Clin Orthop Relat Res (2011) 469:306–308
DOI 10.1007/s11999-010-1316-6

IN BRIEF

In Brief

Crowe's Classification

Arthroplasty in Developmental Dysplasia of the Hip

Muhammad Umar Jawad MD, Sean P. Scully MD, PhD

Published online: 23 March 2010

History

THA was described as "The operation of the century" [13]. Despite success of the procedure for patients with idiopathic or traumatic degenerative arthritis, hip replacement for congenital dislocation or subluxation was controversial as late as the 1970s [3, 6, 8, 13]. Different anatomic characteristics observed on AP radiographs of the pelvis historically were used to assess the degree of acetabular dysplasia. These included acetabular angle of Sharp, center edge angle of Wiberg, acetabular index of depth to width as described by Heyman and Herndon [11], acetabular roof obliquity described by Massie and Howorth [14], femoral head extrusion index, lateral subluxation, and peak to edge distance [15]. Crowe et al. described a relatively simple method to determine degree of hip dysplasia in 1979 [4].

Purpose

The controversy surrounding the indications and techniques for hip arthroplasty in adult patients with developmental dysplasia of the hip highlighted the need for a system to gauge the degree of dysplasia. A fair comparison among the outcomes for different operative techniques was possible only with a classification system for preoperative assessment of the degree of dysplasia.

An ideal staging system should be practical, reproducible, and provide prognostic estimation. As the normal anatomy of the hip is distorted in a patient with developmental hip dysplasia, a practical staging system should be based on readily identifiable landmarks that will be affected minimally by the disorder to ensure measurements can be made in a consistent and reliable manner for patients with diseases across the spectrum.

M. U. Jawad, S. P. Scully (✉)
Department of Orthopaedics, University of Miami Miller School of Medicine, 1400 NW, 12th Avenue, Miami, FL 33136, USA
e-mail: sscully@med.miami.edu

Crowe's Classification

Crowe's classification is based on three easily identifiable anatomic landmarks: (1) the height of the pelvis; (2) the medial head-neck junction in the affected hip; and (3) the inferior margin of the acetabulum (the teardrop).

The measurements are made on AP radiographs of the pelvis. The reference line is drawn joining the inferior margins of each teardrop. The medial head-neck junction is identified and its distance from the reference line is noted. In the absence of subluxation this distance is close to zero. This distance was described as a measure of the degree of dysplasia by Crowe et al. [4]. According to the original investigation, the height of the pelvis is measured as the vertical distance from the highest point on the iliac crest to the inferior margin of the ischial tuberosity. The normal ratio of vertical diameter of the femoral head to the height of the pelvis was approximately 1:5 [4]. A hip was considered subluxated 50% or greater only if the medial head-neck junction was situated above the reference line by at least 10% of the measured height of the pelvis.

Taking into account these relative measurements, dysplastic hips are classified based on the amount of subluxation: Group 1, $< 50\%$ subluxation; Group 2, 50%–75% subluxation; Group 3, 75%–100%, and Group 4, $> 100\%$ subluxation (Table 1) [4]. This is the most commonly used classification system for dysplastic hips in adult patients.

Table 1. Crowe's classification

Group	Description
I	Subluxation < 50% or proximal dislocation < 0.1% of the pelvic height
II	Subluxation 50%–75% or proximal dislocation of 0.1% to 0.15% of pelvic height
III	Subluxation 75%–100% or proximal dislocation of 0.15% to 0.20% of pelvic height
IV	Subluxation > 100% or proximal dislocation of > 0.20% of pelvic height

Another commonly used classification system for developmental dysplastic hips in adults is that described by Hartofilakidis et al. in 1988 [9], who classified dysplasia in three groups based on anatomic correlations (Table 2). In this system a hip either is considered as dysplastic or as dislocated. A hip is classified as dysplastic when the femoral head is contained in the original acetabulum despite the degree of subluxation. For dislocated hips two distinct patterns of dislocations were outlined. A hip is classified as a low dislocation when the femoral head articulates with a false acetabulum which partially covers the true acetabulum to a varying degree. A high dislocation was defined as the femoral head that is completely out of the true acetabulum and migrated superiorly and posteriorly to a varying degree.

In addition to these two commonly used classification systems, other classification systems have been proposed [7, 12]. Eftekhar classified dysplastic hips in four types: A through D [7]. Type A is a slightly elongated dysplastic acetabulum accommodating a flattened mushroom-shaped femoral head, Type B is intermediate dislocation, Type C is high dislocation, and Type D is an old, unreduced dislocation. Kerboul et al. [12] classified dysplastic hips in three categories: Type A, anterior dislocation; Type B, intermediate dislocation; and Type C, posterior dislocation.

Reliability

High levels of interobserver and intraobserver reliability have been reported using Crowe's classification. Yiannakopoulos et al. reported kappa coefficients as high as 0.92 and 0.95 for interobserver and intraobserver reliabilities, respectively [16], and Decking et al. reported kappa coefficients of 0.82 and 0.86 for interobserver and intraobserver reliabilities, respectively [5]. These two investigations compared the classifications of Crowe et al. and Hartofilakidis et al. for dysplasia for reliability. Although Crowe's classification had higher kappa coefficients for reliability in both investigations, the difference was not clinically meaningful. Both investigations concluded that both classification systems are reliable.

Others have examined the reliability of the classification systems of Eftekhar and Kerboul et al. [1]. Although both classification systems showed sufficient reliability, they were less reliable when compared with Crowe's classification system. Brunner et al. recommended using the classification systems of Crowe et al. or Hartofilakidis et al. to assess the severity of hip dysplasia [1].

Validity for classification systems refers to the inherent ability of the proposed system to measure what it is supposed to measure. Validity has not been formally investigated for Crowe's classification, as it measures radiographic findings pathognomonic and unique to dysplastic hips. However, the influence of Crowe's rating on the outcome of THA for patients with congenital dysplasia was investigated by Cameron et al. [2]. They concluded that the complication rate increased with an increase in Crowe's rating, validating its prognostic significance.

Limitations

The main limitation of Crowe's classification system is the lack of correlation of the rating system with anatomy as

Table 2. Hartofilakidis classification

Type	Description	Anatomic correlation as verified during surgery
Dysplasia	The femoral head is not dislocated out of the acetabulum despite the degree of subluxation	Segmental deficiency of the superior wall, secondary shallowness attributable to fossa-covering osteophytes
Low dislocation	The femoral head is dislocated and articulates with a false acetabulum which partially covers the true acetabulum to a varying degree	Complete absence of the superior, anterior, and posterior segmental deficiency, narrow opening, and inadequate depth of the true acetabulum
High dislocation	The femoral head is dislocated and has migrated superiorly and posteriorly with no articulation with any part of the true acetabulum	Segmental deficiency of the entire acetabulum with narrow opening, inadequate depth, excessive anteversion, abnormal distribution of bone stock, mainly located anteroposteriorly in relation to the true acetabulum

seen during surgical exposure. This arises because Crowe's classification is a 2-D assessment of a 3-D problem. This limitation was addressed by Hartofilakidis et al. with their classification system (Table 2) [10]. They used 3-D CT to investigate four parameters of acetabular anatomy: (1) segmental deficiencies in the rim of the acetabulum superiorly, anteriorly, and posteriorly; (2) the amount of anteversion and the depth and opening, ie, the distance between the anterior and posterior rim of the true acetabulum; (3) the amount of acetabular bone stock superiorly, anteriorly, and posteriorly; and (4) the presence of osteophytes in the area of the true and false acetabula. Anatomic correlations are shown in Table 2.

Conclusions/Uses

Crowe's classification system for dysplastic hips is reliable, reproducible, and related to prognosis of patients with THA who have developmental hip dysplasia [2]. It is well accepted and widely used for classification by orthopaedic adult reconstruction surgeons worldwide. However, the classification system of Hartofilakidis et al. is similarly reliable and a combination of both classification systems probably would be most useful for clinical decision-making.

References

1. Brunner A, Ulmar B, Reichel H, Decking R. The Eftekhar and Kerboul classifications in assessment of developmental dysplasia of the hip in adult patients: measurement of inter- and intraobserver reliability. *HSS J.* 2008;4:25–31.
2. Cameron HU, Botsford DJ, Park YS. Influence of the Crowe rating on the outcome of total hip arthroplasty in congenital hip dysplasia. *J Arthroplasty.* 1996;11(5):582–587.
3. Charnley J, Feagin JA. Low-friction arthroplasty in congenital subluxation of the hip. *Clin Orthop Relat Res.* 1973;91:98–113.
4. Crowe JF, Mani VJ, Ranawat CS. Total hip replacement in congenital dislocation and dysplasia of the hip. *J Bone Joint Surg Am.* 1979;61:15–23.
5. Decking R, Brunner A, Decking J, Puhl W, Gunther KP. Reliability of the Crowe und Hartofilakidis classifications used in the assessment of the adult dysplastic hip. *Skeletal Radiol.* 2006;35:282–287.
6. Dunn HK, Hess WE. Total hip reconstruction in chronically dislocated hips. *J Bone Joint Surg Am.* 1976;58:838–845.
7. Eftekhar NS. *Total Hip Arthroplasty*, 2nd ed. St Louis, MO: Mosby; 1993:927.
8. Harris WH, Crothers O, Oh I. Total hip replacement and femoral-head bone-grafting for severe acetabular deficiency in adults. *J Bone Joint Surg Am.* 1977;59:752–759.
9. Hartofilakidis G, Stamos K, Ioannidis TT. Low friction arthroplasty for old untreated congenital dislocation of the hip. *J Bone Joint Surg Br.* 1988;70:182–186.
10. Hartofilakidis G, Stamos K, Karachalios T, Ioannidis TT, Zacharakis N. Congenital hip disease in adults: classification of acetabular deficiencies and operative treatment with acetabuloplasty combined with total hip arthroplasty. *J Bone Joint Surg Am.* 1996;78:683–692.
11. Heyman CH, Herndon CH. Legg-Perthes disease; a method for the measurement of the roentgenographic result. *J Bone Joint Surg Am.* 1950;32:767–778.
12. Kerboul M, Mathieu M, Sauzieres P. Total hip replacement for congenital dislocation of the hip. In: Postel M, Kerboul M, Evard J, Courpied JP, eds. *Total Hip Replacement.* Berlin, Germany; Springer; 1987:51–66.
13. Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. *Lancet.* 2007;370:1508–1519.
14. Massie WK, Howorth MB. Congenital dislocation of the hip. Part I. Method of grading results. *J Bone Joint Surg Am.* 1950;32-A(3):519–531.
15. Umer M, Sepah YJ, Asif S, Azam I, Jawad MU. Acetabular morphometery and prevalance of hip dysplasia in the South Asian population. *Orthop Rev.* 2009;1:e10.
16. Yiannakopoulos CK, Chougle A, Eskelinen A, Hodgkinson JP, Hartofilakidis G. Inter- and intra-observer variability of the Crowe and Hartofilakidis classification systems for congenital hip disease in adults. *J Bone Joint Surg Br.* 2008;90:579–583.