ONE-STAGE CORRECTION OF NEGLECTED
DEVELOPMENTAL DYSPLASIA OF THE HIP
BY OPEN REDUCTION AND PEMBERTON OSTEOTOMY

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Background and purpose: Pemberton osteotomy is commonly used for correction of hip dysplasia. Its application in treating hip dislocation is rarely reported. The purpose of this study was to determine the efficacy of one-stage open reduction and Pemberton osteotomy of neglected developmental dysplasia of the hip (DDH).

Methods: We retrospectively reviewed the clinical and radiographic results of one-stage total correction in 75 patients with neglected DDH (86 hips) from 1984 through 1996. Sixty-nine patients (77 hips) aged 13 to 76 months (mean, 21.5 mo) underwent open reduction, Pemberton osteotomy, and hip spica for 8 weeks. Seven patients (9 hips) aged 29 to 73 months (mean, 46.6 mo) underwent additional femoral shortening (another hip in one bilaterally involved patient underwent only open reduction and Pemberton osteotomy).

Results: Acetabular index improved markedly from 40.4° (range, 25–60°) preoperatively to 16.2° (range, 0–30°) postoperatively. Complications included redislocation in four patients (4 hips) and avascular necrosis in three patients (3 hips). Reoperation was performed in four patients (4 hips). All patients were followed up for at least 3 years. By Severin’s classification, all operated hips had excellent (18) or good (68) final radiographic results. The functional results, evaluated by McKay’s criteria, were also excellent (52 patients/60 hips) and good (23 patients/26 hips).

Conclusions: Neglected DDH was safely and effectively treated by open reduction, Pemberton osteotomy, and optional femoral shortening with limited complications.

Although neonatal screening programs for hip dislocation have been implemented in many countries, it is not uncommon to see a child with neglected developmental dysplasia of the hip (DDH) reach walking age [1, 2]. Treatment of DDH in older children who have begun to walk is difficult due to adaptive shortening of the extra-articular soft tissues, and deformity of the bony structure including acetabular dysplasia, angulation, and rotation of the proximal femur [3]. Many methods including closed and open reduction have been proposed to solve this perplexing problem. However, complications such as avascular necrosis of the femoral head and residual hip dysplasia remain unacceptably high [4–6]. One-stage total correction consisting of open reduction, capsulorrhaphy, pelvic osteotomy, and optional femoral shortening has been used with various degrees of success [2, 4, 5, 7, 8]. Pemberton pericapsular osteotomy is an accepted treatment for hip dysplasia and subluxation [9–11]. However, its application in the treatment of hip dislocations has rarely been reported. This study assessed the clinical and radiographic results, complications, and requirement for subsequent operations in patients with neglected DDH who underwent one-stage total correction with open reduction, Pemberton osteotomy, and optional femoral shortening.
Materials and Methods

We retrospectively reviewed the charts and radiographs of 75 patients of walking age with neglected DDH (86 hips) treated at National Taiwan University Hospital from 1984 through 1996 (Table). No dislocated hips had been previously treated. Children with connective tissue disorders, neuromuscular diseases, infection of the hips, previous treatment for dislocation, or lack of follow-up records for at least 3 years were excluded. Of the 11 patients with bilateral dislocations, one patient underwent different operations for two hips.

Sixty-nine patients (77 hips) aged 13 to 76 months (mean, 21.5 mo) underwent one-stage open reduction, capsulorrhaphy, Pemberton osteotomy, and hip spica for 8 weeks. Seven patients (9 hips) aged 29 to 73 months (mean, 46.6 mo) underwent additional femoral shortening due to difficulty of reduction (another hip in one patient underwent only open reduction and Pemberton osteotomy). No patient underwent preoperative traction.

An anterior iliofemoral approach was used for the open reduction, and an iliopsoas tenotomy was routinely performed. The ligamentum teres and transverse acetabular ligament were also removed during operation. The joint was then inspected for intraarticular fibrofatty tissue, limbus, and acetabular dysplasia. Any soft tissue in the acetabular fossa was cleared away to allow reduction of the head deeply into the socket. The likelihood of achieving a stable reduction was also assessed. Pemberton periacetabular osteotomy was then performed, in which a resected triangular bone of iliac crest was lodged in the upper margin of the acetabular rim to change the direction of the acetabular roof anteriorly and laterally without internal fixation.

If reduction of the femoral head after Pemberton osteotomy was difficult without excessive pressure, proximal femoral shortening was performed. Using a lateral approach, the proximal end of the femur was exposed subperiosteally and a transverse osteotomy was made at the subtrochanteric region. The two mobilized femoral segments were allowed to overlap, and reduction of the hip was usually obtained quite easily. The overlapped part of the femur was removed. The osteotomy was then fixed with a small dynamic-compression plate and screws.

A one-and-a-half hip spica cast consisting of plaster of Paris covered with fiberglass was applied immediately after operation for a period of 8 weeks. The hips were held at 30° of abduction and 20° of flexion with neutral rotation. During this period, patients were allowed to be carried horizontally but not vertically.

Data on several radiographic evaluations were collected for analysis. The acetabular index on the initial and final radiographs was measured to evaluate the acetabular correction and development. The center–edge angle of Wiberg was also measured on the last follow-up radiographs. The severity of dislocation was graded using the Commission for the Study of the Hip Dysplasia System [12], based on the relationship between the ossified nucleus of the femoral head and the superolateral margin of the acetabulum. All operated hips in this study were obviously dislocated, among which six hips (7.0%) were classified as grade II, 51 hips (59.3%) as grade III, and 29 hips (33.7%) as grade IV.

All radiographs were evaluated to determine the presence of avascular necrosis of the femoral head by the criteria of Salter et al [13]. Severin’s classification was used to grade the hips radiographically from excellent to poor [4]. Clinical results were determined using a modification of the McKay criteria [4].

Results

The average duration of follow-up was 49.5 months (range, 36–181 mo). All hips were concentrically reduced, as shown in the follow-up radiographs (Fig. 1), except for four hips that were redislocated. After the index operation, 18 hips (20.9%) were in Severin class I, 64 (74.4%) in class II, and four (4.7%) in class VI. However, this classification improved to 18 hips (20.9%) in Severin class I and 68 hips (79.1%) in class II after subsequent operations. One patient underwent two more operations due to subluxation and coxa valgus, which developed after the first open reduction.

The mean preoperative acetabular index was 40.4 ± 7.0° (range, 25–60°), and the mean postoperative acetabular index was 16.2 ± 6.8° (range, 0–30°) (p < 0.001, paired t-test). The mean postoperative center–edge approach, the proximal end of the femur was exposed subperiosteally and a transverse osteotomy was made at the subtrochanteric region. The two mobilized femoral segments were allowed to overlap, and reduction of the hip was usually obtained quite easily. The overlapped part of the femur was removed. The osteotomy was then fixed with a small dynamic-compression plate and screws.

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angle was 40.1 ± 10.9° (range, 15–73°). Functional results were rated as excellent in 52 patients (60 hips, 69.8%) and good in 23 patients (26 hips, 30.2%), according to the McKay criteria.

Avascular necrosis of the femoral head was noted in three of 86 hips (3.5%) at follow-up. The age at operation was 14 months, 22 months, and 19 months, respectively (mean, 18.3 months). These patients were all asymptomatic in daily life. No avascular necrosis of the femoral head was noted in patients who underwent femoral shortening.

Redislocation developed in four of 86 hips (4.7%). The age at operation was 22 months, 48 months, 21 months, and 16 months, respectively (mean, 26.8 mo). One of these patients underwent open reduction and hip spica fixation again 3 months later (Fig. 2), another patient underwent open reduction, femoral shortening, and hip spica 3 months later, another underwent closed reduction and spica fixation 1 year later, and one patient developed subluxation and coxa valgus 11 months after the first re-operation (which included open reduction, hip spica fixation for 2 months, and abduction brace fixation for another 3 months). Further open reduction, Pemberton osteotomy, and varus derotational osteotomy were performed again in this patient and the hip was finally reduced to a good position. All four hips were reduced in the last radiographs.

Two patients had mild hip dysplasia, detected on 51-month and 54-month follow-up radiographs; these patients were also asymptomatic.

Discussion

The successful treatment of DDH includes concentric reduction without interposition of soft tissues, maintenance of good joint congruity, maintenance of the hip in a stable position without interference with blood supply, minimization of immobilization time, and good remodeling of the hip [1].

Many treatment modalities have been reported to achieve an excellent prognosis for DDH with indications depending on the age and specific pathologic conditions. Treatment becomes more difficult as patients grow older [1–3].

Conservative treatment with closed reduction and hip spica casting requires a long immobilization time and is likely to require subsequent acetabular or femoral reconstruction if patients are older than 1 year [14]. Open reduction alone may also not be adequate to obtain and maintain hip stability. A combination of open reduction with femoral or pelvic osteotomy is usually applied to facilitate stable reduction [15]. It is reasonable to correct all abnormalities of the hip joint in one surgical session, which minimizes the length of hospitalization, avoids prolonged immobilization in plaster, and offers the newly formed hip a chance to grow in a theoretically normal condition.

Several studies have evaluated the long-term functional and radiographic results of a one-stage operation for DDH in children beyond walking age. Salter and Dubos reported the results of open reduction and innominate osteotomy of 30 hips in children who were 4 to 10 years old [6]. Most (57%) hips had good or excellent radiographic results at an average of 7 years’ follow-up. Galpin et al reported the results of one-stage treatment without preoperative traction in patients who were older than 2 years [5]. Almost 75% of patients

Fig. 1. This boy had neglected developmental dysplasia of the hip on the right side with grade III dislocation. Open reduction and Pemberton osteotomy were performed under general anesthesia. A one-and-a-half hip spica cast was applied for 8 weeks. A) Radiograph at the age of 15 months. B) Latest radiograph at 4 years after operation, showing Severin class II.
achieved good or excellent radiographic results. Shih and Shih reviewed the results of one-stage combined surgery for congenital dislocation of the hips in older children and found a similar satisfactory rate (80%) [2]. Karakas et al performed one-stage combined operations in 55 hips in 47 patients, and found that 37 hips had good or excellent clinical results and 36 hips had good or excellent radiographic results [7]. Huang and Wang reviewed a comparative study of nonoperative versus operative treatment of developmental dysplasia between the ages of 13 and 17 months [3]. They concluded that neglected DDH in patients of walking age was better treated by open reduction plus pelvic osteotomy, with good to excellent results in 31 of 32 hips.

Fig. 2. This girl had neglected developmental dysplasia of the hip on the left side with grade III dislocation. Open reduction and Pemberton osteotomy were performed under general anesthesia. A one-and-a-half hip spica cast was applied for 8 weeks. However, redislocation was noted 3 months after operation and open reduction was performed again. A) Radiograph at the age of 21 months. B) Radiograph at 8 weeks postoperatively after removal of the cast. C) Redislocation developed 3 months after operation and open reduction was performed immediately. D) Radiograph at 9 months after operation. E) Radiograph at 4 years and 5 months after operation, showing Severin class II.
Pelvic osteotomy can redirect the acetabulum, increase the stable zone of the hip, and facilitate the development of the hip toward normal. The treatment was designed to correct acetabular dysplasia. The indications for Pemberton osteotomy are large acetabular index, flexible triradiate cartilage, and age ranging from 1 to 14 years according to Pemberton [10] and 3 to 10 years according to Faciszewski et al [9]. The benefits of this osteotomy procedure include covering the anterior defect, downward and lateral displacement of the acetabular roof, rotation axis within the hip joint, no fracture, good stability, no rotation of the entire socket, greater degree of correction, and no need for internal fixation and secondary operation to remove previous implants. However, Coleman claimed Pemberton osteotomy had the disadvantages of being a difficult technique that alters the configuration and capacity of the acetabulum [16]. MacEwen reported stiffness due to change in the acetabular roof and increased acetabular pressure after Pemberton osteotomy [17].

There have been few reports of Pemberton osteotomy [9–11]. Pemberton reported good results in all of the 46 patients who were younger than 4 years at the time of operation [10]. However, of the 21 patients who were older than 7 years, only 12 had good results and six had fair results. Coleman reported that 42 of 52 patients between the ages of 3 and 10 years achieved essentially developed hips [16]. In the present series, we broadened the indication of Pemberton osteotomy to dislocated hips and the results were satisfactory.

The acetabular index and center–edge angle in postoperative follow-up examinations are helpful in understanding acetabular development and the acetabular-femoral relationship. The center–edge angle should be at least 20° and preferably 25° to ensure normal seating of the femoral head [17]. Wiberg reported that the physiologic range of the center–edge angle was 20 to 40° [18]. Karakas et al reported the final measurement of the mean center–edge angle at 37° in patients undergoing Salter osteotomy [7], whereas Barrett et al reported an average of 30° [4]. In the present study, the mean postoperative center–edge angle was 40.1°, which indicates a deep seating of the femoral head after Pemberton osteotomy. The average improvement of the acetabular index was 24.2°, from 40.4° preoperatively to 16.2° postoperatively, which is superior to the results of Utterback and MacEwen, who found an average 10° improvement in acetabular index after pelvic osteotomy, and Barrett et al, who reported an average 16° improvement with Salter osteotomy [4]. In the present study, the improvement of the acetabular index was superior to that reported with Salter osteotomy.

Avascular necrosis of the femoral head is one of the most serious complications in treating DDH and can lead to leg length discrepancy, head and neck deformities, relative overgrowth of the greater trochanter, acetabular dysplasia, joint incongruity, and late arthritis [19]. In our series, three of 86 hips (3.5%) developed avascular necrosis, which is similar to the percentage reported by Tönnis (5.5%, regardless of the treatment method) [20]. Premature closure of the triradiate cartilage, an unusual complication of Pemberton osteotomy [21], was not found in our series.

Redislocation occurred in four of 86 hips (4.7%), less frequent than reported by Galpin et al (12.1%) or Karakas et al (6.15%) after Salter osteotomy [5, 7]. There were two grade III and two grade IV dislocations preoperatively in the present study, both of which were successfully treated by closed or open reduction and spica immobilization. Another redislocation occurred in a patient with high dislocation who underwent open reduction, Pemberton osteotomy, and inadequate femoral shortening. Subsequent open reduction and femoral shortening was performed in this patient to obtain a stable joint. The last case of redislocation occurred due to inappropriate acetabular redirection, and involved retroversion of the acetabulum after Pemberton osteotomy and persistent coxa valgus, which necessitated additional Pemberton osteotomy and femoral derotational osteotomy. All patients with redislocation finally obtained good radiographic and clinical results.

In conclusion, one-stage total correction consisting of open reduction, capsulorrhaphy, Pemberton osteotomy, and optional femoral shortening can be safely and effectively applied in the same procedure in patients with neglected dislocated DDH with open triradiate cartilage without increasing the risk of complications compared to multiple-stage procedures.

References


