SPHERICITY OF THE FEMORAL HEAD ON ANTERIOR-POSTERIOR RADIOGRAPHS OF DYSPLASTIC HIPS

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Abstract: We analyzed the sphericity of the femoral head of dysplastic hips. Using standard anterior-posterior radiographs of the hips, we assessed the femoral head's deviation from a spherical shape using a computer algorithm and via Severin grading. The method presented could serve as a useful tool to quantify differences in sphericity in cases where it is difficult to grade the hip radiologically.

Key Words: Hip Dysplasia, Severin Index, Deviation From Spherical Shape.

INTRODUCTION

In a healthy hip, an anterior-posterior radiograph shows an almost spherical femoral head, corresponding to a congruent spherical shape of the acetabulum. In certain pathological conditions, such as hip dysplasia, the shape of the femoral head may deviate considerably from spherical [1]. The radiological assessment of such deformations (e.g. the Severin index [2]) often depends on subjective criteria. A quantitative evaluation of the contour of the femoral head could provide doctors with an additional objective criterion.

MATERIALS AND METHODS

We analyzed radiographs of 39 dysplastic hips taken from the archive of the Department of Orthopedic Surgery in Ljubljana. We used a previously developed algorithm [3] that determines a perfect best-fitting circle for a given digital contour of the femoral head. A larger deviation of the femoral head from a spherical shape means a greater discrepancy between the contour and the best-fitting circle. This is a measure of the deviation from spherical:

$$\text{deviation} = \frac{1}{r_0}\sqrt{\frac{(r_1 - r_0)^2 + (r_2 - r_0)^2 + \mathbf{K} + (r_n - r_0)^2}{n}} \tag{1}$$

where r_1, r_2, ... r_n are the distances of the respective contour points from the center of the best-fitting circle and r_0 is the radius of the best-fitting circle. The

femoral contours of the hips were put into digital form using a graphic table and the corresponding values of the deviation from sphericity were computed (Fig. 1). The pelvic radiographs of the dysplastic hips were independently graded according to Severin [2] and compared with the computed values.
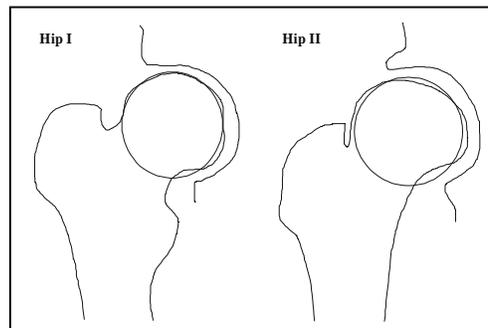

Fig. 1.   The femoral contours of two dysplastic hips with the corresponding best-fitting circles. Hip I was graded as 1b (Severin index), and the computed deviation from spherical equals 3.8%. Hip II was graded as 2a, with a computed deviation of 8.1%.

RESULTS AND DISCUSSION

In the group of hips with heads radiologically graded as spherical (1a and 1b on the Severin index, 17 hips), the average deviation from spherical was 4.2% $\pm$ 1.0% (range 2.7% - 6.6%). In the group of hips with heads radiologically graded as deformed (2a and 2b on the Severin index, 22 hips) the average deviation from spherical was 7.6% $\pm$ 2.8% (range 4.3% - 14.9%). The difference in the average values is statistically significant ($p < 10^{-4}$). We estimated that the heads with values lower than 4.0% correspond to the group with spherical heads while the heads with values higher than 7.0% correspond to the group with deformed heads.

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