, it is not always successful and individuals have been discharged from the Service.” Whilst there is currently no data in publication, if the level 4 opinion is correct, this is an area in which we need to ensure that patients are getting the correct procedure for the correct pathology. We believe our results may help guide the diagnosis and treatment in service personnel. This situation also means that there is a requirement for further investigation into patients who have had the appropriate surgery and not returned to full fitness.

If FAI is suspected we recommend that military patients are sent for specialist orthopaedic examination, to a practitioner familiar with this type of pathology and imaging, but also familiar with the expectations and requirements of service life. Because of the difficulty and complexity of FAI presentation we hope that this approach will improve diagnosis in the service community and reduce the potential for patients who have an incidental radiological finding receiving unnecessary surgery.
References


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