



Should routine pelvic osteotomy be added to the treatment of DDH after 18 months ?

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The treatment of developmental dysplasia of the hip (DDH) between ages 1-3 years is controversial. Particularly controversial is the age after which pelvic osteotomy should be added to the treatment. In the present study, the outcomes of DDH patients aged 1-3 years treated with anterior open reduction alone were evaluated, and the relationship between inadequate acetabular development, the need for secondary pelvic osteotomy, and age was investigated. A total of 53 patients (70 hips) who had begun walking, who had undergone open reduction through an anterolateral approach, who had a follow-up period of at least 2 years, and who had Tönnis grade III and IV hip dysplasia were included in the study. They were grouped according to treatment age (pre-18 months : Group I ; post-18 months : Group II), and the two groups were compared with regard to radiological and functional outcomes and the need for a secondary acetabular procedure. In Group I there were 29 hips (mean age : 16.09 months) and in group II there were 41 hips (mean age : 23.1 months), and the mean follow-up period was 48.9 months. According to the modified Trevor score, in Group I outcomes were excellent in 23 hips (79.3%) and good in 6 hips (20.7%), while in group II outcomes were excellent in 30 hips (73.2%), good in 10 hips (24.4%), and fair in 1 hip (2.1%). The difference between outcomes was not significant ($P > 0.05$). Inadequate acetabular development was determined in 11 hips in group I (37.9%) and in 16 hips in group II (39%). There was no difference between groups in terms of inadequate acetabular development or the need for acetabular procedures ($p > 0.05$). No significant difference was determined between DDH patients treated before 18 months and those treated after

18 months with regard to unsatisfactory acetabular development or the need for secondary acetabular procedures. According to these results, reduction prior to 18 months does not always achieve satisfactory acetabular development, and secondary acetabular procedures are not always necessary in patients who undergo reduction after 18 months. In the treatment of DDH, the decision to perform primary pelvic osteotomy in addition to open reduction should be made not according to whether the patient is older or younger than 18 months, but according to stability, and all patients should be followed closely with regard to the need for pelvic osteotomy.

Key Words : Developmental hip dysplasia, open reduction, pelvic osteotomy.

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INTRODUCTION

The goal in the treatment of developmental dysplasia of the hip (DDH) is to achieve and maintain concentric reduction. If concentric reduction can be maintained, then it is assumed that the acetabular abnormalities will be corrected and normal development will take place (1,5,6,15,23).

Inadequate treatment leads to secondary acetabular dysplasia and, in the young adult period, secondary osteoarthritis. In order to prevent secondary acetabular dysplasia and osteoarthritis, the first treatment must be carried out early, correctly, and adequately (7,14,16,17,21).

The method of treatment in children aged 1-3 years with DDH is controversial (3,9,12). In the literature various treatment methods in this age group are reported, including closed reduction alone, open reduction alone, and open reduction along with pelvic and/or femoral osteotomy (3,6,9,17). In general, there is a widespread tendency for open reduction alone before 18 months, and open reduction along with femoral and/or pelvic osteotomy after 18 months. This tendency is based on the notion that the acetabulum will not be corrected in patients who do not undergo osteotomy after 18 months and that secondary acetabular dysplasia will develop. However, it is not known how true this notion is.

In the present study, the outcomes of children treated with open reduction alone between ages 1-3 were evaluated, and the relationship between the development of secondary acetabular dysplasia, the need for a secondary acetabular procedure, and treatment age was investigated.

MATERIALS AND METHODS

A total of 53 patients (46 female, 7 male ; 70 hips) treated in our clinic between 1999 and 2009, the youngest 13 months and the oldest 32 months, were investigated. All had undergone open reduction through an anterolateral approach after the onset of walking, had follow-up periods of at least 2 years, and had Tönnis grade III or IV hip dysplasia. Left hip dislocation was present in 21 patients, right hip dislocation in 15, and bilateral dislocation in 17.

Patients were placed into two groups according to treatment age : Group I (younger than 18 months) and Group II (older than 18 months). In Group I, 29 hips of 24 patients were evaluated. The mean age was 16.06 months (± 1.16), the youngest being 13 months and the oldest 17 months. In Group II, 41 hips of 29 patients were evaluated. The mean age was 22.87 months (± 4.54), the youngest being 19 months and the oldest 39 months. The total follow-up period was at least 24 months, the longest being 136 months, with an average follow-up period of 48.92 months (± 33.61).

Skeletal or skin traction was not performed in any of the patients in the period prior to surgery.

In the patients' preoperative radiological assessment, neutral pelvis A-P radiographs were taken. Because all patients were Tönnis grade III or grade IV, the treatment planning did not require radiography in other positions.

Clinical and radiological evaluation was carried out according to the modified scoring system of Trevor *et al* (18). In this system, the maximum is 20 points and the minimum 5 points. Hips are classified as excellent at 18-20 points, good at 15-17 points, fair at 12-14 points, and poor below 12 points.

Images taken at the final follow-up were used in measuring the acetabular index and Wiberg's central-edge angle. Radiographic evaluation of osteonecrosis was performed according to Kalamchi and MacEwen's classification (10). The two groups were compared with regard to radiological and functional outcomes and the need for a secondary acetabular procedure. A broken Shenton-Menard line, and/or an upward-oriented acetabular sourcil and an acetabular index (AI) of 35° or higher 2 years after reduction were considered to be indicative of secondary acetabular dysplasia (2,11,12).

Between-group descriptive statistics included the mean, the standard deviation, and the minimum and maximum values. The suitability of continuous variables for the normal distribution hypothesis was investigated using the Kolmogorov-Smirnov test, and homogeneity by the Levene test. The independent Student's t test was used in the comparison of between-group averages, and the chi-square test was used in assessments of frequency (countability).

A 95% confidence interval was used in all tests in this study. Descriptive statistics and analyses were carried out using an SPSS 15.0 package program for Windows.

RESULTS

In Group I, the preoperative mean acetabular index was 39.38 (± 5.86), the final mean control

acetabular index was $25.21 (\pm 6.70)$, and the final mean control CE index was $21.06 (\pm 6.89)$. In Group II, the preoperative mean acetabular index was $39.12 (\pm 5.13)$, the final mean control acetabular index was $25.10 (\pm 6.75)$, and the final mean control CE was $20.02 (\pm 5.56)$. No statistically significant difference was found between groups in the preoperative and final mean control acetabular index angles and the final mean control CE angle ($p > 0.05$).

According to the modified Trevor score, in Group I outcomes were excellent in 23 hips (79.3%) and good in 6 hips (20.7%), while in Group II outcomes were excellent in 30 hips (73.2%), good in 10 hips (24.4%), and fair in 1 hip (2.4%) (Fig. 1). The difference in outcomes was not significant ($p > 0.05$).

AVN ratios were evaluated according to the Kalamchi-MacEwen classification. However, because our cases did not have adequate intermediate follow-up images, grade IV avascular necrosis was present only in 2 hips in which we thought it affected the hips' functional outcome. One hip in Group I, the other one in Group II.

The two groups were compared with regard to inadequate acetabular development and the need for a secondary acetabular procedure. Inadequate acetabular development was found and a secondary surgical procedure required in 11 hips in Group I (37.9%) and in 16 hips in Group II (39%).

The first preoperative (open reduction) mean acetabular index was $40.44 (\pm 4.66)$ in those requiring a secondary surgical procedure, and $38.47 (\pm 5.74)$ in those not requiring one. The difference was not statistically significant ($p > 0.05$).

No neurovascular damage or surgical site infection was found in any of our cases. Blood transfusion was not necessary in the intraoperative or postoperative period.

DISCUSSION

The goal in the treatment of DDH is to achieve concentric reduction and to maintain it throughout childhood and adolescence. When concentric and stable reduction is achieved, it is assumed that hip pathologies will be corrected and that there will be normal growth and development (2,3,16,17).



Fig. 1. — (A) 15 months old female patient with right DDH, (B) X-ray three years postoperatively shows secondary acetabular dysplasia, AI is 39° , and Shenton-line is broken (C) three years after Pemberton Osteotomy, x-ray shows good coverage.



Fig. 2. — (A) 28 months old child with left hip DDH, (B) x-ray two years postoperatively, (C) and eight years postoperatively, showing an AI angle of 18° and CE angle of 25° .

Secondary dysplasia resulting from inappropriate treatment leads to early degenerative joint disease. There is much data showing a relationship between the success of the primary treatment and degenerative joint disease. Malvitz and Weinstein reported that degenerative joint disease developed in 46% of Severin grade III and IV cases, and in only 3% of grade I and II cases (14). There are two ways to avoid these negative outcomes of secondary dysplasia. The first is to perform the primary treatment of DDH appropriately to the patient's age, and the second is the early identification of patients developing secondary dysplasia, and the addition of secondary pelvic osteotomy. However, the treatment of DDH between 1-3 years is a subject of debate (2,3,9). The age after which pelvic osteotomies should be added to the primary treatment is particularly controversial (8,19). Alongside authors recommending early, routine osteotomy (17), there are those who think that this is unnecessary for many patients (1,5). Generally, open reduction alone is prevalent before 18 months, and there is a tendency to perform femoral and/or pelvic osteotomy in addition to open reduction after 18 months. This tendency is based on the notion that the acetabulum will not improve and that secondary acetabular dysplasia will develop in patients not undergoing osteotomy after 18 months. However, it is not known how true this notion is. In the present study, the outcomes of patients younger and older than 18 months who were treated with anterior open reduction and who did not undergo pelvic or femoral osteotomy in addition to their primary treatment were compared with regard to the development of secondary acetabular dysplasia and the need for a secondary acetabular procedure. High rates of secondary acetabular dysplasia and the need for a secondary acetabular procedure were found both in the first group, with a mean age of 16.06 months, and in the second group, with a mean age of 22.87 months, and the rates were similar in the two groups. According to these results, the notion that secondary dysplasia will be rare in patients younger than 18 months receiving appropriate treatment but that it will nearly always develop in patients older than 18 months if pelvic osteotomy is not added to the primary treatment is not correct. Adding early rou-

tine pelvic osteotomy to the primary treatment of every DDH patient older than 18 months amounts to unnecessary pelvic osteotomy in 60% of patients. According to our findings, the decision to perform a primary acetabular procedure in addition to open reduction in the treatment of DDH should be made not according to whether the patient is younger or older than 18 months, but according to stability, and every patient should be followed closely with regard to acetabular development.

It is debated whether the pre-reduction AI value should be used as a criterion in the decision to add an acetabular procedure to the primary treatment (8, 11, 12). In the present study, the preoperative mean acetabular index was found to be 40.44 (\pm 4.66) in cases requiring a secondary surgical procedure, and 38.47 (\pm 5.74) in those not requiring one. The difference was not statistically significant ($p > 0.05$). In light of this finding, we think that preoperatively measured acetabular index value should not be a criterion in early primary pelvic osteotomy. The preoperative acetabular index improvement rate and the final value of the acetabular index are more important criteria.

It is of great importance to identify residual acetabular dysplasia correctly and at an early age. In this way, secondary surgeries performed at young ages in hips that are likely to have bad outcomes could positively change the outcomes, and unnecessary secondary surgeries at young ages would be prevented for dysplasias that are likely to have good outcomes (1, 2, 11, 12, 22). For this, the diagnostic criteria for residual acetabular dysplasia need to be clear and predictive. However, different diagnostic criteria are used by different authors in the literature on this subject (2, 11, 12, 20). The predictors of residual acetabular dysplasia include V-shaped teardrops, a broken Shenton line, and upward-oriented acetabular sourcil. Albinana *et al* (2) found that acetabular index is an early predictor of Severin classification in the adult period, and that in cases where the acetabular index is 35° or greater two years after reduction, there is an 80% chance of a Severin classification of III or IV in adulthood. Kim *et al* (12, 13) report that the center-head distance difference (CHDD), previously described by Chen *et al* (5), is predictive of outcome in patients treated

with closed reduction and followed up for an average of 13 years. They report that if the CHDD is 6% or greater at 4-5 years of age, and if the acetabular sourcil has an upward slope, then dysplasia is permanent and requires secondary surgical correction. While many radiographic diagnostic criteria have been identified, these are inadequate, particularly in borderline cases. Wakayashi *et al* state that, while there is a high signal intensity region in the weight bearing section of acetabular cartilage on T2-weighted coronal MRI cross sections, the high signal intensity region disappears or decreases in the postoperative period (20). In the present study, we used three diagnostic criteria for residual acetabular dysplasia: a broken Shenton-Menard line and/or an upward-oriented acetabular sourcil, as well as an AI of greater than 35° in the second year after open reduction. While these diagnostic criteria are controversial, this will not affect the results of the study, since the same criteria were used in both groups.

This study has three weaknesses. The first is that one of the parameters according to the modified Trevor score, which evaluates the functional status of the hips, is Wiberg's CE angle. However, because some of our patients were younger than 6 years at follow-up, the appropriateness of the CE angle is debatable. The second is that, although the follow-up period was sufficient (at least 2 years), we think that a longer follow-up time is needed for the determination of long-term complications such as osteoarthritis. The third is that AVN ratios could not be thoroughly evaluated because the intermediate follow-up images were missing.

In terms of inadequate acetabular development and the need for a secondary acetabular procedure, there was no difference between patients treated before 18 months and those treated after. Open reduction performed before 18 months does not always achieve adequate acetabular development, and patients undergoing reduction after 18 months do not always require a secondary acetabular procedure. The decision to perform primary pelvic osteotomy in addition to open reduction should be made not according to whether the patient is younger or older than 18 months, but according to stability, and every patient should be followed closely with regard to acetabular development.

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