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ORIGINAL STUDY

Unexpected long femur in adults with acetabular dysplasia

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Femoral length symmetry is assumed when assessing a patient with a dysplastic acetabulum. An unexpected long femur has been observed in some adults with acetabular dysplasia.

We undertook a retrospective observation study of 18 adults with unilateral and 11 adults with bilateral acetabular dysplasia. Femoral lengths were assessed using CT measurements.

The ipsilateral femur was found to be 5-10 mm longer in 66% (12 patients) with unilateral dysplastic acetabulae. Femoral lengths varied greatly in the presence of bilateral dysplastic acetabulae.

In the presence of a acetabular dysplasia, asymmetry of femoral lengths is common and unpredictable. Femoral and total limb length assessment (with CT) is advised preoperatively. This will alert the surgeon and patient to the possible risk of post operative ipsilateral limb lengthening.

Keywords : acetabular ; dysplasia ; limb length.

INTRODUCTION

The assessment and treatment plan of an adult with a painful dysplastic acetabulum and a subluxed femoral head assumes symmetry of femoral lengths. A limb length discrepancy encountered is assumed to be due to migration of the proximal femur alone.

Long leg dysplasia has been described in children with developmental dysplasia of the hip (DDH) who have undergone femoral and acetabular surgery, the aetiology being a surgical stimulation of the femur causing overgrowth. However, unexpected long femurs have been observed in adults with dysplastic acetabulae who were not treated surgically as children. In the presence of an unexpected long femur and assuming femoral length symmetry, restoration of the hip centre either with arthroplasty or osteotomy may lengthen the affected leg. This limb length inequality is a source of patient complaint and litigation.

The aim of the study was to assess femoral lengths in adults with dysplastic acetabulae and the null hypothesis tested was femoral length symmetry.

PATIENTS AND METHOD

This was a retrospective observational study of consecutive patients with acetabular dysplasia attending two

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Table I. — Table showing the numbers in the groups according to Crowe grading of the affected hip in unilateral DDH and the worst affected hip in bilateral DDH

Crowe Grading	Crowe One	Crowe Two	Crowe Three	Crowe Four
Unilateral DDH	10	4	3	1
Bilateral DDH (Worse Side)	6	0	4	1

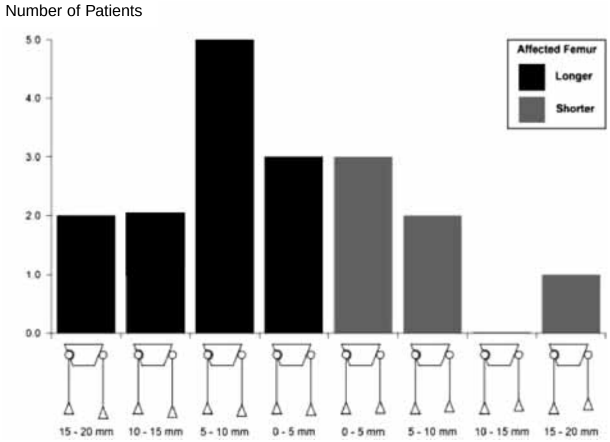
tertiary referral centres belonging to two consultants between 2001 and 2003. The patients presented with painful hips and were seeking surgical intervention in the form of pelvic osteotomy or arthroplasty. CT evaluation of the acetabulum and femoral anteversion is routine for surgical planning in all such patients. In order to assess anteversion a scanogram is performed from the hip to the knee to calculate the rotational profile. All CT information is routinely backed-up.

Femoral lengths were measured from retrieved CT scanograms. All CT measurements were performed by two authors supervised by an experienced scanning radiographer in an effort to reduce observer bias. The length of the femur from the superior aspect of the femoral articular surface to the intercondylar notch was calculated using standard measuring software available on the CT scan machine.

Eighteen patients (1 male and 17 females) had unilateral acetabular dysplasia (mean age of 41 ± 9 years). Of these 4 had childhood surgery (3 acetabular and one combined acetabular and femoral procedure). Eleven females had bilateral acetabular dysplasia (mean age 39 ± 11 years). Of these patients 4 had childhood surgery to acetabulum and femur.

The degree of femoral head subluxation was assessed using the Crowe grading (*2*) ; most were Crowe grade 1 and grade 2 (table I). In those with bilateral dysplasia there was asymmetry in the degree of femoral head subluxation. Hence in this bilateral group the femur with the greatest subluxation is designated the worst hip. Femoral lengths are referenced from this side.

The data were analysed using Statview (*1*). Femoral length measurements were compared using the paired t-tests and standard deviations were compared with the F test. Comparison of femoral length asymmetry within a normal population was not possible as no literature exists. However, the total limb length variation in the normal population is known (*5, 7, 8*). It is hence assumed that the variation in limb segments, namely the femoral length, would reflect the total variation of limb lengths.



[Key to figure 1 : The x axis displays the femoral length difference between the femurs in adults with unilateral acetabular dysplasia. The black columns indicate that the affected femur is longer and grey columns shorter. The diagrams at the bottom indicate a dysplastic left acetabulum ; each interval represents a femoral length difference].

Fig. 1. — Histogram showing the frequency of leg length discrepancy in unilateral acetabular dysplasia.

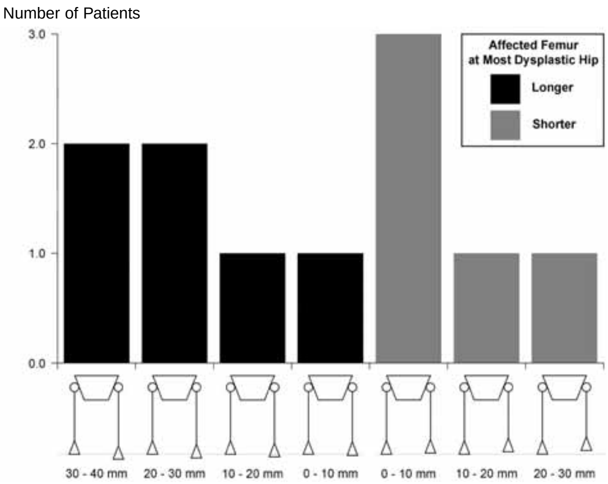
The percentage of subjects grouped into intervals with limb length inequality of 0-5 mm, 6-10 mm, 11-20 mm and greater than 21mm were plotted against femoral length inequality grouped in same intervals for the unilateral dysplasia group only (fig 3). Direct comparison of this variation was facilitated by the coefficient of variation.

The coefficient of variation measures the relative scatter in data with respect to the mean and thus provides a relative measure of data dispersion. This is calculated by dividing the standard deviation by the mean difference of leg lengths and multiplying the product by 100 to make this a percentage. When the coefficient of variation is small, the data scatter compared to the mean is small. When the coefficient of variation is large compared to the mean, the amount of variation is large.

RESULTS

Unilateral Acetabular Dysplasia

The ipsilateral femur was longer than the normal femur in 66% (12 patients) with a peak frequency of femoral lengthening in the 5-10 mm interval (fig 1). The ipsilateral femur was a mean of 4.1 ±



[The x axis displays the femoral length difference between the femurs in adults with bilateral acetabular dysplasia. The femur with the greatest degree of subluxation therefore acetabular dysplasia is designated the reference femur. The black columns indicate that the reference femur is longer and grey columns shorter. The diagrams at the bottom indicate that the left acetabulum is the most dysplastic with greater femoral head subluxation ; each interval represents the femoral length difference].

Fig. 2. — Histogram showing the frequency of leg length discrepancy in bilateral acetabular dysplasia.

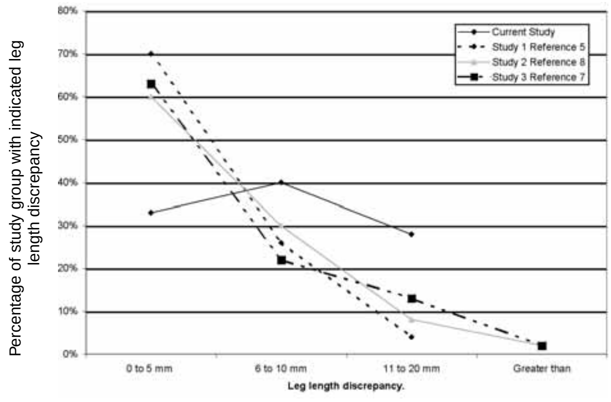


Fig. 3. — Graph showing percentage of study group with a leg length discrepancy.

10.1 mm longer but this difference failed to achieve statistical significance, (p = 0.11). Previous surgery had a deleterious effect on the femoral length with the ipsilateral femur being a mean of 7 mm shorter. In those without previous surgical intervention, the affected femur was a mean of 7.3 ± 6.3 mm longer (p = 0.02). The ipsilateral femur was longer by a mean of 7.2 ± 7.7 mm in the Crowe 1 hips but shorter in Crowe 2 and 3 hips.

Bilateral Acetabular Dysplasia Group

There was a normal distribution of femoral length differences with a large variation (fig 2). The femur with the greater degree of DDH was longer by a mean of 7.5 ± 19.3 mm femoral head to knee. These differences were not statistically significant (p = 0.22). The effect of surgery in this cohort was to lengthen the worst side and these differences failed to reach statistical significance. A relationship between Crowe grade and femoral length difference could not be established.

Variance Compared with Normal Population

In the normal population there is a mean limb length difference of 4 to 5 mm (table II and III). In the normal population the peak frequency of this limb length inequality is in the 0-5 mm interval. In the study group, the peak frequency of femoral length inequality was in the 5-10 mm interval (fig 3). There is a three-fold increase in the coefficient of variation in the study group than exists in a normal population ; this was statistically significant using the F test (p < 0.001). This illustrates that the variation of femoral lengths is greater than limb length variation in the general population.

DISCUSSION

In the presence of a unilateral dysplastic acetabulum, the affected femur is often longer than expected. When both acetabulae are dysplastic, then femoral lengths are unpredictable. The null hypothesis is thus rejected. The variation of the femoral length inequality is greater than exists in a normal population, hence there are abnormal biological factors causing overgrowth of this femur. In the small cohort of patients who had surgical intervention as children, the affected femur was shorter, thus excluding an iatrogenic aetiology for this phenomenon. The exact aetiology for this femoral length difference is unclear.

Table II. — Variance of Leg Length Inequality in Normal population

Study	Number of Participants	Mean Leg Length Inequality	Standard Deviation	Coefficient of Variance
Study 1	100	4.1 mm	3.0 mm	75%
Study 2	247	5.5 mm	4.1 mm	74%

Table III. — Variance of Femoral Length Inequality in the current study

Study	Number of Participants	Mean Femoral Length Inequality	Standard Deviation	Coefficient of Variance
Unilateral DDH	18	4.1 mm	10.1 mm	246%
Bilateral DDH	11	7.5 mm	19.3 mm	295%

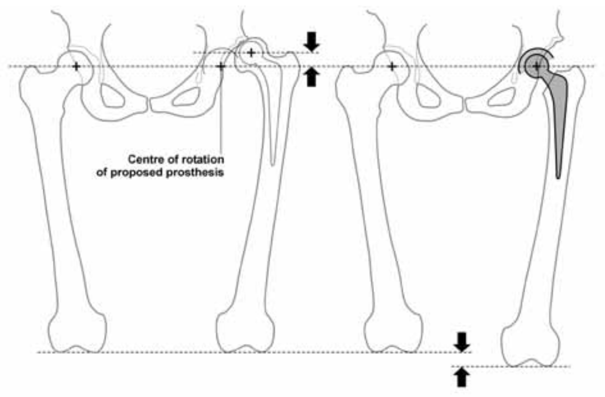


Fig. 4. — Diagram depicting the pelvis and femora of an adult with a dysplastic acetabulum and a long ipsilateral femur ; the knee joint levels are symmetrical. After arthroplasty when the hip centre has been restored the knee joint levels are not symmetrical and the leg has been lengthened.

The value of this paper lies not in the absolute values of femoral length difference but in the observation that in the presence of a dysplastic acetabulum femoral length is unpredictable. Surgical reconstruction, with either arthroplasty or osteotomy, dictates restoration of the hip centre. In the majority of our patients this ipsilateral femur is longer ; restoration of the hip centre would lengthen the limb (fig 4) and such lengthening must enter pre operative calculations and counselling.

Quantitative femoral length inequality in acetabular dysplasia has not been published to our knowledge. Tibial length inequality has been quantified using clinical measurements. In a cohort of patients with unilateral DDH, the ipsilateral tibia was found to be shorter by a mean of 1 cm (7). The assessment of total limb discrepancy in the presence of acetabular dysplasia requires careful assessment of both limb segments. This may be difficult to quantify clinically in the presence of hip subluxation. CT measurements of the femoral and tibial length would give more accurate information. An accurate prediction on limb length inequality post operatively after restoration of the hip centre may be achieved.

Although the main objectives of total hip arthroplasty are in order of priority the relief of pain, stability, mobility and the restoration of equal leg lengths (*3*), limb length discrepancy post arthroplasty is a source of patient dissatisfaction despite achieving a pain free functioning hip (*9*). Such limb length discrepancy is a source of litigation (*4*). Furthermore, in the females with developmental dysplasia of the hip, inequality of leg lengths was considered a major reason for surgery (*9*). Even for lesser degrees of dysplasia, achieving limb length equality is difficult and requires careful planning. Careful preoperative counselling of each patient is necessary as no guarantee can be made that leg lengths can be equalised.

It is advisable when encountering such a patient to assess femoral and tibial lengths preoperatively. CT limb length measurement as an adjunct to a preoperative planning CT scan would not increase the dose of X-ray exposure to a significant degree and would alert the surgeon to the possibility of lengthening the limb.

In the presence of DDH with a high hip centre, several methods may be employed to avoid over lengthening the leg whilst restoring the hip centre. A subtrochanteric osteotomy would minimise this leg length discrepancy and de-tension the sciatic nerve however this is a complex procedure associated with morbidity. A further option would include a trochanteric approach with a low cut on the femoral neck ; reattaching the abductors in an optimal position would minimise the limb length discrepancy.

In conclusion, in the presence of acetabular dysplasia, asymmetry of femoral lengths is common and unpredictable. Careful femoral length assessment (with CT leg lengths) is advised preoperatively. This will alert the surgeon and patient to the possible risk of post operative ipsilateral limb lengthening.

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