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A PROSPECTIVE STUDY ON THE EARLY FINDINGS CEMENTLESS ACETABULAR COMPONENT WITH OR WITH OUT UPWARD IMPLANTATION IN HIP DYSPLASIA

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Abstract

The defective acetabulum makes total hip arthroplasty (THA) challenging in cases of developmental dysplasia of the hip (DDH). This study aimed to assess the anatomical and upward positioning differences of the acetabular component in the early stages. Forty DDH patients (Crowe I to III, 42 hips) were prospectively allocated to either the upward or anatomic group between April 2006 and June 2009 . From the time before surgery until a year following it, WOMAC and Harris scores were recorded. Age and body mass index (BMI), among other patient characteristics, did not differ significantly ($P > 0.05$). Surgery time, intraoperative blood loss, haemoglobin (Hb), blood transfusion, albumin decrease, and length of stay did not differ statistically significantly between the two groups; however, the anatomic group experienced significantly longer surgery times and blood losses among patients who received structural bone grafts. Although there was no difference in the postoperative limb-length discrepancy (LLD), the anatomic group's limb lengthening was superior ($P = 0.042$). Although there were no appreciable changes, the anatomic group's overall hospital expenses were greater. A suitable upward placement (less than 20 mm) that can achieve at least 70% native bone coverage of the acetabular implant is a useful technique for an early, quicker recovery. Acetabular reconstruction for DDH subluxation should be reconstructed as close to the actual acetabular location as possible.

Introduction

One of the most effective orthopedic procedures for reducing pain, enhancing function, and enhancing quality of life in patients with end-stage osteoarthritis (OA) of the hip is primary total hip arthroplasty (THA). [1] However, because of the acetabular structural abnormalities and varying degrees of bone deformities surrounding the acetabulum, THA in secondary OA caused by diseases of developmental dysplasia of the hip (DDH) is challenging. When properly positioned components and bone coverage are guaranteed, the principles of acetabulum reconstruction make the surgical process easier for these patients and prevent the need for a large structural bone transplant.[2,3]

The best option for DDH patients is to reconstruct an anatomic rotation center. However, several retrospective studies have found that appropriately placing the acetabular component upward is a safe and efficient surgical procedure to avoid structural bone grafting and achieve good bone coverage of the acetabular component by following certain procedures.[4] Early weight-bearing walking and functional activities are made possible for patients, which benefits independent living, surgical healing, and financial load. An upward placement of more than 35 mm from the teardrop is sometimes referred to as high acetabular upward placement.[5]Although it is possible to position the teardrop within 35 mm upwards, the cadaver research and other relevant studies show that it is better to place it within 20 mm upwards and without any lateral placement.[6,7]

In the early post-operative follow-up period (up to 12 months), this study aims to provide a single-center evaluation of two distinct surgical techniques for acetabulum reconstruction: the 0–5 mm (anatomic center group) and the 5–20 mm upward placement from the teardrop (upward center group).[8] Our goal is to examine the disparity between early outcomes and in-hospital costs as determined by the WOMAC index and Harris ratings. Additionally, we assess how the two techniques differ in terms of surgical parameters such as leg length disparity, transfusion, blood loss, component alignment, operating duration, and early problems.

Materials and methods

This study was approved by the institutional review board before it started. ERA'S Lucknow Medical College and Hospital, *Sarfarazganj Hardoi Raod, Lucknow*'s ethics committee gave its approval for this study. Every patient consented to the study's conditions. This analytical study was conducted from April 2006 through June 2009. The inclusion criteria were the following: Crowe I with over 35% subluxation, Crowe II and III DDH patients with secondary osteoarthritis who elected to undergo THA; the patient's age at the time of surgery was between 30 and 80 years; the patient was able to comply with the requirements of the study, including preoperative and post-operative evaluations and questionnaires.[9] The exclusion criteria were as follows: Crowe I with less than 35% subluxation and Crowe IV DDH patients; simultaneous THA; patient refusal at any time during the research; presence of any serious illness that would make surgery impossible; an age less than 30 or more than 80 years; an inability or unwillingness to comply with the postoperative rehabilitation or follow-up protocols.[10]

We adopted the randomization criteria and obtained a list of 40 numbers divided into 2 parallel groups equally, labeled A (anatomical location) and B (upward location) from ERA'S Lucknow Medical College and Hospital, *Sarfarazganj Hardoi Raod, Lucknow*. After the patients were enrolled and informed consent was obtained, the randomization was carried out. Each patient was counselled that both techniques are clinically successful and the comparison of the techniques was being made to minimize potential patient bias. The patient is positioned in the lateral decubitus position. A posterior-lateral incision was placed over the greater trochanter, slightly curved posteriorly. Following dislocation and neck resection, the acetabulum was sufficiently exposed while protecting the sciatic nerves. The acetabulum was identified by removing the acetabular labrum, part of the joint capsule, and hyperplastic osteophytes.[11] For the normal rotational center placement (0-5 mm) group, the acetabulum was gradually reamed at suitable abduction and anteversion, and the cementless acetabular component was installed with primary stability. If the installation of the acetabular component has poor bone coverage, the morselized bone graft (the bone defect was less than 30% of the acetabulum) or intra-acetabulum structural bone autograft was used with the femoral head for early partial weight-bearing.[12]

Preoperative data analysis revealed that the upward placement group experienced an upward displacement of the acetabular component. In order to do this, the implant was positioned as near to the real acetabulum as feasible. To minimize lateral placement and substantial structural bone graft restoration, the acetabular implant's minimal upward placement distance was usually less than 20 mm, resulting in 70% bone coverage and high stability. Anatomical markers that assess the upward displacement include the distance between the transverse acetabular ligament, the teardrop, and the top edge of the acetabulum. Gently, the acetabulum was reamed at the appropriate abduction and anteversion. When necessary, intraoperative roentgenoscopy was utilized to determine the installation site of the acetabular component, making sure that the acetabular rotational center would not be raised by more than 20 mm.[13]

After joint realignment, soft tissue tension around the affected hip, range of motion, and joint stability were evaluated. Following confirmation, drainage tubes were placed, external rotators were fastened, and the incision was sutured layer by layer. A cementless full hip system was administered to each study participant. Standardized perioperative care protocols were adhered to by all patients. Analgesics, low-molecular-weight heparin to prevent DVT, and antibiotics to prevent infection were used to treat the symptoms.[14] The patients were told to start practicing isometric and isotonic contractions of lower limb muscles on the first day after surgery and to ambulate weight-bearing with a walker or crutches on the second day, with a range of motion restriction for flexion limited to 90° and no adduction beyond neutral. The drainage tube was removed around 48 hours after the procedure. After the sutures were removed on the fourteenth day, he was discharged from the hospital.

Following surgery, there was in-hospital surveillance and routine outpatient follow-ups at three, six, and yearly intervals. The primary observation indicators included in-hospital costs, early mobility, WOMAC index and Harris scores, operating time, component placement, blood loss, transfusion, early issues, and leg length difference. The data was gathered by two individuals, and the average value was used when the results of the examination were inconsistent.[15]

Table 1 Demographic Patient Characteristics

	Characteristics	**0-5 mm group (Anatomic center) (N = 19 hips) 01 has not followed procedure out of 20**	**5-20 mm group (Upward center) (N = 18 hips) 02 has not followed procedure out of 20**	*P* Value
1	Age (yr)	65.5 ± 11.7	65.7 ±8.87	0.314
2	Height (cm)	153.1 ±11.5	166.5 ±11.8	0.215
3	Weight (kg)	76.3 ± 15.8	78.8 ± 10.4	0.398
4	BMI (kg/m^2)	26.2 ±3.6	27.9 ±7.9	0.521
5	Sex(no. of hips)M/F	3/15	3/14	
6	Side affected(no. of hips)L/R	9/10	8/10	
	Classification(no. of hips)			
7	Crowe I	9	10	
8	Subluxation (%)	47.8 ±3.1	49.3 ±4.1	0.089
9	Crowe II	9	7	
10	Subluxation (%)	57.3 ±6.6	56.9 ±4.2	0.219
11	Crowe III	1	1	
12	Subluxation (%)	86.9	75.8	
13	Average Subluxation (%)	47.8 ± 8.7	45.5 ±6.5	0.354

Table 2 Surgical indexes in different upward placement groups.

	Parameters	**0-5 mm group (Anatomic center) (N = 19 hips)**	**5-20 mm group (Upward center) (N = 18 hips)**	*P* Value
1	Surgery duration (min)	154.9 ±11.5	162.4 ±41.5	
2	Upward distance (mm)	7.1 ±3.1	8.4 ± 1.3	<0.0
3	Intraoperative blood loss (ml)	388.8 ±258.9	374.3 ± 146.3	0.2
4	Post-op wound drainage (ml)	367.2 ±192.1	631.9 ±295.7	0.01
5	Hb decrease	14.1 ±8.4	15.5 ±5.3	0.1
6	Albumin decrease	8.4 ± 3.9	8.1 ±4.2	0.3
7	Blood transfusion (U)	1.00 ± 0.5	0.87 ± 1.5	0.6
8	LLD (absolute value, mm)	6.15 ± 4.8	7.6 ±4.5	0.12
9	Limb lengthen (mm)	10.8 ±8.5	7.8 ±4.8	0.02

10	Length of stay-days	17.5 ±5.9	19.1 ±6.2	0.15
11	Structural bone graft	2	0	
12	Morselized bone graft	12	12	

Results

40 hips consecutive DDH patients were referred to the study during the recruitment period. Following exclusion, 40 participants (42 hips) were included to the experiment. The two cohorts' age and body mass index (BMI) did not differ substantially, suggesting that the patient demographics were comparable (Table 1). Every patient had access to full intraoperative, in-hospital, and follow-up data (case report form, CRF).The anatomic centre and upward centre groups did not differ in the length of surgery, however there were statistically significant variations in the upward distance of the acetabular cup's rotation centre ($P < 0.01$). The anatomical group had more postoperative wound drainage ($P = 0.010$), but there was no statistically significant difference in haemoglobin (Hb), albumin, or intraoperative blood loss between the groups. On the other hand, the blood transfusion had no effect on the two groups.

The cup inclination of the anatomic group was higher $P = 0.03$ for better bone coverage than that of the ascending group, even though both groups were in the safe zone. The anteversion of the cup was the same. The anatomic group's limb lengthening was better than the upward group's $P = 0.002$, despite the fact that there was no change in LLD. There were no statistically significant differences between the groups in terms of length of stay or associated inpatient costs. Post-operative walking and durations of stay were similar for the ascending and anatomic groups ($P = 0.015$ and $P = 0.005$, respectively). Overall hospital costs were similar for both groups ($P = 0.002$), while they were somewhat higher for the anatomic group. Furthermore, when the cost of the THA implant or the costs of the implant and anaesthesia were taken out of the equation, there was no discernible difference in the costs ($P = 0.003$ and $P = 0.004$, respectively).

We found no problems throughout the six-month primary follow-up or the 12-month follow-up for these patients during a one-year period. Although structural bone grafting was performed on two hips in the anatomic group, both patients showed positive postoperative results, including complete weight-bearing walking six weeks after the treatment and partial weight-bearing walking two and three days after the procedure. Nonetheless, compared to other situations, the procedure's average length and blood loss were far higher.

Discussion

The most important treatment for elderly DDH patients who develop secondary osteoarthritis is total hip arthroplasty, even if acetabulum restoration is still a major concern in individuals with different hip deformities.[4,6] Acetabular repair for Crowe Type IV should also be performed at the actual acetabular location when femur-shortening osteotomy is performed. The precise location of acetabular reconstruction in Crowe I and Type III cases is still unknown, nevertheless, especially in regards to re-establishing anatomic rotation, entrance, or elevated hip centre. Based on the early functional hip score and limb lengthening, we primarily showed in this prospective study that acetabular reconstruction at the anatomic centre would be a better option for Crowe I and III DDH patients; however, in some cases, especially Crowe II-III, a structural bone graft was necessary.[16] Based on the preliminary assessment of the surgical indices of the anatomic and upward implantation groups, the goal is to position the implant as near to the real acetabulum as feasible.[17] However, the acetabular placement might be chosen upward positioned to obtain 70% native bone coverage and high stability if the preoperative and intraoperative evaluations showed that significant structural bone graft restoration could be necessary for anatomic reconstruction. Additionally, the acetabular implant need to be placed as near to the teardrop as feasible. Less than 20 mm upward implant positioning may result in intraoperative and early postoperative results that are similar to anatomic repair without producing problems or a large leg-length disparity.[18]

Acetabular repair at the anatomical centre reduced hip stress and had favourable long-term results, per mathematical and biomechanical studies. But as we shown in trials 3 and 6, where the cementless acetabular component migrated, autogenous structural bone transplantation could be required for the anatomical repair. We showed that the anatomic centre groups and the upward placement groups had significantly higher WOMAC and Harris hip scores in the early follow-up. Numerous retrospective mid-term and long-term investigations have shown that the high hip centre reconstruction was particularly beneficial for DDH patients with good mid-term and long-term follow-up outcomes. With a >95% survival rate over 11 years, cementless acetabular cups are particularly noteworthy in this regard.[2,6,9,19] Several studies have also shown that just raising the hip joint does not significantly increase compressive stress. With 70% native bone covering and enough stability without a structural bone transplant, we thus thought that appropriate acetabulum upward placement is achievable in the majority of Crowe I-III patients with 35%–90% subluxation.[3,5,8,9,20] The upward placement within 20 mm was achieved.

This secure upward location (less than 20 mm from the teardrop) was confirmed by a few biomechanical and retroactive studies. We found that in almost all patients with hip dysplasia with 35% to 90% subluxation, placing the cementless cup slightly upward (less than 20 mm from the teardrop) can provide primary stability and avoid the need for a structural bone graft, despite some retrospective studies suggesting that placing the cup more than 20 mm above the teardrop produced positive results.[21] Additionally, we found that anatomic placement with structural bone graft obviously leads in increased surgical time (average 145 min vs. 250 min) and intraoperative blood loss (average 410 ml vs. 1000 ml) as compared to upward placement. The limb-length discrepancy is another important issue with THA in DDH patients. To increase efficacy and stop further shortening of the affected limb, the length of the affected limb should be restored as much as possible while doing THA on DDH patients.[22] These results demonstrated that anatomic placement was more successful in limb lengthening, even if upward insertion of the acetabular component may also effectively extend the injured lower limb to ease the condition of LLD. Additionally, for high hip centre (> 35 mm above the teardrop) reconstruction in DDH patients, appropriate head/neck lengths and sufficient elevation of the stem in the femoral canal with a larger-sized stem may also partially or completely heal LLD. [6–8] Therefore, for these two reconstructive surgeries, proper intraoperative posture and careful preoperative planning and design are essential.[19,22] Before surgery, the whole acetabulum's morphology should be well displayed, especially the numerous bone anatomical components that might guide placement. When it has been demonstrated that placing the acetabular component at the normal rotational centre will not produce sufficient bone coverage, it should be suitably relocated higher. To avoid further shortening of the affected limb due to the upward location of the acetabular rotation centre, the maximum size of the femoral component should also be selected, the femoral offset should be corrected, and long-necked components can be employed if needed.

The small sample size and the single-centered nature of the data set are two of the study's weaknesses. The low mean body weights of all the Chinese patients in our study may have affected the soft tissue balance and outcome of surgery. Additionally, the 12-month short-term follow-up was insufficient to determine the implant's lifespan; additional follow-up is necessary. Additionally, the study was unable to blind the surgeon due to the surgical technique.

In conclusion

A good strategy that is advantageous for an earlier, quicker recovery is an appropriate upward placement (less than 20 mm) that can result in at least 70% native bone covering of the acetabular implant. Nonetheless, it is important to repair the DDH acetabular implant as close to the original acetabular location as is practical. Large-sample, multicenter study is needed for further confirmation, long-term monitoring, and observation.

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