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Is There a Difference in the Outcome of Total Hip Arthroplasty Performed for Patients Who Have Developmental Dysplasia when the Acetabular Component Is Positioned in the Anatomical Position Versus the High Hip Center?

Seyed Mohammad Javad Mortazavi, MD [a,*], Pooya Hosseini-Monfared, MD [a], Bülent Atilla, MD [b], Omer Faruk Bilgen, MD [c], Aydin Gahramanov, MD [d], Stefan Kreuzer, MD [e], Mohammadreza Razzaghof, MD [f], Igor Shubnyakov, MD [g], Luigi Zagra, MD [h]

[a] Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran
[b] Faculty of Medicine, Orthopaedics and Traumatology Department, Hacettepe University, Ankara, Turkiye
[c] Department of Orthopedic Surgery, Uludağ University, Nilüfer, Bursa, Turkiye
[d] Azerbaijan State Medical University, Baku, Azerbaijan
[e] Memorial Bone and Joint Research Foundation, Houston, Texas
[f] Department of Orthopedic Surgery, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran
[g] Vreden National Medical Research Centre of Traumatology and Orthopaedics, St. Petersburg, Russian Federation
[h] IRCCS Istituto Ortopedico Galeazzi, Hip Department, Milan, Italy

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Is there a difference in the outcome of total hip arthroplasty performed for patients who have developmental dysplasia when the acetabular component is positioned in the anatomical position versus the high hip center?

Response/Recommendation: No. According to the available literature, in patients who have severe developmental dysplasia of the hip, there is no difference in the outcomes of total hip arthroplasty when the acetabular component is positioned at the anatomic hip center or the high hip center (defined as 30-mm above the interteardrop line or 15-mm above the anatomical hip center).

Level of Evidence: Limited.

Expert Vote: Agree 52.3%, disagree 39.7%, and abstain 8.1%.

Rationale

Total hip arthroplasty (THA) in patients who have severe developmental dysplasia of the hip (DDH) presents a major challenge for orthopaedic surgeons due to complex anatomical deformities and compromised bone stock [1]. A THA aims to restore the anatomical hip center, which reduces joint loading, improves hip biomechanics, and supports a normal gait. However, in patients who have severe DDH, achieving this goal is challenging due to the

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* Address correspondence to: Seyed Mohammad Javad Mortazavi, MD, Joint Reconstruction Research Center, Tehran University of Medical Sciences, End of Keshavarz Blvd, Tehran 1419733141, Iran.

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altered acetabular morphology [2]. The high hip center (HHC) technique has emerged as an alternative to evade these issues and improve bone-implant contact by placing the cementless cup at a higher position than the anatomical center, leveraging the superior periacetabular bone stock available in this region [3,4]. Despite its potential advantages, there have been reports of complications associated with HHC, including higher rates of aseptic loosening, dislocation, limb-length inequality, and increased hip joint reaction forces [5]. These concerns have led to the cautious adoption of the technique. However, recent studies have reported promising results with the high placement of the acetabular cup, suggesting that with careful patient selection and surgical precision, the HHC technique can yield satisfactory outcomes.

Various studies have defined the HHC technique using different criteria, resulting in discrepancies in the exact measurements used. To encompass this range of definitions, we considered the HHC as the placement of the acetabular cup at a minimum of 15-mm above the approximate femoral head center or 30-mm above the interteardrop line. The longitudinal position of the acetabular cup at the HHC was defined regarding the interteardrop line in eight studies, and six studies used the anatomic hip centers (AHCs) as the reference for defining the HHC (Table 1).

Among the 14 studies comparing the outcomes of the HHC technique with the anatomical center, most of the studies were retrospective cohorts, and only three of them were prospective studies designed to compare these two methods. We evaluated the outcomes of THA in dysplastic hips as measured by the Harris hip score (HHS), revision rates, and postoperative complications in two groups of cup position of the acetabular cup in the HHC versus the AHC.

Only the Yang et al. and Karaismailoglu et al. studies included patients who have severe DDH (Crowe III and IV) [10,11]. The two studies conducted by Karaismailoglu et al. were designed to evaluate the gait of the patients following THA and excluded patients who have limb-length discrepancy > two centimeters and HHS < 85 points and therefore were not included in the meta-analysis [10,11].

Postoperative function was assessed using the HHS in seven of the included studies [6–8,12,14,16,17]. The results of this meta-analysis demonstrated that there is no significant difference between the HHS scores of the HHC and anatomic center groups (Hedges's g = 0.11 [−0.30, 0.52], *P* value = 0.59). The meta-analysis demonstrated significant heterogeneity among these studies (I^2 = 73.26, *P* value < 0.01) suggesting variability in the effect sizes across the studies. This could be due to differences in study design, population characteristics, or other factors.

The abductor lever arm was measured in three of the included studies [6,9,14]. Comparing the abductor lever arm between the two groups did not show any significant difference (Hedges's g = −0.03 [−0.48, 0.41], *P* value = 0.89). The three studies had a moderate degree of heterogeneity (I^2 = 73.15%, *P* value = 0.02). Also, the meta-analysis of limb-leg difference between the two methods using the data from five studies demonstrated no significant difference (*P* value = 0.32) [6,7,14,17,18].

Although Watts et al. reported a higher incidence of cup revisions in the HHC group, the meta-analysis demonstrated no significant difference between the two groups regarding the cup revision rates (overall log odds ratio = 0.70 [−0.49, 1.89], *P* value = 0.25) [5–7,12–15,17]. Studies had low heterogeneity (I^2 = 8.82%, *P* value = 0.43). Also, any cause revisions were not significantly different between the two groups (log odd ratio = 0.02 [−0.81, 0.85], *P* = 0.96).

Nerve injury rates were reported in 4 studies [6–8,15]. Although nerve injuries were predominantly observed in the anatomic group, meta-analysis revealed no statistically significant difference

Table 1
Summary of the Included Studies.

Study	Study Design	Number of Patients	Dysplasia Classification	High Hip Position Definition	Reference Landmark
Demirel, 2022 [6]	Retrospective	57 patients/57 hips	Crowe type II, type III	Vertical distance of 15 mm from AHC	Anatomic Head Centers
Christodoulou, 2010 [7]	Retrospective	88 patients/104 hips	Hartoflakidis classification	>35 mm from the interteardrop line, >15 mm from AFHC	Interteardrop line
Dogra, 2023 [8]	Prospective	30 patients/30 hips	Crowe type II, type III	>15 mm from AHC	Interteardrop line
Fukui, 2013 [9]	Prospective	200 patients/200 hips	Crowe type I, II, III	>22 mm from the interteardrop line	Interteardrop line
Karaismailoglu 2019-1 [10]	Retrospective	20 patients/20 hips	Crowe III/IV	>15 mm superior to AHC	approximate femoral head center
Karaismailoglu 2019-2 [11]	Retrospective	10 patients/20 hips	Crowe III/IV	>15 mm superior to AHC	approximate femoral head center
Murayama, 2012 [12]	Retrospective	43 patients/43 hips	Crowe I to III	>24.5 mm above interteardrop line	Interteardrop line
Nawabi 2013 [13]	Retrospective	46 patients/51 hips	Crowe I to III	>10 mm superior to AFHC	Interteardrop line, (Ranawat method)
Shen, 2021 [14]	Retrospective	42 patients/42 hips	Crowe II to III and IV	>22 mm above interteardrop line	Interteardrop line
Traina, 2008 [15]	Retrospective	67 patients/88 hips	Crowe Ito IV	≥30 mm above interteardrop line	Interteardrop line
Wang, 2017 [16]	Retrospective	68 patients/86 hips	Hartoflakidis classification	>35 mm above interteardrop line	Interteardrop line
Watts, 2018 [5]	Retrospective	88 patients/88 hips	Crowe II to III	>1 cm superior and >1 cm lateral to AFHC	Interteardrop line, (Pagnano and Ranawat method)
Yang, 2017 [17]	Retrospective	21 patients/21 hips	Crowe III to IV	Superior displacement	Interteardrop line (Pierchon method)
Zhang, 2017 [18]	Prospective	40 patients/42 hips	Crowe I to III	Upward placement of 5 to 20 mm	Interteardrop line

The longitudinal cup position was significantly higher in the postoperative radiographic evaluations in the high hip center group compared to the anatomic center (Hedges's g = 2.32 [1.56, 3.07], *P* value < 0.01).
AHC, anatomic hip center; AFHC, approximate femoral head center.

in nerve injury rates between the HHC and anatomic groups (log odd ratio = −1.24 [−2.83, 0.35], *P* value = 0.13). The incidence of postoperative dislocations was also evaluated in 6 studies [5–8,12,14]. The meta-analysis demonstrated no significant difference regarding the dislocation rate between the two groups (*P* value = 0.96).

Theoretically, one might expect to detect clinical differences due to the significant deviation from the AHC and a HHC. Although some biomechanical studies have shown that this variation reduces abductor efficiency and increases load, joint surface stress, and forces on the components, our analysis concluded that these effects are not clinically meaningful. This controversy may be explained by the insufficient sensitivity of the scoring tools to detect differences in functional outcomes over the given follow-up period.

CRediT authorship contribution statement

Seyed Mohammad Javad Mortazavi: Writing – review & editing, Validation, Supervision, Project administration, Investigation. **Pooya Hosseini-Monfared:** Writing – original draft, Methodology, Investigation, Data curation. **Bülent Atilla:** Writing – review & editing, Supervision. **Omer Faruk Bilgen:** Writing – review & editing, Validation, Supervision. **Aydin Gahramanov:** Validation. **Stefan Kreuzer:** Validation. **Mohammadreza Razzaghof:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Igor Shubnyakov:** Validation. **Luigi Zagra:** Validation.

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