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Radical reduction for developmental dislocation of the hip (Çakırgil's procedure)

Gelişimsel kalça displazisinde radikal redüksiyon (Çakırgil ameliyatı)

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Bu makalede, dört yaş üstü çocuklarda yüksek kalça çıkıklarının tedavisinde kullanılan radikal redüksiyonun (Çakırgil ameliyatı) püf noktaları ve diğer yöntemlere üstünlüğü tartışılmıştır. Adduktor tenotomi, açık redüksiyon, femoral kısaltma, proksimal femoral varizasyon-derotasyon osteotomisi ve Dega asetabuloplastisini tek seansta uygulayan bu teknik, belirli kurallara sadık kalındığında komplikasyon oranı düşük, başarılı bir girişimdir.

This paper describes the so called "radical reduction of the hip" (Çakırgil's) procedure for children above four years of age, with high developmental dislocation of the hip. The procedure is a combined one-stage operation including adductor tenotomy, open reduction, femoral shortening, proximal femoral varus-derotation osteotomy and Dega's osteotomy. Radical reduction is a safe and effective procedure for high dislocations with shallow acetabulum.

Introduction and technique

Nowadays, surgical treatment for developmental dislocation of the hip (DDH) is decreased with hospital births, routine physical examination, early diagnosis with the advent of ultrasound and successful Pavlik harness treatment in the first 6 months. The main goal of the treatment is to obtain a nearly normal hip joint anatomically and functionally while avoiding avascular necrosis and redislocation. If harness therapy fails, closed reduction and casting under anesthesia or open reduction and casting gives good results.[1,2] In children over 18 months, to decrease the incidence of secondary surgeries; bony procedures may be added to open reduction. Proximal femoral varization – derotation osteotomy and / or pelvic osteotomies (usually Salter) are used to treat bony pathologies.[2,3] Salter osteotomy may not correct a shallow acetabulum with an acetabular index angle more than 40 – 45 degrees in a child over 4 years old.[2,4] A forced reduction of the femoral head without shortening will lead to avascular necrosis and /or reluxation.[5,6] One of our mentors in the clinic, Professor Güngör Sami Çakırgil described a "radical reduction" procedure for the treatment of developmental dislocation of the hip in older children to overcome all the pathologies.[7,8] This procedure include; adductor tenotomy, open reduction, femoral varization – derotation osteotomy with shortening and Dega osteotomy. The aim of this article is to give details of the procedure and compare it with the similar procedures.

Surgical technique

Under general anesthesia and the patient positioned supine, surgical field is prepared from the 12th rib to the foot. The whole iliac wing, the hip joint and the proximal half of the femur should be accessible and draped. Initially adductor tenotomy is done from a small medial incision. The main incision begins 3 cm posterior to spina iliaca anterior superior (SIAS), curved to trochanter major and than extended straightly to the shaft for 5 – 7 centimeters.

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(Fig 1A). Fascia is incised from SIAS down with the line of the skin incision (Fig 1B). Fascia is retracted superiorly and hip joint is approached anterolaterally between tensor fascia latae and musculus sartorius (Fig 1C). Anterior 2/3 of iliac aphophysis is cut to the bone into 2 halves and by subperiosteal blunt dissection separated from the iliac wall. By this way abdominal muscles medially and gluteal muscles laterally were released from the iliac wing. Two blunt Hohmann retractors are inserted in the sciatic notch laterally and medially. Direct head of musculus rectus femoris from the inferior iliac spine is found (Fig 1D) and after marking with a 0 whip suture for later reattachment, is cut. The reflected head of rectus femoris muscle is also found in the superior acetabular margin and cut. The hip capsule to the point of inferomedial acetabulum is bluntly dissected and a clear vision is obtained. Over the capsule, by blunt dissection medially, the tendinous part of the iliopsoas muscle is found and tenotomized near its insertion (Fig 1E). The elongated capsule is cut parallel to the anterior acetabular rim to the inferior end. With another incision perpendicular to the first, the capsule is opened in a "T" fashion. Ligamentum teres is cut from both sides and resected. A Hohmann retractor is placed inferior to the transverse ligament and the ligament is cut. The fibrofatty tissue inside the acetabulum is also removed (Fig 1F). If the inverted labrum still not allowing reduction, with 1 or 2 radial incisions it might be released. To prevent iatrogenic injury to the acetabular growth centers, extreme care should be taken. The capsule is released from the lateral wall of the ilium to the superior acetabulum. After these measures, proximal femoral osteotomy is done. Vastus lateralis muscle is sharply dissected in an "L" fashion distal to the trochanteric apophysis and proximal femur is exposed. After reduction of the hip, by abduction and internal rotation, the most congruent and concentric reduction is obtained and the proximal femur is hold steadily in this position. A guide K wire is inserted parallel to the floor and perpendicular to the patient, centrally in the femoral neck showing the amount of varus and derotation. In high dislocations which the hip could not be reduced, after the correction of anteversion, the K-wire is inserted parallel to the floor and with an angle that would correct coxa valga. This guide wire will also help to manipulate the proximal femur after trochanteric osteotomy. A blade plate guide is driven by light hammer blows distal to the trochanteric apophysis to the inferomedial border of femoral neck parallel to the K-wire in two planes (Fig 1G). A 90º AO infantile blade plate is chosen with appropriate sized blade and medial displacement. The more varus correction needed, the more medial displacement of the distal part should be done in order to prevent mechanical axis deviation and bone healing problems in a laterally placed femoral shaft. To medially displace the distal part, a blade plate with more displacement should be chosen. After extracting the guide, the appropriate blade plate is placed in the center of the neck to the previously prepared bed until the distal part impinges on the femoral shaft. An inter-trochanteric or subtrochanteric osteotomy parallel to the blade of the plate, at the level of the distal bend of the plate is done. After completion of the osteotomy, by the help of the guide wire; the proximal portion is abducted and the blade plate is driven down to the end of the plate without damaging capital femoral physis. After reduction of the head, the amount of shortening needed is calculated from the overlapping proximal and distal parts. The shaft osteotomy is done after lateral rotation of the distal part to neutral, parallel to the proximal osteotomy and perpendicular to the femoral axis with appropriate shortening (Fig 1H). Flexion or extension deformity will occur if the osteotomy is not done perpendicular to the shaft axis in the sagittal plane. Also if the osteotomy is not done parallel to the proximal part, the correct varization could not be achieved or the plate will not properly seated to the shaft. The resected trapezoidal bone is kept for iliac osteotomy bone grafting procedure. After the osteotomy, distal part is fixed to the proximal part in compression mode by three screws from the plate. The next step is Dega pericapsular acetabuloplasty. The osteotomy line is parallel to the curve of the capsule approximately 7 to 10 mm superior to the acetabular margin (Fig 1I). A curved osteotome is used during osteotomy. The level and direction of the osteotomy; and the medial wall integrity is controlled with image intensifier or by direct radiograms (Fig 1J). Great care is taken no to disturb the posterior part of the triradiate cartilage. We prefer Dega's first technical description in which acetabulum is mobilized from the cancellous bone of the roof portion and the medial iliac wall is left intact.[9]

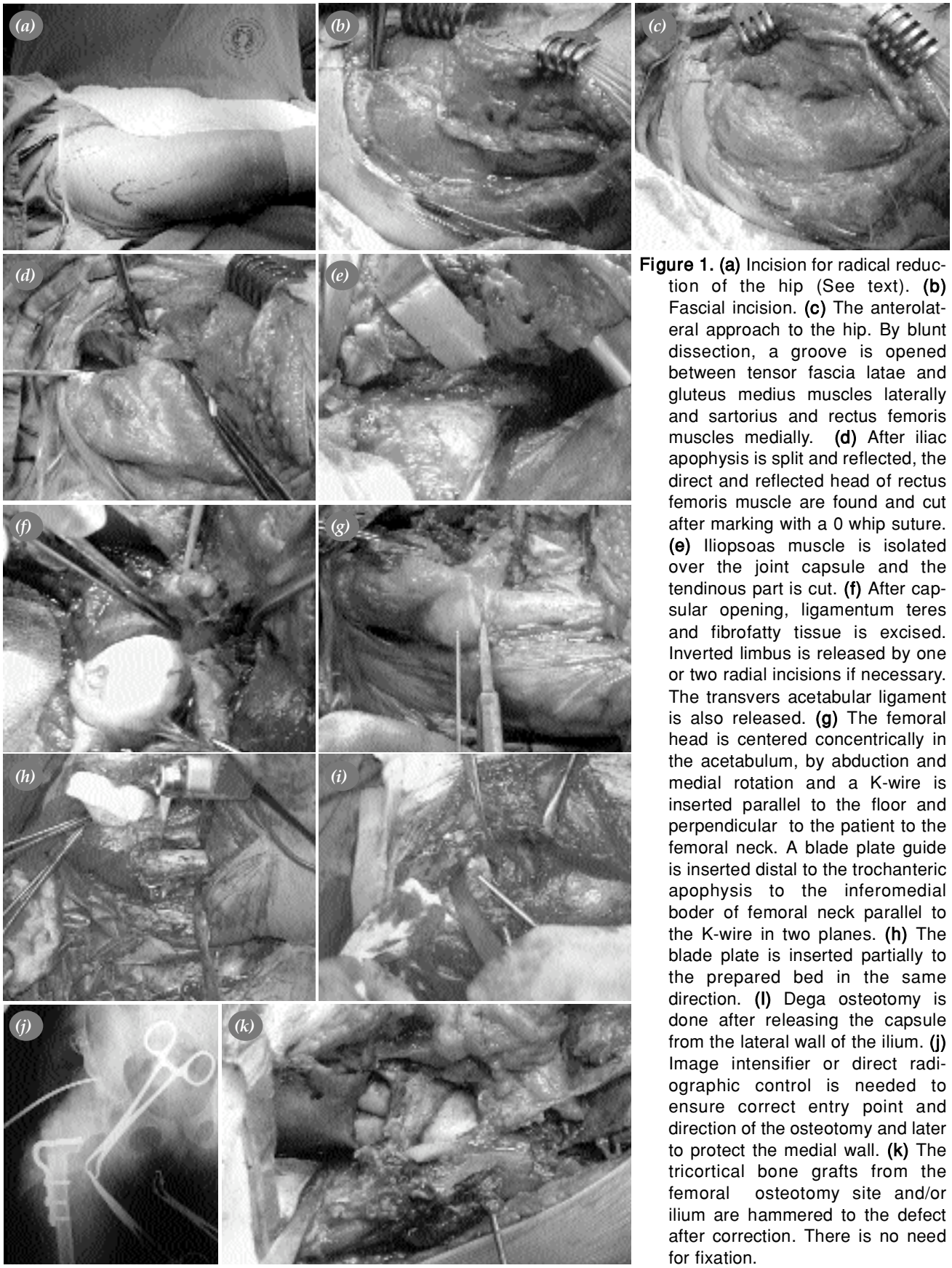

Figure 1. (a) Incision for radical reduction of the hip (See text). **(b)** Fascial incision. **(c)** The anterolateral approach to the hip. By blunt dissection, a groove is opened between tensor fascia latae and gluteus medius muscles laterally and sartorius and rectus femoris muscles medially. **(d)** After iliac apophysis is split and reflected, the direct and reflected head of rectus femoris muscle are found and cut after marking with a 0 whip suture. **(e)** Iliopsoas muscle is isolated over the joint capsule and the tendinous part is cut. **(f)** After capsular opening, ligamentum teres and fibrofatty tissue is excised. Inverted limbus is released by one or two radial incisions if necessary. The transvers acetabular ligament is also released. **(g)** The femoral head is centered concentrically in the acetabulum, by abduction and medial rotation and a K-wire is inserted parallel to the floor and perpendicular to the patient to the femoral neck. A blade plate guide is inserted distal to the trochanteric apophysis to the inferomedial boder of femoral neck parallel to the K-wire in two planes. **(h)** The blade plate is inserted partially to the prepared bed in the same direction. **(I)** Dega osteotomy is done after releasing the capsule from the lateral wall of the ilium. **(j)** Image intensifier or direct radiographic control is needed to ensure correct entry point and direction of the osteotomy and later to protect the medial wall. **(k)** The tricortical bone grafts from the femoral osteotomy site and/or ilium are hammered to the defect after correction. There is no need for fixation.

The osteotomy is curvilinear, starting just above the iliopectineal eminence and ending in a point 1 to 1.5 cm in front of the sciatic notch not to disturb the triradiate cartilage. After completion of the osteotomy by the help of 1 or 2 osteotomes, the osteotomy site is levered open until enough femoral head coverage is obtained. Two trapezoidal bone grafts from femoral osteotomy or iliac crest are gently hammered to the osteotomy site. The larger graft is placed usually anteriorly, since acetabular deficiency is more pronounced there (Fig 1K). Any fixation is unnecessary since the elastic recoil of the pelvis stabilizes the osteotomy site. After reduction, the hip stability is controlled in every direction. If the hip is found stable, the redundant superolateral part of the capsule is resected and a careful capsulorraphy with plication is done. A hemovac drain is inserted to medial side of the iliac wing and then the iliac apophysis is repaired. Rectus femoris muscle is reattached to its origin. The wound is closed in routine manner. After radiographic control a hip spica cast is applied for 6 weeks. After the cast is off, the patient is allowed to move the hip and given a Denis – Brown abduction splint for another 6 weeks. After this period, full weight bearing and unlimited hip range of motion is allowed.

Discussion and results

In the past, combination of pelvic and femoral osteotomies with open reduction was believed as a risk factor that increases the rate of avascular necrosis. For this reason, multiple sequential operations were done to treat a hip dislocation. These multiple operations placed the patients also in an increased risk of complications. Some authors recommended a long period of hip traction to bring the femoral head to the level of the acetabulum. Unfortunately, in older children the downward descend of the femoral head was usually insufficient. Also because of insufficient elongation of the pelvifemoral and pelvitrochanteric muscles, recontraction of these muscles resulted in redislocation or avascular necrosis and/or fibrous ankylosis due to the increased joint pressure.[10] Also in open reduction procedure, surgical release of the muscles does not always allows joint reduction and most of the time femoral shortening is done afterwards. Many authors stressed the importance of femoral shortening in patients over 2 years of age. [2,5,6,7 and 11] The femoral head could be distracted 3 to 4 mm from the acetabulum with gentle traction after reduction. If it is not achieved femoral shortening should be done. Schoenecker and Strecker compare the results of patients treated with open reduction and femoral shortening with a group treated with open reduction after traction.[5] They reported 85 % excellent and good results in the shortening group compared to 44 % excellent and good results in the traction group. They had experienced avascular necrosis over 50% in the traction group.

The so called “Radical reduction” procedure described by one of our mentors Professor Çakırgil include adductor tenotomy, anterolateral open reduction, femoral varization – derotation with shortening, and acetabuloplasty (usually Dega pericapsular acetabuloplasty). The author reported he prefer Dega acetabuloplasty till triradiate cartilage closure and then his own “dome type” acetabuloplasty. He used Chiari osteotomy in reluxations and subluxations as a salvage procedure.[7-8] By this protocol excellent and good results were reported as 88 % in 1.5 – 4 years old age group, 77 % in 4- 8 years old age group and 53 % in 8 – 14 years age group. The oldest group has statistically important bad results than other groups. Complications are 10 % avascular necrosis in varying degrees, 1.2 % fibrous ankylosis and 2.7 % redislocation.[8] This method has distinct advantages as no need for traction, managing all pathologies in one session and with the same approach, the capability of balancing the counteracting muscular forces and the lengthening of the lower limb by iliac osteotomy; with femoral shortening to prevent excessive pressure to the femoral head, complete centralization of the femoral head with varization and derotation osteotomy and good coverage in shallow acetabuli with the help of Dega osteotomy (Figs 2A-D & Figs 3A-D).

Many authors noted the effectiveness of combined procedures. These procedures do not increase the complication rate. Olney et al, reported the results of 18 hips of 13 patients treated with open reduction, femoral shortening and derotation, and Pemberton osteotomy. The patient age at surgery was changing between 15 to 117 months and mean follow-up was 43 months.[12] They reported avascular necrosis in one patient (5.5%), all patients were pain free and ambulatory. Neither of the patients

required a second operation. They recommended open reduction and combined osteotomies and noted that they were safe and effective.

Reichel and Hein, reported an average of 15 years follow-up results of 51 patients treated with open reduction and combined trochanteric osteotomy and Dega acetabuloplasty. The mean patient age was 2.9 years.[13] They had excellent and good results in 80 % of the patients and experienced a 5.7 % rate of avascular necrosis.

Galpin et al, treated 33 hips of 25 patients with congenital dislocation of the hip over 2 years old.[6] Twenty-one of them were treated with combined femoral and pelvic (mainly Salter) osteotomies. They reported satisfactory results clinically in 85 % and radiographically 75 % of their patients. They noted a 9 % avascular necrosis rate and cautioned against posterior instability with Salter osteotomy when it is combined with femoral derotation osteotomy. We did not experience such a problem in our clinic in combined Salter and femoral osteotomies. Since we make femoral derotation osteotomy after Salter osteotomy, we can easily adapt the amount of femoral anteversion correction, to the final position of the acetabulum. An intraoperative control of hip stability and range of motion is also mandatory. In radical reduction procedure, we can tailor our osteotomy displacement and put the grafts to cover the most deficient part of the acetabulum to prevent instability.

The age of the child at the time of treatment is an important prognostic factor in the outcome. Ryan et al [14] reported a higher rate of Severin type III and IV

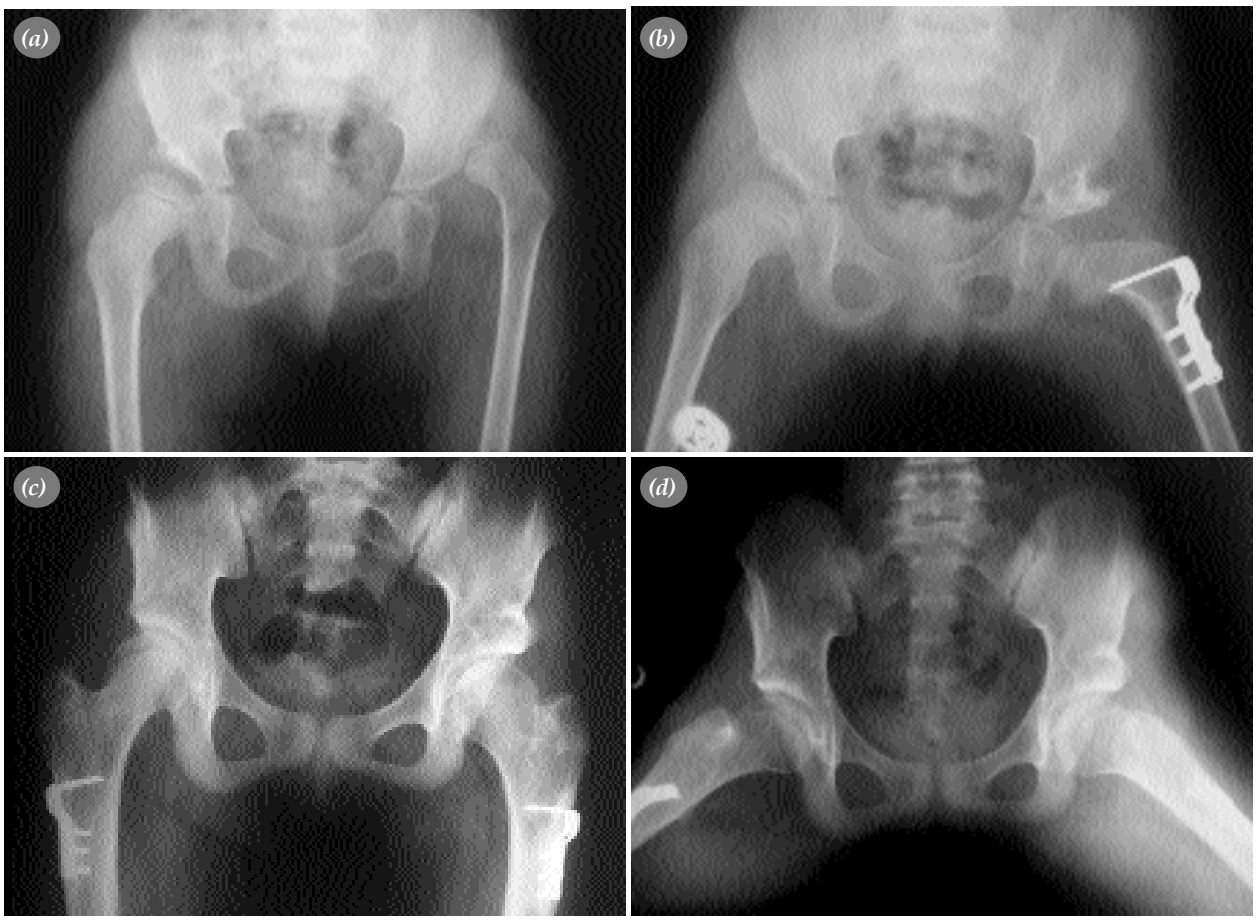

Figure 2.(a) A five years old girl with left hip dislocation and right hip dysplasia. The dislocation was graded as Tonnis type IV. **(b)** In the 6th week postoperative control radiogram; the reduction was good, the iliac graft began to incorporate and the femoral osteotomy site was united. **(c, d)** Nine years follow-up AP and frog-leg radiograms. Femoral head coverage is good. The right hip was treated with a later Salter and varization-derotation osteotomy. The patient has full range of motion in both hips and has no complaints. Her McKay functional score was excellent and Severin score was Type IA.

residual dysplasia and growth disturbance in patients over 7 years old in a group of 25 hips of 18 children between 3 to 10 years of age. The authors found other factors such as the development of avascular necrosis might be more important than the Severin classification for determining the outcome in adult.

Some authors especially in bilateral cases over 8 years prefer non-operative treatment. On the other hand, some authors presented good results in operatively treated older children. Klisic et al reported 3 % excellent, 60 % good, 30 % moderate and 7 % bad results in 60 patients, whom ages changing between 5 and 15.[11]

Grudziak, a former fellow of Dega's clinic; provide a description of the two techniques Dega had used that had not printed in detail in English language literature.[15] In the initial description of the technique that was printed in the textbooks, the semicircular osteotomy is located approximately 1 cm over the acetabular rim and leaves the medial cortex intact.[2,9] We prefer this osteotomy in our clinic. Dega later described another osteotomy. In this variant, the osteotomy line begins just over the anterior inferior iliac spine and extends posterior to end 1 to 1.5 cm in front of the sciatic notch. The osteotomy plane is directed downward and medial. The steep acetabular inclination, the higher midpoint of the osteotomy is required. The osteotomy line exits through the medial cortex just above the iliopubic and ilioischial limbs of triradiate cartilage. This osteotomy leaves the posterior one third of the inner cortex intact and cuts the anterior two thirds. So this variant both reorients the acetabulum and changes its shape. The first osteotomy variant does not reorient the acetabulum but can support the insufficient part and reshape it.

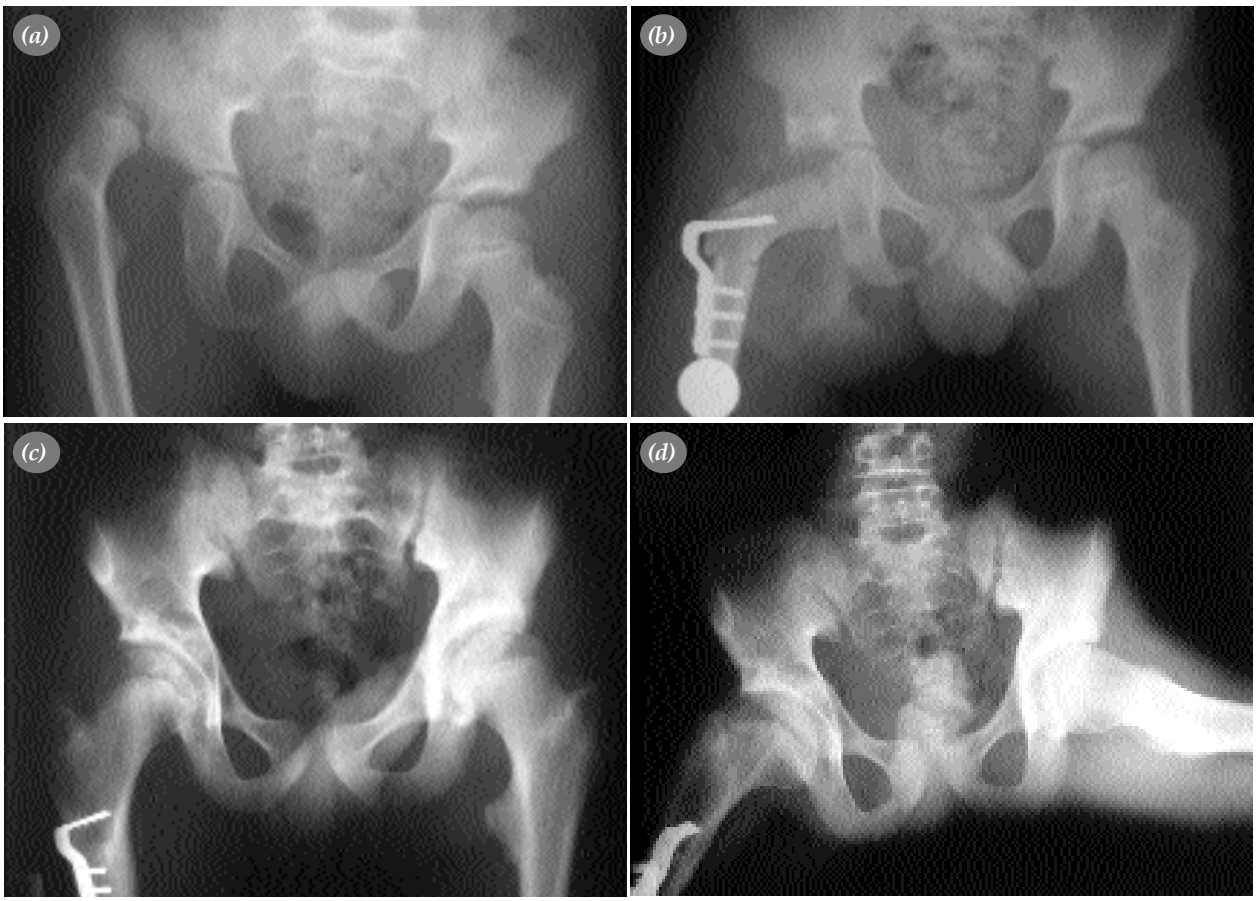

Figure 3. **(a)** Five years old boy with right hip dislocation. The dislocation was rated as Tonnis type IV **(b)** Early postoperative view showed concentric reduction. **(c, d)** Ten years follow-up radiograms revealed Severin type 1A hip. He had no complaints, full ROM and an excellent McKay functional score.

In Pemberton osteotomy, the medial wall is cut and the fulcrum of rotation and angulation takes place at the triradiate cartilage.[16] An unusual but possible complication is triradiate cartilage damage and growth disturbance.[17] Although in classical literature, Pemberton and Dega osteotomies are reported to decrease the acetabular volume[2] ; Özgür et al showed an increased acetabular volume after Dega osteotomy in 9 patients with MR[18] ; and Slomczykowski et al also showed an increase in acetabular volume by CT evaluation after Pemberton osteotomy.[19] The volumetric increase in these procedures probably stemmed from the increase of the depth of the acetabulum. Although the volume could be increased by acetabuloplasty; this may not correlate with better coverage. Therefore in patients with coxa magna these procedures may still be contraindicated.

In conclusion, radical reduction of the hip is a safe and effective procedure for the treatment of high developmental hip dislocations of patients between 4 and 8 years of age.

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