Differentiating subluxation from developmental dislocation of the hip

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Abstract

The radiological and clinical picture of a developmental hip dislocation and a severe subluxation are identical. According to Leveuf and Wiberg the diagnosis can only be made by arthrography. The differential diagnosis is critical, as treatment differs dependent on the diagnosis. In this study, the diagnosis of subluxation was based on a plain radiograph of the pelvis. A radiograph of the pelvis with the hips abducted at least 45° and internally rotated (AIR view) was used to differentiate these two entities. In subluxations, the femoral head will relocate into the acetabulum with perfect or near perfect reconstitution of the Shenton’s line. It will fail to do so in true dislocations.

The differential diagnosis has important therapeutic implications. Subluxation in a child younger than two years of age may be treated with an abduction brace in an outpatient setting. Dislocation in a child too old for the Pavlik harness (usually older than six months) will need closed or open reduction, pelvic osteotomy and/or femoral shortening when indicated, the use of general anesthesia, and immobilization in a spica cast in an inpatient setting.

Five patients, mean age 14.6 months (range 9 to 20 months), presented with diagnosis of hip dysplasia. The examination revealed minimal or no limitation of hip abduction and a leg length discrepancy. The three patients who were of walking age exhibited a Trendelenburg gait. The standard AP radiographs of the five patients suggested hip dislocations. The diagnosis of hip subluxation was based on the relocation of the femoral head with the abduction/internal rotation radiograph. All were successfully treated with an Ilfeld abduction splint. None required general anesthesia for examination, arthrograms or immobilization in spica cast.

Case Report #1

In March 1982, a 1-year, 8-month old girl was evaluated. A few weeks before referral, her mother noticed a painless limp. The child developed normally and started walking independently at approximately one year of age. On physical examination, the girl displayed an obvious limp (Trendelenburg gait). She had a leg length inequality with a positive Galeazzi sign, the right being shorter than the left. A subtle (less than 10°) limitation of abduction of the right hip was noted; no instability was felt.

A standard anterior posterior (AP) supine radiograph of the pelvis showed: i) superior and lateral migration of the proximal right femur, ii) delayed maturation of the ossify nucleus of the right femoral head, and iii) increased slope of the right acetabulum (Figure 1A). The initial diagnosis of a hip dislocation was made. The patient was admitted to the hospital for a closed reduction. However, an abduction/internal rotation radiograph was obtained before the scheduled procedure. It disclosed that the right femoral head relocated into the acetabulum, confirming the diagnosis of subluxation (Figure 1B). The patient was fitted with an Ilfeld splint (Fillauer Manufacturing, Chattanooga, TN) (Figure 1C) and discharged. The brace was worn 23 hours per day. The mother was allowed to remove the splint one hour in the morning. Standard AP supine radiographs taken at 6 weeks, 2.5 months, 4 months and 6 months of treatment showed continuous improvement of the subluxation. After 12 months of treatment, she continued wearing the splint at night for one additional year. She continued to improve even after the brace was removed. She was seen for the last time at age 6 years 8 months. She had no limp. The radiologic examination disclosed an excellent result by the Severin classification (Figure 1D). The patient was lost for follow-up.

Case Report #2

In August 1990, a 1-year-old girl presented to our clinic. She had just started walking when her mother noticed a limp and a leg length inequality, the right being shorter than the left. The patient had a Trendelenburg gait, but no limitation of abduction of either hip. An extra skin crease was present on the right thigh. The Galeazzi sign was positive, the right

locations have appreciable limitation of abduction. On a plain AP radiograph, both dislocation and severe subluxation present with: i) superior and lateral migration of the proximal femur, ii) delayed maturation of the ossify nucleus of the right femoral head, and iii) increased slope of the right acetabulum. Thus, a severe subluxation can appear like a low dislocation on an AP radiograph.

A radiograph of the pelvis with the hips abducted at least 45° and internally rotated (AIR view) will help differentiate these two entities. In subluxations, the femoral head will relocate into the acetabulum with perfect or near perfect reconstitution of the Shenton’s line. It will fail to do so in true dislocations.

The differential diagnosis has important therapeutic implications. Subluxation in a child younger than two years of age may be treated with an abduction brace in an outpatient setting. Dislocation in a child too old for the Pavlik harness (usually older than six months) will need closed or open reduction, pelvic osteotomy and/or femoral shortening when indicated, the use of general anesthesia, and immobilization in a spica cast in an inpatient setting.

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All were successfully treated with an Ilfeld abduction splint. None required general anesthesia for examination, arthrograms or immobilization in spica cast.

Case Report #1

In March 1982, a 1-year, 8-month old girl was evaluated. A few weeks before referral, her mother noticed a painless limp. The child developed normally and started walking independently at approximately one year of age. On physical examination, the girl displayed an obvious limp (Trendelenburg gait). She had a leg length inequality with a positive Galeazzi sign, the right being shorter than the left. A subtle (less than 10°) limitation of abduction of the right hip was noted; no instability was felt.

A standard anterior posterior (AP) supine radiograph of the pelvis showed: i) superior and lateral migration of the proximal right femur, ii) delayed maturation of the ossify nucleus of the right femoral head, and iii) increased slope of the right acetabulum (Figure 1A). The initial diagnosis of a hip dislocation was made. The patient was admitted to the hospital for a closed reduction. However, an abduction/internal rotation radiograph was obtained before the scheduled procedure. It disclosed that the right femoral head relocated into the acetabulum, confirming the diagnosis of subluxation (Figure 1B). The patient was fitted with an Ilfeld splint (Fillauer Manufacturing, Chattanooga, TN) (Figure 1C) and discharged. The brace was worn 23 hours per day. The mother was allowed to remove the splint one hour in the morning. Standard AP supine radiographs taken at 6 weeks, 2.5 months, 4 months and 6 months of treatment showed continuous improvement of the subluxation. After 12 months of treatment, she continued wearing the splint at night for one additional year. She continued to improve even after the brace was removed. She was seen for the last time at age 6 years 8 months. She had no limp. The radiologic examination disclosed an excellent result by the Severin classification (Figure 1D). The patient was lost for follow-up.
thigh being shorter than the left. The hips were stable by clinical examination. The AP radiograph of the pelvis revealed dysplasia of the right hip (Figure 2A). Relocation of the femoral head could be obtained with the abduction/internal rotation view (Figure 2B).

The patient was fitted with an Ilfeld splint, which she wore 23 hours per day. Two months later, the mother brought the child back for her only follow-up visit. The radiograph disclosed marked improvement of subluxation (Figure 2C). Fourteen years later, in August 2004, the girl presented to the clinic, again. She was experiencing discomfort in both hips when she engaged in sports activities. The subsequent examination and radiographs were normal (Figure 2D). At that time, the mother reported that when the child was initially seen, she had worn the splint for a total of six months, without medical supervision. The current hip pain was considered to be caused by overuse. The mother was reassured and the girl was discharged from our institution.

Case Report #3

In October 2003, this 6-day-old infant was referred to our clinic. The physical examination by her pediatrician was normal. However, the infant was a first-born female and a breech delivery, placing her at high risk for hip dysplasia. On examination, no instability was felt in either hip and no click was detected. She was seen again at 9 months of age. The parents reported that when they held her in the standing position, her right leg was shorter than the left and not moving as well as the left.

On physical examination, the child appeared to have a large leg length inequality, magnified by a residual abduction contracture of the left, normal hip. An approximate 10° limitation of abduction was apparent on the right hip. Both hips were stable by clinical examination. The radiograph showed the classic signs of developmental dislocation of the right hip, including a false acetabulum (Figure 3A). However, the abduction/internal rotation view showed relocation of the right femoral head (Figure 3B). The child was fitted with an Ilfeld splint.

Because the child was uncooperative, the parents were instructed to gradually increase wearing time to almost full time, except one hour a day. Five days later, a radiograph was obtained with the patient in the splint (Figure 3C). The right femoral head was facing the acetabulum slightly more lateral than the opposite hip. The slight limitation of abduction had completely resolved. She wore the brace almost full time for three months. A radiograph showed marked improvement of the acetabular index, the center of ossification to be medial to the Perkins’ line, and a persistent, although improved, break in the Shenton’s line. Because of marked improvement she then was permitted 4 hours a day out of the brace. She started walking with and without the splint at age 13 months. She wore it at night for the second year of treatment. Three years after treatment the Shenton’s line was close to normal, the femoral head was medial to the Perkins’ line, and the acetabular index was still elevated. Six years after the initial diagnosis, the patient had a normal examination. She’s involved in gymnastics without limitations. The femoral head is well covered (Figure 3D). A three year follow-up appointment was given.

Figure 1. A) Initial radiograph of patient 1 taken at 1 year 8 months of age; B) an abduction/internal rotation view shows relocation of the femoral head; C) in a radiograph taken with the patient wearing the Ilfeld splint, the right femoral head is pointing to the triradiate cartilage, slightly more lateral than the opposite hip; D) a radiograph taken at age 6 years 8 months shows an intact Shenton’s line and the CE angle to measure 25° bilaterally.

Figure 2. A) Initial radiograph of patient 2 taken at 12 months of age; B) an abduction/internal rotation view shows relocation of the right femoral head; C) after 2 months of treatment; the ossific nucleus of the right femoral head is medial to the Perkins’ line; D) a radiograph taken at age 15 years is normal.
Case Report #4

This 13-month-old boy was evaluated in February 2008 for weak ankles. He was the product of a Caesarean birth. He was in the neonatal intensive care for two weeks for respiratory distress. On clinical examination, the boy could stand up with help. A severe pes planus deformity was then apparent. He had hyperligamentous laxity. The left hip had a 10° limitation of abduction. A radiograph revealed a left hip dysplasia (Figure 4A). The hip relocated with the abduction/internal rotation view (Figure 4B). The child was placed in an Ilfeld brace for 23 hours a day. One week later, the limitation of abduction had completely resolved. A radiograph was then taken with the child in the Ilfeld splint (Figure 4C). After 3 months of brace wear a radiograph showed medialization of the femoral head. The Perkins’ line was bisecting the ossific nucleus and improvement was apparent in the break of the Shenton’s line. He started walking independently at 16 months of age. On the 7th month of brace wear, the child started removing the brace during the day. The mother continued the brace at night. After one year of treatment, he learned how to remove the brace at night as well, and the compliance became sporadic. The radiographic improvement was unimpeded. At the age of 3 years and 4 months the hip shows an excellent recovery (Figure 4D).

Case Report #5

In March of 2009, this 19-month-old girl was examined for a painless limp. It was first noticed when she started walking independently at the age of 17 months. She was the product of a normal pregnancy and delivery. At birth her left hip was noted to be dislocatable. Her right foot had an equinovarus deformity. At the age of six days, she was seen by a pediatric orthopedic surgeon and the hips were found to be stable. The right foot deformity was diagnosed as a positional club foot. It was treated successfully for 2 weeks in a long leg cast. At the age of six weeks, she had a hip sonogram, which was reported as normal. Subsequent routine hip examinations performed by the pediatrician were also normal. On physical examination, she had a Trendelenburg gait, no limitation of abduction of the hips, and a positive Galeazzi sign, the left thigh being shorter than the right. The radiograph showed a left hip dysplasia (Figure 5A). The femoral head relocated with abduction and internal rotation (Figure 5B). She was placed in an Ilfeld brace (Figure 5C). The girl wore the brace 22 hours a day for the first year and at night for the second year. Progressive medialization of the femoral head and improvement of the break in the Shenton’s line occurred, although the acetabular index remained elevated (Figure 5D). Her gait and examination are normal. She’s scheduled to have a follow-up radiograph in 12 months.

Discussion

The term congenital dysplasia of the hip (CDH) was coined by Hilgenreiner in 1938.1 In most cases, it accurately describes this disease process. It is an abnormal growth or development (dysplasia) of the hip, present at birth (congenital). This entity is now designated developmental dysplasia of the hip (DDH).2 Whereas certain deviations from normal are

Figure 3. A) An initial radiograph of patient 3 taken at 9 months of age shows classic signs of right hip dislocation including a false acetabulum; B) an abduction/internal rotation view confirms the diagnosis of subluxation; C) In a radiograph taken after 5 days wearing the Ilfeld splint, the right femoral head is slightly more lateral than the opposite hip; D) a radiograph taken at age 6 years and 10 months shows that the CE angle is 35° on the right and 38° on the left. Changes are present on the right hip; a longer femoral neck, the sourcil is not well defined.

Figure 4. A) Initial radiograph of patient 4 at the age of 13 months; B) relocation of the femoral head with the AIR view; C) wearing the Ilfeld splint; D) near normal hip at the age of 3 years and 4 months.
true dislocations. I had occasion to confirm this observation by performing arthrogram in in hip subluxations in need of femoral and pelvic osteotomies.

This concept of relocation is well known. In 1929, Putti reported that in some early cases of hip dysplasia, subluxations or predislocations as they were then designated, positioning the hips in 45° of abduction and internal rotation was sufficient to bring the femoral head opposite the acetabulum. Bracing them in that position for a few months was enough to obtain a normal hip development. He identified Agostino Paci as the originator of the method in the 1890’s. In 1948, Grego and Schwartzmann reported the abduction and internal rotation position of immobilization in older children. They stated: In subluxation the heads were reduced by simple manipulation without an anesthetic and did not require preliminary skeletal traction.

Once the diagnosis of subluxation is made, I have used the Ilfeld abduction splint. A radiograph is taken in the splint to confirm that the head is directed into the acetabulum. This radiograph (frog leg view) alone cannot rule out a posterior dislocation. The head is slightly laterally displaced in relation to the acetabulum. These two views (wearing the brace and the abduction/internal rotation view) confirm that the head is in the acetabulum, and the brace treatment may proceed. An abduction device is used routinely when a need exists to maintain the hips in abduction for the treatment of both the early diagnosed and for residual hip dysplasia, after closed or open reduction. When wearing the Ilfeld splint, the patient can roll over, sit, crawl, and stand. As these children did not have significant limitation of abduction the risks of avascular necrosis are minimized.

The association of clinical and radiological features as represented by these five patients occurred during the course of my 30 years of practice. In cases 1, 2, and 5, with the exception of an obvious Trendelenburg gait, the limitation of hip abduction and leg length inequality were very subtle. Understandably, these three cases could remain undiagnosed until walking age. Patient 3, with high risk factors for hip dysplasia, should have been followed closely and would have benefited from a hip ultrasound for the early diagnosis. It provides an example of subluxation that could be easily called a missed dislocation. Hip dysplasia cannot always be diagnosed in the newborn by instability. In those cases, the resulting dislocation can be considered developmental, meaning that is not present at birth but will appear later. None of these five reported cases had a true hip dislocation, but the dysplasia could possibly evolve into one in the absence of treatment. Because of the limited number of patients, I have no studies on the optimal schedule for brace wear. At three months, good radiographic improvement is seen. For my reassurance, I have the patients wear the brace most of the day for one year. The second year, the brace is worn just in the night time even in the presence of considerable, but improving dysplasia.

Patient 2 wore the brace for six months, at which point the mother removed it. The child had no medical supervision and was only seen for follow-up at age 15. Her final radiographs were normal. Patient 4 did not have full compliance to the program after the 6th month of treatment and likewise did have a good result. Possibly, the almost full-time brace wear could be reduced to six months without compromise of the final result.

Figure 5. A) Initial radiograph of patient 5 at the age of 19 months; B) relocation of the femoral head with the AIR view; C) wearing the Ilfeld brace; D) at age 3 years and 10 months, three months after the completion of treatment: the acetabular index is 24° on the left hip and 16° on the right.

Figure 6. A photograph of a child wearing an Ilfeld splint. The degree of abduction can be changed by the width of the adjustable spreader bar and by the rotation of the thigh cuffs. The thigh felt liners can be washed and replaced. The metal frame can be reused.
The value of the AIR radiograph is well known. It has been used extensively in planning femoral and pelvic osteotomies for the treatment of hip subluxation. Less well known is its efficacy in differentiating between a dislocation and a severe subluxation, where the ossific nucleus of the femoral head is lateral to the Perkins’ line. Leveuf and Wiberg stated that the proper diagnosis could only be established by an arthrogram.

A small number of late diagnosed hip dysplasias are subluxations, not true dislocations. They may be amenable to abduction brace treatment as is typical of infants with an early diagnosis. Avoiding over diagnosis of hip dislocation in cases of subluxation is imperative. This is necessary to prevent overtreatment and to accurately assess the results of treatment. The abduction/internal rotation view may achieve this goal while avoiding diagnostic and therapeutic procedures, such arthrograms, cast immobilization and surgery.

References

1. Hilgenreiner H. Zur Angeborenen Dysplasia der Heufte. Z Orthop 1938;69:30.
2. Surgery Advisory Statement. American Academy of Orthopaedic Surgeons. CDH should be DDH. Park Ridge, IL AAOS, 1991. Available from: http://www.orthopaedicweblinks.com/Evidence_Base_d_Orthopedics/index.html
3. Coleman SS. Management of congenital dysplasia and dislocation of the hip from birth to eighteen months of age. In: Congenital Dislocation of the Hip, ed Tachdjian, MO. New York, Edinburgh, London, Melbourne: Churchill Livingstone; 1982. pp 181-203.
4. Wiberg G. Shelf operation in congenital dysplasia of the acetabulum and in subluxation and dislocation of the hip. J Bone Joint Surg Am 1953;35:65-80.
5. Leveuf J. Results of open reduction of true congenital luxation of the hip. J Bone Joint Surg Am 1948;30:875-83.
6. Severin E. Congenital dislocation of the hip. Development of the joint after closed reduction. J Bone Joint Surg Am 1950;32:507-18.
7. Tönnis D. Arthrography of the hip joint. In: Tönnis D, ed. Congenital Dysplasia and Dislocation of the Hip. Berlin, Germany: Springer-Verlag; 1987. pp 143-155
8. Putti V. Early treatment of congenital dislocation of the hip. J Bone Joint Surg 1929;11:789-809.
9. Putti V. Early treatment of congenital hip dislocation. J Bone Joint Surg 1933;15:16-21.
10. Crego CH, Schwartzmann JR. Follow up study of the early treatment of congenital dislocation of the hip. J Bone Joint Surg Am 1948;30:428-42.
11. Ilfeld FW. The management of congenital dislocation and dysplasia of the hip by means of a special splint. J Bone Joint Surg Am 1957;39:99-110.
12. Ilfeld FW. The management of congenital dislocation of the hip. Clin Orthop Relat Res 1962;22:43-59.
13. Ponseti IV. Non-surgical treatment of congenital dislocation of the hip. J Bone Joint Surg Am 1966;48:1392-03.
14. Tavares JO, Gottwald DH, Rochelle JR. Guided abduction traction in the treatment of congenital hip dislocation. J Ped Orthop 1994;14:643-9.
15. Graf R. The ultrasound examination of the hip. In: Tönnis D, ed. Congenital Dysplasia and Dislocation of the Hip. Berlin, Germany: Springer-Verlag; 1987. pp 172-229.
16. Tönnis D, Storch K, Ulbrich H. Results of newborn screening for CDH with and without sonography and correlation of risk factors. J Pediatr Orthop 1990;10:145-52.
17. Davies SJ, Walker G. Problems in the early recognition of hip dysplasia. J Bone Joint Surg Br 1984;66:479-84.
18. Ilfeld F, Westin GW, Makin M. Missed or developmental dislocation of the hip. Clin Orthop Relat Res 1986;203:276-81.
19. Ortolani M. Congenital hip dysplasia in the light of early and very early diagnosis. Clin Orth Relat Res 1976;119:6-14.
20. Barlow TG. Early diagnosis and treatment of congenital dislocation of the hip. J Bone Joint Surg Br 1962;44:292-301.
21. Griffin PP. Pitfalls of early treatment of congenital hip dislocation and causes of failure. In: Tachdjian. Congenital dislocation of the hip. New York, Edinburgh, London, Melbourne: Churchill Livingstone; 1982. pp 205-213
22. Green NE, Griffin PP. Hip dysplasia associated with abduction contracture of the contralateral hip. J Bone Joint Surg Am 1982;64:1273-81.
23. Catterall A. What is congenital dislocation of the hip? J Bone Joint Surg Br 1984;66:469-70.