

The necessity to restore the anatomic hip centre in congenital hip disease

George A. Macheras, Panagiotis Lepetsos, Panagiotis P. Anastasopoulos, Spyridon P. Galanakis

Fourth Department of Trauma & Orthopaedics, KAT Hospital, Athens, Greece

Correspondence to: George A. Macheras, MD, PhD. Chief Orthopedic Surgeon, Fourth Orthopaedic Department, Director, Medical Services, "KAT" General Hospital, 2 Nikis str, 14561, Kifisia, Athens, Greece. Email: gmacheras@gmail.com.

Provenance: This is a Guest Perspective commissioned by Section Editor Pengfei Lei, MD (Clinical research fellow at Department of Orthopedic Surgery Brigham and Women's Hospital, Harvard University, Boston, MA, USA; Surgeon of Department of Orthopaedic Surgery, Central South University Xiangya Hospital, Changsha, China).

Comment on: Watts CD, Abdel MP, Hanssen AD, *et al.* Anatomic Hip Center Decreases Aseptic Loosening Rates After Total Hip Arthroplasty with Cement in Patients with Crowe Type-II Dysplasia: A Concise Follow-up Report at a Mean of Thirty-six Years. *J Bone Joint Surg Am* 2016;98:910-5.

Abstract: Total hip replacement (THR) is the treatment of choice for the patient suffering from end-stage hip osteoarthritis. In the presence of deformities due to congenital hip disease (CHD), THR is, in most of the cases, a difficult task, since the technique of performing such an operation is demanding and the results could vary. We present our experience and preferred strategies focusing on challenges and surgical techniques associated with reconstructing the dysplastic hip.

Keywords: Total hip replacement (THR); congenital hip disease (CHD); anatomic hip centre

Submitted Sep 30, 2016. Accepted for publication Oct 11, 2016.

doi: 10.21037/atm.2016.11.49

View this article at: <http://dx.doi.org/10.21037/atm.2016.11.49>

THR in patients with congenital hip disease (CHD) remains a difficult and challenging technical procedure for surgeons to perform because of the potential for these patients to have severe anomalies in their bones and soft tissues (1,2).

The goal of THR in CHD is the proper restoration of the centre of rotation and proximal femoral anatomy to allow optimal abductor function, a task quite challenging due to the anatomical abnormalities encountered. Proper preoperative planning is required to assess the location and severity of defects, angular deformities, fixed deformities of lumbar spine, limb-length discrepancy, along with the depth and the anteversion of the acetabulum and the femoral neck (1).

Especially the acetabular reconstruction is technically demanding because of anterolateral bone deficiency and increased socket anteversion, which compromise superior coverage (3,4). While multiple strategies have been described to address this challenge, the optimal cup position continues to be debated (5-9).

The anatomical placement (true acetabulum) of

the acetabular component is recommended mainly for biomechanical reasons (7,10,11). On the basis of a mathematical model of the hip joint, Johnston *et al.* (12) suggested that the displacement of the centre of rotation of the cemented acetabular component medially, inferiorly and anteriorly reduces hip loads significantly. High placement of the component in the region of false acetabulum has also been proposed (13,14). However, at this level, the lever arm for the body weight is much longer than that of the abductors and causes excessive loading of the hip. Also, the shearing forces acting on the acetabular component at a higher level can lead to early loosening. In addition, in unilateral cases a high acetabular component does not correct leg-length and leaves the patient with a limb.

In cases of hip dysplasia, according to Hartofilakidis (7) classification the acetabular cup usually does not pose problems in the ideal placement at the original acetabulum. During the preparation, care should be taken to ream the osteophyte that covers the fossa, in order to place the prosthesis in proper depth.

In low dislocation, the femoral head articulates with a false acetabulum that partially covers the true acetabulum. Besides the superior segmental defect there is an anterior segmental defect of the true acetabulum due to erosion by the migrating head.

In our experience, adequate coverage of a small press fit cup is possible although technically more demanding, not only compared to simple dysplasia, but also compared to high dislocation cases. As, cup is usually left more than 20% uncovered, even after cotyloplasty (as described below for high dislocation), we often favour the use of a porous acetabular component in combination with cancellous autograft impacted onto the uncovered shell portion.

Placing the cup at the anatomic level of the true acetabulum is crucial in order to medialise the centre of hip rotation and restore the lever arm of the gluteal muscles to correct any pelvic imbalance (15). The inadequate medialisation of the hip centre may affect long term results; superior or lateral placement of the acetabular implant has been proven to be a risk factor for implant loosening due to increased joint loads in supero-lateral compared to medial-inferior position (16,17).

In high dislocation, although the hypoplastic appearance of the acetabulum, the superior rim is not eroded as in low dislocated hips while the anterior and posterior walls provide adequate coverage. The best bone stock to support reconstruction is postero-superiorly, therefore placement of the implant in the true anatomic position is possible, having in mind that the true acetabulum is narrow and shallow with a characteristic pulvinar fatty tissue. Our technique includes widening and deepening of the true acetabulum by using small diameter reamers, following a superior and posterior direction, where bone stock is usually adequate (18). Care should be taken to avoid fracture of the anterior thin wall and to protect the bone bridge between the two acetabula. After reaming with the final reamer is performed, we use the reverse reaming technique impacting the cancellous bone to the soft porotic acetabular medial wall. If the created cavity is able to accommodate a small cementless press-fit cup with 40–45° abduction, 10° anteversion and there is less than 30–40% of uncovered area, we implant that prosthesis. When adequate coverage by native bone cannot be achieved (more than 40% uncovered), we perform cotyloplasty technique by inserting a press-fit cup whose initial fixation supports upon the acetabular rim. Initial reaming provides adequate autogenous cancellous graft that in combination with the morsellised femoral head is reverse reamed and impacted towards the fragmented acetabular wall, thus

restoring bone stock in the long term.

Since 1997 we use the Trabecular Metal for the CHD cases, initially Monoblock acetabular components and after that the Trabecular Metal Modular Acetabular cup (Zimmer Inc., Warsaw, Indiana). The external surface of porous implants has a high coefficient of friction with this cancellous bone and they provide excellent initial stability, with possible osteoconductive and osteoinductive properties (19,20).

Concerning the positioning of the acetabular components, biomechanical analysis showed that higher joint contact forces occurred with lateral placement of the cementless acetabular components in patients who did not have CHD (21). In addition, lateral positioning of the cemented cup has been reported to have significantly higher long-term complications in THR for CHD (9,11).

Dorr *et al.* (6) described a cementless acetabular protrusion cup fixation technique for 24 cases of CHD and reported good results with medial and lower cup positioning at a mean of 7 years of follow-up. In a study by Georgiades *et al.* (3), 28 cementless cups placed with a horizontal distance from cup to teardrop of more than 25 mm had significantly higher wear rate and periacetabular osteolysis compared to the remaining 25 cementless cups placed within a horizontal distance from cup to teardrop of less than 25 mm. In addition, they had a higher frequency of osteolysis around the femoral component that was not statistically significant probably due to the small size of their sample. Moreover, the 12 cups placed at a height of more than 25 mm superior to the interteardrop line (ITL) showed a statistically significant higher aseptic loosening rate only of the femoral component although none of those cups was placed at a height of more than the 35 mm, placement distance over which it is considered as high placement of the cup (9,22,23).

On the basis of a mathematical model of the hip joint, Johnston *et al.* (12) suggested that the displacement of the center of rotation of the cemented acetabular component medially, inferiorly, and anteriorly reduces hip loads significantly. However, Russotti and Harris reported acceptable results with the superior and medial positioning of cemented acetabular components in patients with and without CHD (9). According to a high hip center defined by the authors, the reconstructive rotation center of the hip could be considered as a high hip center (>35 mm above the interteardrop) without concomitant lateralization (9).

Moreover, Hirakawa *et al.* (22) reported good results with superior placement, relatively low inclination, and medial positioning of the cemented cup exclusively in patients with CHD.

Recently, Sen *et al.* (24) performed acetabuloplasty in 54 hips (44 patients) by reaming the posterior wall of the native acetabulum and medialising the acetabular component to restore the anatomic centre of hip rotation using a small cup without bone grafting. The mean follow-up was 5 years (range, 2–14 years) and on average, the prosthetic survival rates were 92.7% and 88.5% at 2 and 5 years, respectively post surgery. The authors mentioned that the placement of the acetabular cup on the true acetabulum is biomechanically superior to any other position and increases the survival rate in their series. This is in agreement with other investigators which stress the biomechanical advantages of component placement in the anatomical position (25,26).

In contrast, other authors found increased rates of loosening of the femoral and acetabular components with superior positioning of the acetabular component in patients without or with CHD, even without lateral displacement (27,28).

Furthermore, recent studies reported excellent long-term results of cementless cups with a high hip center placement for CHD. The authors stated that the implant survival rate for any reasons was >95%, and the complications such as aseptic loosening, polyethylene wear, and dislocation had no significant differences compared with reconstruction of an anatomic rotation center of the hip (29,30).

Whether to determine the value of anatomic hip centre in hip dysplasia, Watts *et al.* (31) investigated if long-term acetabular and/or femoral component loosening and revision rates were correlated with the initial placement of the hip center relative to superior displacement, presence within the true acetabular region (TAR), and the location as determined with a four-zone system (28). They found that the overall cumulative incidence of aseptic revision at thirty-five years was 32% for acetabular cups and 21% for femoral stems. Acetabular loosening was less likely with a hip center placed within the TAR, <15 mm superior to the approximate femoral head center, <35 mm superior to the ITL, or within the inferomedial acetabular zone (zone 1). Femoral loosening and revision were less likely with the hip center placed <35 mm superior to the ITL and within zone 1. They stated that an anatomic hip center was associated with significantly lower loosening and aseptic revision rates for both acetabular and femoral components.

However at the same study, the authors noted that recent reports have shown excellent outcomes in dysplastic hips treated with a superiorly placed cementless acetabular component (29,30,32) While the positive results of non-anatomically placed uncemented components are intriguing, Watts *et al.* (31) mentioned such reports must be interpreted

with attention to the definition of a “high hip center.” In the three aforementioned studies of uncemented components, the hip center was placed an average of 24 to 27 mm superior to the ITL. These mean values would actually be classified as “anatomic” if the methods used in study by Watts *et al.* (31) were applied and they noted that it is acceptable slightly superior cup placement with Crowe type II dysplasia when performing cementless THR.

Nevertheless, Chen *et al.* (33) mention that the concept of high hip centre (HHC) may insufficiently illuminate the degree of elevating rotation center of the hip owing to individual differences. They introduced the concept of ratio of the HHC to the height of patient. The ratio of the height of the hip center (HHC ratio) was calculated with the formula: OA/height, where OA, is the height of the hip center, vertical distance along a line extending from the center of the femoral head perpendicular to the ITL. They also noted that analyses of anthropometric data may be valuable and will give a good comparison for future studies.

In conclusion, THR in patients with CHD is a demanding operation associated with higher failure and revision rates, thus an experienced surgical team is needed. Many of the problems arising with reconstruction in CHD can be overcome by understanding the anatomical basis of the underlying anomalies encountered. A detailed preoperative planning is of capital importance. Our main goal is restoration of the anatomic hip centre which serves to restore abductor lever arm and pelvic imbalances thus eliminating abnormal contact stresses on the hip joint. This is not a straight forward procedure in the majority of cases and special techniques are usually required. With the advances in technology and adherence to the proper surgical steps, THR is becoming a very valuable option but it still can prove to be a technically demanding operation even for experienced surgeons.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Macheras GA, Koutsostathis SD, Lepetsos P, et al. THA

- following deformities due to congenital dislocation of the hip joint. *Hip Int* 2014;24 Suppl 10:S29-32.
2. Sanchez-Sotelo J, Berry DJ, Trousdale RT, et al. Surgical treatment of developmental dysplasia of the hip in adults: II. Arthroplasty options. *J Am Acad Orthop Surg* 2002;10:334-44.
 3. Georgiades G, Babis GC, Kourlaba G, et al. Effect of cementless acetabular component orientation, position, and containment in total hip arthroplasty for congenital hip disease. *J Arthroplasty* 2010;25:1143-50.
 4. Jasty M, Anderson MJ, Harris WH. Total hip replacement for developmental dysplasia of the hip. *Clin Orthop Relat Res* 1995;(311):40-5.
 5. Barrack RL, Newland CC. Uncemented total hip arthroplasty with superior acetabular deficiency. Femoral head autograft technique and early clinical results. *J Arthroplasty* 1990;5:159-67.
 6. Dorr LD, Tawakkol S, Moorthy M, et al. Medial protrusion technique for placement of a porous-coated, hemispherical acetabular component without cement in a total hip arthroplasty in patients who have acetabular dysplasia. *J Bone Joint Surg Am* 1999;81:83-92.
 7. Hartofilakidis G, Stamos K, Karachalios T, et al. 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;78:683-92.
 8. McQueary FG, Johnston RC. Coxarthrosis after congenital dysplasia. Treatment by total hip arthroplasty without acetabular bone-grafting. *J Bone Joint Surg Am* 1988;70:1140-4.
 9. Russotti GM, Harris WH. Proximal placement of the acetabular component in total hip arthroplasty. A long-term follow-up study. *J Bone Joint Surg Am* 1991;73:587-92.
 10. Hartofilakidis G, Stamos K, Karachalios T. Treatment of high dislocation of the hip in adults with total hip arthroplasty. Operative technique and long-term clinical results. *J Bone Joint Surg Am* 1998;80:510-7.
 11. Karachalios T, Hartofilakidis G, Zacharakis N, et al. A 12- to 18-year radiographic follow-up study of Charnley low-friction arthroplasty. The role of the center of rotation. *Clin Orthop Relat Res* 1993;(296):140-7.
 12. Johnston RC, Brand RA, Crowninshield RD. Reconstruction of the hip. A mathematical approach to determine optimum geometric relationships. *J Bone Joint Surg Am* 1979;61:639-52.
 13. Paavilainen T, Hoikka V, Solonen KA. Cementless total replacement for severely dysplastic or dislocated hips. *J Bone Joint Surg Br* 1990;72:205-11.
 14. 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;59:752-9.
 15. Boisgard S, Descamps S, Bouillet B. Complex primary total hip arthroplasty. *Orthop Traumatol Surg Res* 2013;99:S34-42.
 16. Doehring TC, Rubash HE, Shelley FJ, et al. Effect of superior and superolateral relocations of the hip center on hip joint forces. An experimental and analytical analysis. *J Arthroplasty* 1996;11:693-703.
 17. Kennedy JG, Rogers WB, Soffe KE, et al. Effect of acetabular component orientation on recurrent dislocation, pelvic osteolysis, polyethylene wear, and component migration. *J Arthroplasty* 1998;13:530-4.
 18. Macheras GA, Kateros K, Koutsostathis SD, et al. The Trabecular Metal Monoblock acetabular component in patients with high congenital hip dislocation: a prospective study. *J Bone Joint Surg Br* 2010;92:624-8.
 19. Bobynd JD, Pilliar RM, Cameron HU, et al. The optimum pore size for the fixation of porous-surfaced metal implants by the ingrowth of bone. *Clin Orthop Relat Res* 1980;(150):263-70.
 20. Tanzer M, Karabasz D, Krygier JJ, et al. The Otto Aufranc Award: bone augmentation around and within porous implants by local bisphosphonate elution. *Clin Orthop Relat Res* 2005;441:30-9.
 21. Devane PA, Bourne RB, Rorabeck CH, et al. Measurement of polyethylene wear in metal-backed acetabular cups. I. Three-dimensional technique. *Clin Orthop Relat Res* 1995;(319):303-16.
 22. Hirakawa K, Mitsugi N, Koshino T, et al. Effect of acetabular cup position and orientation in cemented total hip arthroplasty. *Clin Orthop Relat Res* 2001;(388):135-42.
 23. Morag G, Zalzal P, Liberman B, et al. Outcome of revision hip arthroplasty in patients with a previous total hip replacement for developmental dysplasia of the hip. *J Bone Joint Surg Br* 2005;87:1068-72.
 24. Sen C, Bilsel K, Elmadag M, et al. Acetabuloplasty at the anatomic centre for treating Crowe class III and IV developmental hip dysplasia: a case series. *Hip Int* 2016;26:360-6.
 25. Mu W, Yang D, Xu B, et al. Midterm Outcome of Cementless Total Hip Arthroplasty in Crowe IV-Hartofilakidis Type III Developmental Dysplasia of the Hip. *J Arthroplasty* 2016;31:668-75.
 26. Karachalios T, Roidis N, Lampropoulou-Adamidou K, et al. Acetabular reconstruction in patients with low and

- high dislocation: 20- to 32-year survival of an impaction grafting technique (named cotyloplasty). *Bone Joint J* 2013;95-B:887-92.
27. Yoder SA, Brand RA, Pedersen DR, et al. Total hip acetabular component position affects component loosening rates. *Clin Orthop Relat Res* 1988;(228):79-87.
 28. Pagnano W, Hanssen AD, Lewallen DG, et al. The effect of superior placement of the acetabular component on the rate of loosening after total hip arthroplasty. *J Bone Joint Surg Am* 1996;78:1004-14.
 29. Nawabi DH, Meftah M, Nam D, et al. Durable fixation achieved with medialized, high hip center cementless THAs for Crowe II and III dysplasia. *Clin Orthop Relat Res* 2014;472:630-6.
 30. Murayama T, Ohnishi H, Okabe S, et al. 15-year comparison of cementless total hip arthroplasty with anatomical or high cup placement for Crowe I to III hip dysplasia. *Orthopedics* 2012;35:e313-8.
 31. Watts CD, Abdel MP, Hanssen AD, et al. Anatomic Hip Center Decreases Aseptic Loosening Rates After Total Hip Arthroplasty with Cement in Patients with Crowe Type-II Dysplasia: A Concise Follow-up Report at a Mean of Thirty-six Years. *J Bone Joint Surg Am* 2016;98:910-5.
 32. Kaneuji A, Sugimori T, Ichiseki T, et al. Minimum ten-year results of a porous acetabular component for Crowe I to III hip dysplasia using an elevated hip center. *J Arthroplasty* 2009;24:187-94.
 33. Chen M, Luo ZL, Wu KR, et al. Cementless Total Hip Arthroplasty With a High Hip Center for Hartofilakidis Type B Developmental Dysplasia of the Hip: Results of Midterm Follow-Up. *J Arthroplasty* 2016;31:1027-34.

Cite this article as: Macheras GA, Lepetsos P, Anastasopoulos PP, Galanakos SP. The necessity to restore the anatomic hip centre in congenital hip disease. *Ann Transl Med* 2016;4(23):470. doi: 10.21037/atm.2016.11.49