



Original Article

A clinical comparative study of anatomic parameters before and after total hip replacement on congenital dysplasia

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Abstract. [Purpose] To study preoperative and postoperative hip circumference data of various types of congenital dysplasia of the hip treated with total hip replacement, including the femoral offset, femoral neck length, height, and hip abductor arm parameters. [Subjects and Methods] This study included seventy-eight cases of congenital dysplasia of the hip (I–III type). Furthermore, four parameters were measured, including the preoperative and postoperative femoral offset. Statistical data analysis was performed using the SPSS 13.0 software. [Results] The femoral offset was 33.3 ± 8.4 mm (preoperative) and 39.1 ± 7.1 mm (postoperative). The femoral head height was 59.5 ± 8.7 mm (preoperative) and 68.8 ± 11.0 mm (postoperative). The femoral neck length was 50.8 ± 10.8 mm (preoperative) and 61.5 ± 10.4 mm (postoperative). The hip abductor arm was 54.3 ± 9.6 mm (preoperative) 64.7 ± 10.1 mm (postoperative). The preoperative and postoperative parameters showed statistical differences. Furthermore, no significant differences were evidenced when comparing the postoperative hip parameters with the normal data parameters. [Conclusion] Total hip replacement on congenital dysplasia of the hip could lead to the rebuilt of an almost normal physiological anatomy for each hip case (type I–III).

Key words: Congenital dysplasia of the hip, Femoral neck, Hip abductor arm

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INTRODUCTION

The incidence of congenital dysplasia of the hip (CDH) is known to be higher in China than in the European and American countries². Ultimately, CDH can cause osteoarthritis and other joint destruction, and lead to loss of the joint function². It is known that one of the main functions of the artificial joint is to overcome the anatomic deformity of the hip^{1,3}. Studying the anatomic parameters of CDH before and after total hip replacement is of great scientific and clinical value. Lindgren et al. had measured 47 cases of hip dysplasia after total hip replacement, analyzing the differences between the femoral eccentricity, hip abductor arm, height and hip rotation center, and the leg lengths³. Dastane M et al. had measured femoral offset to investigate the guiding role of the total hip replacement¹. According to the radiographic images, the difference in the femoral eccentricity between the preoperative arthritic hip and the contralateral normal hip was -12 to 21 mm (average, 1.5 mm), while the postoperative femoral offset difference value between the two sides was 1.4 – 6.4 mm². The study did not present any preoperative and postoperative data on the hip femoral offset, length of the femoral neck, and femoral head height. Normal femoral offset, hip abductor muscle of the arm, the soft tissue tension, and abductor muscle strength are important parameters for the improvement of the gait and lower limb movement. CDH is more complex than single femoral head necrosis or osteoarthritis

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surgery; thus, the postoperative anatomic parameters directly affected the quality of surgery and the long-term follow-up. The objective of this study was to investigate the relevant preoperative and postoperative anatomic parameters, and evaluate the surgical corrective effect, while providing a reference for future improvement of the surgical method.

SUBJECTS AND METHODS

Location: The People's Liberation Army (PLA) General Hospital (301 hospital, Beijing) and The People's Hospital of Lishui city (Zhejiang province), China.

Patients: The inclusion criteria were: (A) I–III congenital dysplasia of the hip and patients with unilateral total hip replacement for the first time; (B) patients treated with class III and class IV ceramic prosthesis; (C) preoperative and postoperative pelvic radiography.

This study included 78 patients. All had signed the informed consent prior to clinical data collection. All the experimental designs and processes were approved by the Ethics Committee of the PLA General Hospital (301 hospital) and The People's Hospital of Lishui city. According to the Developmental Congenital Dysplasia of the Hip (DDH) classification, we grouped the cases as follows: (1) type I: femoral head translocation < 50% of the femoral head height, or femoral head translocation < 10% of the pelvic height; (2) type II: femoral head translocation < 50–75% of the femoral head height, and femoral head translocation < 10–15% of the pelvic height; (3) type III: femoral head translocation < 75–100% of the femoral head height, or femoral head translocation < 15–20% of the pelvic height.

Materials used for the measurements: For this study, to estimate the size of the prosthesis we used concentric circles made on paper cards. By using Photoshop Cs 53 (Adobe, USA), we drew various concentric circles with a minimum radius of 0.5 mm (minimum radius value was 0.5 mm and this was increased to 0.5 mm). The concentric circles were printed on H₂SO₄ paper and a 6 cm × 6 cm square card was prepared. The concentric circles card was placed on the screen to determine the center of the femoral head.

In order to choose the appropriate size of the hip prosthesis, the prosthetic hip was compared with the acetabulum and the femur. When the magnified prosthetic template matched the values evidenced by the radiographic images, we estimated the size of the acetabular cup and that of the femoral handle.

Methods: The elected surgical method was the lateral approach. To start, the joint capsule was cut and removed, followed by anterior dislocation of the hip joint. A space of 4 cm was left between the femoral neck and the small tuberositas; the femur length was maintained at 10–15 mm, while the femoral head was removed. Additionally, three retractors were used to reveal the acetabulum. The prosthesis was placed into the reshaped socket, and two holes were drilled into the greater trochanter of the femur. Further, the medius gluteus was stitched on the rotator tendon of the femur, and further the integrity of the hip joint lateral tissue was reconstructed.

The following preoperative and postoperative parameters of the hip were analyzed on the radiograms using the PS software (Adobe Photoshop CS5, Adobe Systems Inc.).

- (1) The center of the femoral head: H₂SO₄ paper was used to determine the center of the femoral head on its both sides.
- (2) Femoral neck length (FNL): The distance between the center of the femoral head and the central and femoral neck long axes.
- (3) The height of the femoral head (HFH): The distance between the center of the femoral head and the connection to the sciatic nerve branch.
- (4) The longitudinal plane of gluteus medius (LGM): The distance between the center of the femoral head or the center of the femoral head of the prosthesis to the big tuberosity of the femur.
- (5) Postoperative and preoperative Harris hip score.
- (6) Femoral eccentricity (FE): The distance of the center of femoral head to femoral long axis.

Correlation analysis: The correlation between the femoral eccentricity, length of the femoral neck, femoral head height, and hip abductor muscle arm, and the hip motion with Harris hip score were compared.

The SPSS 13.0 (SPSS, USA) package was used to analyze the statistical significance of the results, which were expressed as mean + standard deviation (SD). T-test was used to compare the results obtained before and after the surgical operation and the difference was statistical different for $p < 0.05$. Furthermore, logistic regression analysis was used when analyzing the relationships between the parameters.

RESULTS

This study included 78 cases, of which 50 were males and 28 were females. According to the DDH classification, 28 cases were type I, 26 cases were type II, and 24 cases were type III. The hospitalization time was 10 to 14 days (12 ± 1.8 days). The mean weight of the patients was 55.1 ± 23.9 kg, and the mean height was 150 ± 20.5 cm. For all the patients the chosen prosthetic components were BetaCup acetabular cup (WALDEMAR LINK, Germany), CORAIL shank (Johnson & Johnson, DePuy Synthes, product number 3192509-15). Additionally, the collodiaphyseal angle was 135° . From each patient preoperative and postoperative radiograms were collected. Additionally, a circular metal mark (5 cm in diameter) was drawn at a distance of 10 cm from the small tuberositas to correct the magnification of the radiologic image. When analyzing the

types of prosthesis, in 90% of the cases BetaCup acetabular cup and CORAIL head were used during surgery. Additionally, the diameter for all the four ceramic femoral heads was of 36 mm. Because of economic considerations or acetabulum-related conditions, for 10% of the cases an interface low-density polyethylene hinge and a metal head (28 mm in diameter) were used. [Table 1](#) presents the preoperative and postoperative hip parameters for the total type of congenital dysplasia of the hip. [Table 2](#) presents the preoperative and postoperative hip parameters based on the three types of congenital dysplasia of the hip.

The range of hip motion (anterior and posterior stretch, interior and external rotation extension) during the preoperative assessment was of $60.5 \pm 8.2^\circ$ (minimum= 0° , maximum= 136°), while during the postoperative assessment it was of $168.2 \pm 8.1^\circ$ (minimum= 130° , maximum= 230°).

The results evidenced a relationship between the range of hip motion and the femoral offset ($r=0.419$, $p<0.001$).

The preoperative and postoperative Harris hip scores were 32.4 ± 4.6 points (minimum-maximum: 8–62 points) and 93.6 ± 5.2 points (minimum-maximum: 83–100 points). The analysis evidences a significant difference of $t: 0.471$, $p: 0.0001$.

DISCUSSION

The goal of total hip replacement is to influence the hip biomechanics' reconstruction process⁴. Mechanics' reconstruction effect had a direct relationship with the postoperative hip joint quality. The degree of improvement of the biomechanics of the hip joint function was directly related to the total hip arthroplasty and the time period since using the prosthesis^{5–7}. Among the four parameters studied (eccentricity, femoral head height, length of the femoral neck, and abductor muscle arm of the hip), the eccentricity parameter was the most important. According to the results, eccentricity had a positive relationship with the other three parameters. When the eccentricity value was too small, it would reduce the distance between the femur end and the pelvis; it would reduce the range of the hip motion and the hip muscle relaxation; and it would increase the risk of collision and joint dislocation. Alternatively, if the eccentricity value was high, the acetabulum interface friction would increase the risk of plastic deformation and lead to dissolution. For patients with DDH, the acetabulum hypoplasia would directly affect the eccentricity, therefore, for all the three types of hip replacement the acetabulum and the center of rotation would influence hip arthritis development. Furthermore, patients affected by necrosis of the femoral head evidenced a change in eccentricity. Some studies had shown that the change of the rotation center could cause the change of the eccentricity^{8–11}. To reconstruct the femoral eccentricity we used one specific method. When the femoral handle length increased, the lower limb length would increase, thus causing sciatic nerve palsy and low back pain. Compared with the opposite hip side that did

Table 1. Preoperative and postoperative values of the hip parameters on total type ($x \pm SD$)mm

	Preoperative	Postoperative
Femoral eccentricity	$33.3 \pm 8.4^*$	39.1 ± 7.1
The height of the femoral head	$59.5 \pm 8.8^*$	68.9 ± 11.0
Femoral neck length	$50.9 \pm 10.8^*$	61.5 ± 10.4
Longitudinal of gluteus medius	$54.3 \pm 9.6^*$	64.7 ± 10.1

*There are significant differences between the preoperative and postoperative values.

Table 2. Preoperative and postoperative values of the hip parameters on different type ($x \pm SD$)mm

		Preoperative	Postoperative
Type I	FE	$3435.1 \pm 7.2^*$	38.9 ± 5.7
	HFH	$59.8 \pm 10.1^*$	71.3 ± 10.1
	FNL	$57.0 \pm 12.0^*$	67.2 ± 10.4
	LGM	$56.8 \pm 12.0^*$	66.7 ± 10.2
Type II	FE	$33.9 \pm 6.6^*$	39.6 ± 9.6
	HFH	$60.6 \pm 6.1^*$	68.9 ± 9.0
	FNL	$49.6 \pm 8.5^*$	61.2 ± 9.5
	LGM	$54.3 \pm 7.1^*$	65.0 ± 11.6
Type III	FE	$30.2 \pm 10.4^*$	38.7 ± 5.3
	HFH	$57.9 \pm 10.1^*$	65.8 ± 14.1
	FNL	$45.6 \pm 9.3^*$	55.8 ± 8.7
	LGM	$51.8 \pm 7.7^*$	62.7 ± 8.8

FE: femoral eccentricity; HFH: height of the femoral head; FNL: femoral neck length; LGM: longitudinal of gluteus medius.

*There are significant differences between the preoperative and postoperative values.

not undergo surgery, the rebuilt eccentricity increased less than 4 mm. For our study, 80% of the patients evidenced a large diameter of the femoral head (36 mm), which increased the eccentricity without increasing the lower limb length. Additionally, when choosing the small collodiaphyseal angle of the femoral prosthesis handle, this would increase the eccentricity, and would maintain the length of the body. Furthermore, it will increase the rotation torque of the femoral neck and the risk of a broken neck.

As for the artificial total hip replacement, future consideration should include rebuilding the physiological anatomy as soon as possible. The reconstruction of the femoral eccentricity, femoral head height, and hip muscle arm would improve hip stability^{8, 12–16}, reduce the prosthetic hip wear, avoid postoperative hip muscle weakness, claudication, and improve the prosthesis lifetime. Careful preoperative plan and the use of the appropriate anatomy of the prosthesis handle are very important.

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