



## *When should secondary procedures be performed in residual hip dysplasia?*

### *Kalıcı kalça displazisinde ikincil girişim ne zaman yapılmalıdır?*

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*Gelişimsel kalça displazisinin tedavisinde karşılaşılan en önemli sorunlardan biri kalıcı kalça displazisidir. Bu durum, tedavi edilmediğinde erişkinlik döneminde sorunlara yol açabilir. Gelişen asetabulum, ilium, ishium ve pubis ile bunlar arasındaki üçlü kırkırdaktan oluşur. Üçlü kırkırdığın büyüme plaklarından olan interstisyel büyümenin asetabulumun gelişmesi üzerinde önemli etkisi vardır. Bu gelişme sırasında anatomik eklem ilişkisinin ve devamlılığının sürmesi gerekir. İlk sekiz yaşta çok hızlı olmakla birlikte, asetabulum gelişiminin erişkinlik dönemine kadar sürdüğü kabul edilir. Gelişimsel kalça displazisinin tedavisinde kalıcı displazi gelişip gelişmeyeceği, takip döneminde bu gelişime etkili unsurlar göz önünde tutularak değerlendirilir. Hastanın yaşı, asetabulum ile baş uyumu, başın yuvarlaklığı, başın orta çizgiye olan uzaklığı ve asetabuler çatı kalınlığı asetabulumun gelişmesinde değerlendirilmesi gereken en önemli unsurlardır. Olguların bu unsurların ışığında izlenmeleri, gereksiz cerrahi girişimlerin önlenmesi ve başarılı sonuçların alınması için önemlidir.*

*Residual hip dysplasia is one of the most important complications following treatment of developmental hip dysplasia. If untreated, this condition will cause problems during maturity. The acetabulum consists of the ilium, ischium, pubis, and the triradiate cartilage lying between them. Interstitial growth from the growth plates of the triradiate cartilage plays an important role in the development of the acetabulum. Concentricity and congruity should be maintained during this development, which is very fast during the first eight years and continues until maturity. Whether residual hip dysplasia will occur can be anticipated by evaluating the factors that are effective on this development during the treatment of developmental hip dysplasia. The main prognostic factors include the age of the patient, concentricity and congruity of the hip, sphericity of the femoral head, the distance from the center to the head, and the thickness of the acetabular roof. Taking these factors into consideration during the follow-up is important to eliminate overtreatment and to assess the success of treatment.*

Residual hip dysplasia is one of the most important complications following treatment of developmental hip dysplasia. If untreated, this condition will cause problems during maturity. The acetabulum consists of the ilium, ischium, pubis and triradiate cartilage lying between them. Interstitial growth from the growth plates of triradiate cartilage plays an important role in the development of acetabulum. Concentricity and congruity should be main-

tained during this development which is very fast during the first eight years and continues until maturity. Whether residual hip dysplasia will occur or not can be anticipated by evaluating the factors that are effective on this development during the treatment of developmental hip dysplasia. The main prognostic factors are the age of the patient, concentricity and congruity of the hip, sphericity of the femoral head, the distance from center to the

head and the thickness of the acetabular roof. Taking these factors into consideration during the follow up is important to avoid from overtreatment and to assess the success of treatment.

Healing process of dysplastic osseous acetabulum occurs in a certain period of time after the reduction of developmental hip dysplasia. Factors effecting the length of this healing period which varies for each case are degree of acetabular dysplasia and reduction age of the children. Secondary procedures for osseous structures are usually performed after the reduction when it is thought that spontaneous healing potential of acetabulum has diminished.<sup>[1]</sup> There are many different ideas about the this potential of dysplastic acetabulum. Before discussing these different ideas, natural growth and development of acetabulum and the factors which effect this development favorably and unfavorably should be discussed.

Acetabulum consists of three bones ( ilium, ischium, pubis) and cartilage (triradiate cartilage) between them. It should be realized that development of acetabulum does not occur in one plane as it is seen on X rays but in in three planes. Each part of triradiate cartilage facing to each three bone is a growth plate and interstitial growth of these plates creates the diameter development of acetabulum.

Two third of acetabulum is called as acetabular cartilage. Acetabular cartilage is hyaline cartilage. Its surface which is articulating with femoral head which is covered by articular cartilage. Its inner surface which is adjacent with ilium is similiar with other skeletal physeal cartilages. Intertitial growth of this part decreases the slope of acetabulum or in an other words decreases the value of acetabular index. Lateral part of acetabular cartilage is called as labrum which is fibrous cartilage. Capsule of hip the joint attaches just over the labrum. Depth of acetabulum is increased by the lateral apophyseal growth of perichondrial and periosteal cells which are located on the lateral surface of acetabular cartilage facing out of hip joint and on the lateral surface of ilium respectively.

By this complex growth procedure, most of the acetabular development is completed within the first eight years of childhood. Then, secondary ossifying nuclei occur around the acetabulum during the

accelarated growth period of adolocene. There are three secondary ossifying nuclei; acetabular epiphysis which is the secondary ossifying nucleous of ilium, os acetabulum which is the secondary ossifying nucleous of pubis and the secondary ossifying nucleous of ischium which doesn't have any special name.

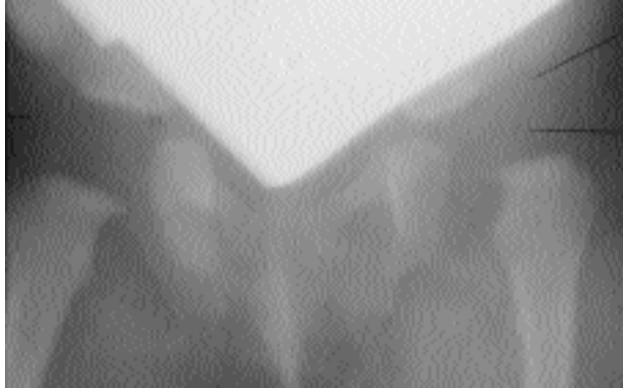
A well developed acetabulum with clear tear drop, contunious Shenton line and letarally inclined sourcil occurs as a result of these growth procedures.

Normal acetabular growth requires a spherical and dynamic femoral head which is reduced in acetabulum with the avoidance of any damage to previously explained growth centers.

Femoral head is not seated in acetabulum in dysplastic hips and applies a compression to acetabular cartilage, perichondrial and periosteal cells laterally depending upon the grade of dislocation. Normal acetabular development could be obtained if femoral head is reduced early with the establishment of its normal functions. This is the reason of % 95 successfull results obtained from the treatment of children who are younger than 6 months and treated by Pavlik harness. If the treatment of dysplasia is delayed, the anormal placement of femoral head rather than its original position and extraordinary compression forces caused by the femoral head can create some residual changes and normal acetabular development can not be obtained even if dysplasia is corrected.<sup>[1-4]</sup>

Acetabular dysplasia should not be confused with subluxation. In subluxation, Shenton line is broken and femoral head is placed in varying degrees of lateral nonconcentric position proximally. However, in acetabular dysplasia Shenton line is not broken, there is congruity between head and acetabulum while only the degree of slope of osseous acetabulum acetabulum, acebular index in an other words, is higher than its normal values.

Hip dysplasia of children younger than 18 months is usually treated conservatively. The most important rule of this treatment is the avoidance of any damage to growth centers of femoral head and acetabulum cartilage during the reduction. Congruity of concentric reduction should be established during the treatment until the acetabulum is well developed.



**Figure 1.**Developmental hip dysplasia of 5.months old child. X ray before operation.

There are many different ideas about the upper age limit of spontaneous healing of acetabular dysplasia. Some authors say that acetabular development should not be expected in children older than 18 months<sup>[5]</sup> while some others say that acetabular development continues until 8 years or more older ages.<sup>[2,3,6-8]</sup>

Clinical results are always better than the radiological results until the end of growth period. However, risk of early degenerative changes for the hips with residual dysplasia is very high. According to Malvitz and Weinstein<sup>[9]</sup> rate of degenerative changes for Severin type III / IV hips was % 46 while it was % 3 for Severin type I / II hips. Rate percentages for the functions of hips according to Iowa scoring system were % 25 very good and %58 good for Severin type I / II hips while they were % 80 fair for Severin type III hips and % 81 poor for Severin type IV hips. According to these results, it



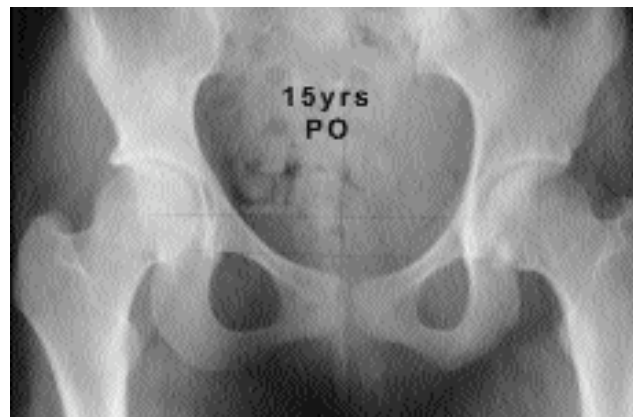
**Figure 2.** X ray of the 5 th year follow up after medial open reduction performed.

can be concluded that Severin classification system can be used for evaluation of the long term radiological and clinical results during maturity.

It is important to predict during younger ages what type of Severin classification would be seen at the end of the maturity. In this way, secondary procedures can be performed for the hips which were expected to have a poor development while unnecessary secondary procedures can be avoided for the dysplasias which were expected to have a good development.

Some surgeons accept early degenerative changes as very unfavorable prognostic factors and advise oversurgical treatment for some hips in order to prevent such changes. On the other hand, according to some surgeons early oversurgical treatment is a harmful procedure and spontaneous healing can occur in some of these hips and by continuous follow-up programs residual dysplasias can be diagnosed early and can be treated by secondary procedures before they cause any residual degenerative changes. On the other hand, it is hard to find the long term results of secondary procedures in literature. Any research with control groups to observe whether the hips which were treated by secondary procedures with short follow up could heal spontaneously or not has not been done yet.

Any relationship between the grade of dislocation according to Tonnis classification and result according to Severin during adulthood has not been observed. Any relationship between acetabular index before reduction and the result during adulthood has also not been observed yet. On the other hand, relationship between thickness of acetabular

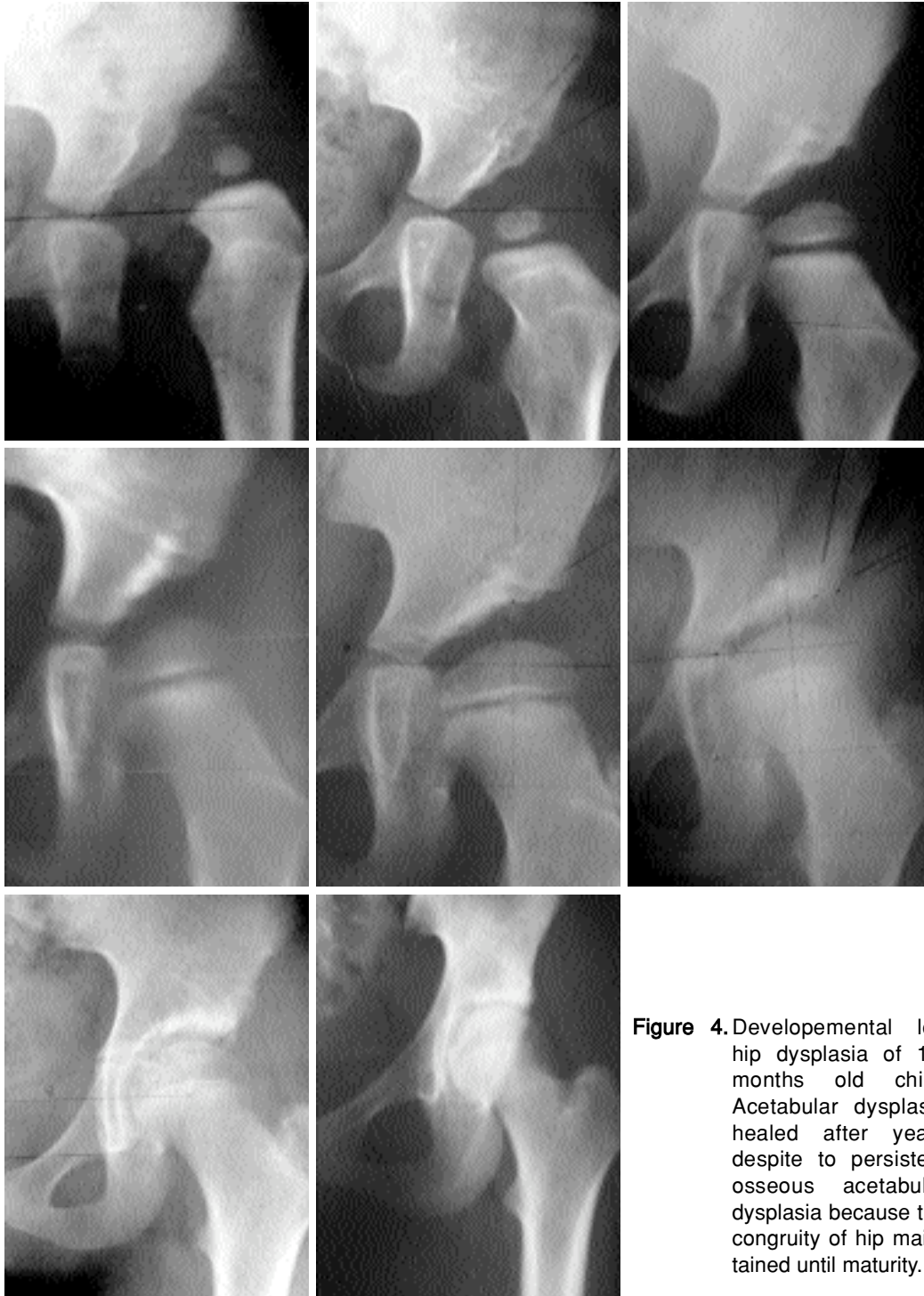


**Figure 3.** Severin type I result during maturity

roof and adulthood has been observed. It was found that increase in the thickness of acetabular roof in Severin type I / II hips ceases at 6 –7 years of age while it continues until maturity for Severin type III / IV hips. However thickness of acetabular roof in nondysplastic normal hips should be found in order

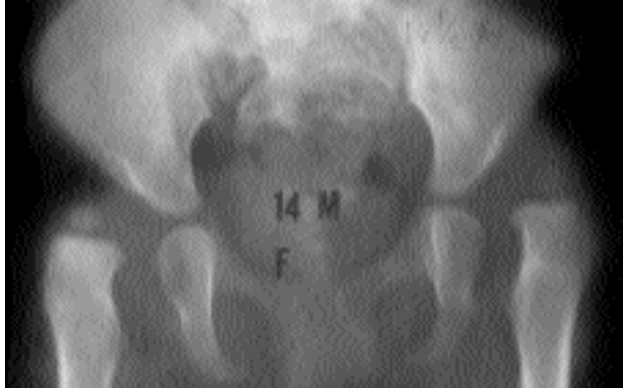
to prove this observation.<sup>[9]</sup>

Alexiev et al.<sup>[10]</sup> have found that there was relationship between developmental dysplasia and echogenic acetabular cartilage of the hips in children which were treated by Pavlik harness and were followed at least for 4 years.



**Figure 4.** Developmental left hip dysplasia of 16. months old child. Acetabular dysplasia healed after years despite to persistent osseous acetabular dysplasia because the congruity of hip maintained until maturity.





**Figure 5.** Bilateral developmental hip dysplasia of 14. months old child. X ray before operation.

Kim et al.<sup>[11]</sup> have announced that center – head difference ( CHDD ) which was described by Chen et al before, was an prognostic factor for the patients who were treated by closed reduction and followed up by yearly X ray controls for 14 years. According to Kim, the dysplasia is residual if CHDD is greater than % 6 and sourcil is inclined proximally which should be treated by secondary surgical procedure. However , these symptoms can be prognostic only in cases with unilateral dislocation.

Significant relation with age of reduction and adulthood result has also been found. Younger the children were when their hips were reduced, the most successful results could be obtained during adulthood (fig. 1-3).<sup>[8,9,13,14]</sup> The reason of these successful results was the reduction the dysplastic hips before residual secondary changes have been occurred. Quality of reduction and its maintenance have also a direct relationship with the adulthood results. If the congruent and concentric reduction of



**Figure 7.** Patient is 30 years old, irregularity of acetabular cartilage has been diminished and the hips healed with severin type II result.



**Figure 6.** Although the congruity of the joint is satisfactory after 8.5 years from medial open reduction, irregularity of acetabular cartilage persists.

the hip can be maintained functionally (functional congruity ) most of the results would be successful<sup>[13]</sup>

We have defined that there isn't any relationship between initial acetabular index and adulthood results. It is known that rate of increase of acetabular index during the first years is high after reduction and it continues with decreasing rate during the foregoing years.<sup>[6,8,13,15]</sup> Weintraub et al.<sup>[8]</sup> have found that correction rate of acetabulum index was high during the first year after reduction and it slowed down during second and third years while its correction continued with a decreasing rate after an increased rate of correction during fourth and fifth years.

According to Albinia et al.<sup>[13]</sup> acetabular index is an early symptom of Severin results during adulthood and the rate of Severin III / IV hips during



**Figure 8.** Bilateral developmental hip dysplasia of 6. months old child.



**Figure 9.** Congruity of the joint is satisfactory after 10 years from medial open reduction but irregularity of acetabular cartilage persists.

adulthood which have acetabular index 35 degrees or higher is % 80.

We have found a direct relationship between the age of children and secondary procedures among the children who were treated by medial open reduction and younger than 18 months during our first studies. There was a significant difference between the rates of secondary procedures for those children who were younger ( 2/21 ) or older ( 9 / 23 ) than 12 months during the first surgical procedure (  $p= 0.023$  )<sup>[16]</sup> Initially, we were performing secondary procedures without any delay if the acetabular index of the children who were medially approached had not reached to its normal value at the end of second follow up



**Figure 10.** Acetabulum had not been deepened enough until the patient was 22 years old because of the disturbances of periacetabular appositional and secondary ossifying growth centers and the hips healed with Severin type III result.

year and our rate of secondary procedures was % 25 in our first study.<sup>[17,17]</sup> However, as we had observed a spontaneous correction among the hips that we were planning to perform secondary procedures but could not be operated, than we began to wait for spontaneous correction and our rate of secondary procedures is now % 2 in our latest study.<sup>[18]</sup> However, we would like to emphasize that this is the result of first 6 years and definite rate of secondary procedures can be found as all of our cases will reach to maturity.

We believe that maintenance of congruent and concentric reduction during growth period is more important than the value of acetabular index. We observed the spontaneous decreasing of acetabular index to normal values if the maintenance of congruent and concentric reduction can be maintained until maturity for the cases that we planned to perform secondary procedures at the beginning (fig.4). We know that concentric and congruent reduction of spheric femoral head is mandatory for normal acetabular development. Any damage to sphericity of femoral head caused by avascular necrosis may be an unfavourable factor for acetabular development. Aspheric femoral head with the retarded development of acetabulum may be a sign of a poor result. In such cases congruity of the joint should be established by secondary procedures performed either for acetabulum or femur or for both of them as soon possible because these hips can not heal spontaneously.

Type II avascular necrosis usually occurs during 4 – 14 years of age. % 60 of this type avascular



**Figure 11.** X ray of the 1st follow up year after bilaterally performed Staheli shelf procedure in one stage.

necrosis do not have a poor effect on the prognosis of the hip.<sup>[19]</sup> If this abnormal growth pattern which is the result of lateral physeal arrest of proximal femoral physis and causes epiphyseal valga deformity occur late in adolescence, it will not effect the prognosis of the hip unfavorably. If avascular necrosis occurs early in childhood before the healing of acetabulum completed, femoral head may begin to incline laterally and this phenomenon may cause a poor outcome for the hip. We are performing percutaneous medial epiphysodesis for such cases.<sup>[20]</sup> Although we can not restore the lateral physeal arrest, we believe that creating a medial physeal arrest will effect the acetabular development favorably even it will cause a coxa brevis deformity. This procedure can be more effective if it is performed in early ages as hemiepiphysodesis which becomes more effective when it performed in such a manner for congenital scoliosis caused by unilateral unsegmentation. Although the number of our cases is limited with a short follow up period, we are still performing this procedure

We have emphasized that earlier the reduction of a dysplasia is performed, higher regression rate of secondary changes due to dysplasia can be seen. However, if the acetabulum cartilage has echogenic ultrasonographic view before the reduction, dysplasia may not heal even after an early reduction (fig.5 – 11). Some factors such as the compression of femoral head to perichondrial and periosteal cells which are located laterally near the Ranvier sulcus or damage of the secondary ossifying centers caused by iliac osteotomies performed to correct acetabular dysplasia may prevent the deepening of acetabulum and as a result a late adolescent dysplastic hip joint can develop. So, either for this reason or for the risk of late occurrence of type II avascular necrosis, all the hips that are treated for dysplasia should be followed until maturity.

As a result, acetabulum is not different from other growing bones. Triradiate cartilage and other acetabular bones are growth cartilages. Reduction of the acetabulum should be performed as soon as possible in younger ages after releasing the soft tissue contractures without damaging joint or growth cartilage. Growth of the acetabulum continues as long as the primary and secondary ossifying centers are active. Maintenance of concentric and congruent reduction of hip joint during this growth period is

mandatory for the healing of dysplastic hip and an orthopaedic surgeon should wait for spontaneous healing instead of performing secondary procedures early during this period. .

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