The initial results of developmental dysplasia of the hip treatment by total hip arthroplasty

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Summary

Objective: Comment on the initial results of developmental dysplasia of the hip treatment by total hip arthroplasty. *Subject and method:* This is a clinical descriptive study, with vertical follow-up and no control group study. 6 patients, including 5 females and 1 male, with developmental dysplasia including 6 hips were operated with total hip arthroplasty at the Joint Surgery Department of 108 Military Central Hospital from April 2018 to July 2022. The age range was 22 to 59 (average 39.1). The mean follow-up period was 37.5 months (ranged from 9 to 60 months). *Result and conclusion:* The average Harris score post-operation was 89.8 ± 7.1, significantly improved compared to 33.7 ± 4.7 pre-operation. 5/6 of cases used cement-less cup, 1 case used a compound of cement and liner polyethylene directly to the acetabulum. 1 case we had to perform proximal femur shortening. Three patients complained about limb length discrepancy. Two patients suffered temporary sciatic nerve paralysis post-operation.

Keywords: Developmental dysplasia, total hip arthroplasty.

1. Background

Dysplasia is one of the main causes of hip degeneration, which results in tremendous pain and limits the function of the hip. Total hip arthroplasty helps by reducing pain, rehabilitating the hip and balancing the limb length for patients who suffer from severe dysplasia. However, the procedure is complicated. Unlike other common hip arthroplasties, total hip arthroplasty for dysplasia treatment often encounter problems caused by abnormalities in acetabulum and femur anatomy. To review and enhance the quality of the treatment, this paper aims to review the initial results of developmental dysplasia of the hip treatment by total hip arthroplasty, by providing comments regarding indication and technique.

2. Subject and method

2.1. Subject

6 patients (6 hips), including 5 females and 1 male, from April 2018 to July 2022 at Joint Department of the 108 Military Central Hospital were selected as the subject of this paper.

Total hip replacement was indicated for cases that suffering from developmental dysplasia, severe pain or having troubles during daily movements and activities (excluding cases of dysplasia but not much pain).

All patients undergone clinical examination (crippled walking position, Trendelenburg position) and assessment of iliac, hip, lumbar spine and lower limb axis X-ray prior to the performance of total hip replacement procedure. Pre-operation A-P Hip X-ray assisted the assessment of acetabulum anatomical position, the estimation of artificial hip dimension, the level of femoral neck cut and the position of femur shortening if needed. The upward hip displacement in the X-ray was determined based on Ranawat Triangle. Three-dimensional anatomy of the acetabulum was constructed using 64 slice-CT-

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Scan (Siemens, Germany). None of the patients had femur or iliac fracture recorded.

2.2. Technique

Patient position and surgical approach

Patients were put in lateral recumbent position after undergone spinal anesthesia. The approach is posterior approach.

Acetabulum replacement technique

For Crowe type I dysplasia, the artificial acetabulum was placed in the original position. Due to the shallowness of the acetabulum, the socket must be trimmed for sufficient coverage.

For Crowe type II and III hip fracture, bone defect of the superior rim of the acetabulum, The following methods can be used for acetabulum bone defect treatment are as followed: (1) Anatomical acetabulum placement combined with bone graft; (2) Anatomical rim to repair lateral bone defect; or (3) Acetabulum reconstruction according to artificial acetabulum position.

For Crowe type IV dysplasia, the superior rim of the acetabulum is less defected compared to type II and type III. Therefore, cement-less cup can be placed in the anatomical position. In these cases, bone graft may not be necessary.

Stem replacement technique

For hip dysplasia type I and II, due to narrow femur medullar and for the recovery of the femoral anteversion, smallest cemented stem or cement-less stem can be used.

For dysplasia type III, the technique is identical to type I and type II, however in some cases, femur shortening must be performed to place the acetabulum into the anatomical position.

For dysplasia type IV, proximal femur shortening is standard. There are two options: (1) Proximal femur shortening and use cement-less stem; or (2) great trochanters osteotomy and use special cemented stem. Recently, the first technique is more preferable, as this technique is more sustainable for the usage of cement-less cup. Moreover, proximal femur shortening can adjust rotate deformity and reduce the chance of bone nonunion complication comparing to great trochanters osteotomy.

Post-operation

Postoperative procedure is mostly identical to common hip arthroplasty. Anticoagulant must be used immediately after operation to reduce the risk of deep vent thrombosis. Postoperative pain control also needs to be critically considered for better postoperative exercise. Postoperative rehabilitation needs to be instructed and monitored by surgeons and physiotherapist. For non-proximal femur shortening cases, patients can weight-bearing immediately post-operation. Otherwise, for Crowe type IV cases, patients will be instructed to weight-bear with crutches in the first 6-8 weeks, then gradually increase the load until they can fully weight-bear without crutches.

2.3. Assessment

Assessment was done based on Harris (Harris Hip Score-HHS) [1], WOMAC (Western Ontario and McMaster Universities Arthritis Index) [2], SF-12 [3], Merle d'Aubigne'-Postel (MAP) (modified) [4], and pain level based on VAS (Visual Analogue Scale). X-ray screening before and after operation and at 3, 6, 12, 24 months after operation (twice per year). We assessed the degree of bone union, possible infection, limb length discrepancy and other complications. Loose prosthetic implants were screened based on the criteria by Gruen [5] for femur, based on DeLee and Charnley [6] for acetabulum. Stability assessment of the prosthetic was assessed based on criteria by Engh [7].

3. Result

3.1. Mutual characteristics

Table 1. Mutual characteristics

Criteria	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Gender	Male	Female	Female	Female	Female	Female
Age at the time of the operation	59	22	33	37	44	40
Crowe type	I	IV	III	II	III	IV
Follow-up	5 years	5 years	4 years	3 years	1 year	9 months
Acetabulum						
Acetabulum bone graft	-	-	+	+	-	-
Cemented cup	-	-	-	-	+	-
Actual position	+	+	+	+	+	+
Stem						
Cemented stem	-	-	-	-	+	+
Femur shortening	-	+	-	-	-	-

3.2. Clinical results

Table 2. Clinical results

Index	Pre-operation	Post-operation
HHS ($\overline{X}$ ± SD)		
Average	33.7 ± 4.7	89.8 ± 7.1
Classification		
Very good (90-100 point)	0	4
Good (80-89 point)	0	1
Moderate (70-79 point)	0	0
Poor (< 70 point)	6	1
VAS Index		
No pain (0 point)	3	4
Mild pain (1-3 point)	2	2
Moderate pain (4-6 point)	1	0
Severe pain (7-10 point)	0	0
MAP (Merle d'Aubigne'-Postel) improved		
Average ($\overline{X}$ ± SD)	6.4 ± 1.4	15.4 ± 1.7
Pain	2.3 ± 1.0	5.6 ± 1.0
Walk	2.0 ± 0.7	4.8 ± 0.7
ROM	2.0 ± 0.8	4.9 ± 0.8
Trendelenburg sign (positive/total)	6/6	2/6

Index	Pre-operation	Post-operation
Limb length discrepancy		
Average in mm ($\overline{X}$ ± SD)	43.8 ± 7.5	7.1 ± 3.7
< 10mm	0	5
10-20mm	0	1
21-30mm	2	0
31-40mm	3	0
41-50mm	1	0
> 50mm	0	0
Crippled walking position (positive/total)	6/6	3/6

3.3. Common complications

Common complications will be mentioned in Table 3. Three patients (1, 2 & 4) complained about limb length discrepancy. Two patients feel no limb length discrepancy 6 months after operation. However, one patient (1) complained about slight limb length discrepancy compared to the last follow up. Two patients suffered temporary sciatic nerve paralysis post-operation, but recovered after six months without any significant effect on the function. Two patients with Trendelenburg sign post op had slight crippled walking position. One hip had a sign of loosening in area 1 and area 7 according to Gruen, but not to the distance of the stem. Displacement of endoprosthesis happened to 1 patient (6) twice: 3- and 19-day post-operation respectively.

Table 3. Common complications

Complications	Number
Femur fracture during operation	1
Deep vein thrombosis	0
Infection	0
Bone nonunion	0
Limb length discrepancy	
Shorter than the other limb	1
Longer than the other limb	2
Post-operative endoprothesis	1
Thigh pain	1
Loose due to infection	0

4. Discussion

4.1. Results

Total hip arthroplasty helped improve both the Harris Score and pain level. In our research, the average HHS post op is 89.8 ± 7.1, significantly improved compared to 33.7 ± 4.7 pre-op. At the same time, the hip function was improved, consequently enhance the quality of life.

In general, for type I and II hip dysplasia, the result is mostly positive, which is comparable to hip arthroplasty in other injury. However, for severe hip dysplasia, the chance of revision replacement is significantly higher than other cases. Patients who suffered from severe hip dysplasia had crippled walking position due to limited adduction function. However, hip function including walking distance, hip pain, hip ROM were significantly improved.

While there was limited number of studies that directly compare the result of hip arthroplasty for dysplasia treatment to other causes, recent studies shown that short-term result (6-month post op) is identical in terms of Oxford score and the chance of revision replacement between two group. However, after 15 years, the revision replacement chance in dysplasia group is 1.5-2 times higher than other injuries.

4.2. Comments about surgical indication

In our sample, 5/6 of cases used cement-less cup, 1 case (patient 5) used a compound of cement

and liner polyethylene directly to the acetabulum due to the lack of cup to fit small acetabulum. The use of cemented cup is not appropriate, since it is reported that the chance of revision replacement is up to 37% [8]. For mild and moderate dysplasia that do not require acetabular bone graft, the use of cement-less cup is widely suggested by authors and is considered to be standard since it reduces the chance of loose joint and medium to long term revision replacement. The chance of revision replacement of cement-less cases is 0-5% at short-term follow up [9], while the chance of cemented cups is 10-35% at long-term follow up [10]. A report suggested that after 10 years, cement-less cup combined with femoral head autograft shown a high survival rate of 94% [11]. In general, most of the authors support the use of cement-less cup, even for cases that require acetabular shaping.

In our study, all cups were put in anatomical position. Some studies mentioned about acetabulum upward placement technique, however, the sample size is still limited. Therefore, results shown that mechanical abnormalities of the acetabulum or the chance of loose acetabular is highly variable, from 16 to 83,3% [12]. Authors suggested that the chance of loose joint is related to the movement of the cup to the lateral position compared to the central acetabulum [12]. A recent report shown that 30 hips with upward acetabulum placement, non-lateral position and cement-less cup, after an average of 15.2 year shown no sign of loose acetabulum. Therefore, it is worth noting that the lateral placement should be avoided in this technique.

In our study, 2/6 of the cases used cemented cup (patient 5.6) due to narrow medullary kernel (under 8mm), making it impossible to use standard sized cement-less cup. Until the last follow-up, the two cases shown no sign of loosening, possibly due to short follow-up time (1 year and 9 months). In general, the use of cemented stem shown more positive result compared to cemented cup despite differences between studies. Two studies evaluated long-term result (9.9 years post-operation), the chance of stem revision replacement due to mechanical abnormalities or loosening was 3-10% [9]. Another study reviewed the chance of stem revision replacement 16 years post op was 15-40% with dysplasia cases [13]. Many studies evaluated the lifespan of cement-less cup for non-dysplasia cases and the results were positive. However, there was limited long-term evaluation of the use of cement-less cup for dysplasia treatment. Mortazavi et al [13] reviewed the result of cement-less cup for 58 hips with deformation in proximal femur after an average time of 4 years post-operation (48.5% due to hip dysplasia), 9% of which has mechanical abnormalities. The author also suggested that the use of traditional cement-less cup to stabilize the proximal femur for severe dysplasia may encounter many difficulties, therefore to achieve optimal result, surgeons must perform osteotomy and use modular stem.

In our study, 1 case (patient 2, Crowe IV type dysplasia) we had to perform proximal femur shortening. In our point of view, the severity of iliac and lumbar spine deformity, hip ROM and soft tissue contracture must be critically considered to determine the osteotomy position and the bone length that need to be shortened. Patients may find difficulties in adapting to the change in limb length and kinetics function after operation if the ROM of the lumbar spine was limited. Many authors mentioned femoral osteotomy in their studies. Proximal femur shortening or great trochanter osteotomy may lead to more complications. Anwar et al reported that 29% suffered from bone nonunion after osteotomy, consequently increasing the chance of Trendelenburg position. Therefore, recent authors suggest sub-trochanter osteotomy for iliac muscles sustainability as well as easy modification of rotator deformity.

Our study has limitations. Firstly, the sample size is small due to limited number of patients. A larger sample size will help improve the precision of the evaluation of complications regarding hip arthroplasty and osteotomy. Secondly, the X-ray assessment occurred at 6- and 12-months follow-up, which may prevent us from precisely determining

the bone union period. Last but not least, we do not have a comparable group, which may hinder the result analysis and the credibilityy of our study.

5. Conclusion

Hip arthroplasty for dysplasia treatment requires surgeons to critically evaluate the particular iliac and femoral characteristics of each patient. Detailed evaluations will help surgeons in the decision-making process during operation for mechanical stability and functional enhancement. This technique helps improve the function and quality of life of patients who suffer from hip dysplasia, however, the chance of complications among this group is higher compared to traditional hip arthroplasty due to highly complicated technical requirements.

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