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ORIGINAL STUDY

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Total cementless unconstrained hip arthroplasty in Crowe type IV hip dysplasia with subtrochentric derotation osteotomy

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Developmental hip dysplasia is a common cause for secondary osteoarthritis and in the past it was considered impossible to do hip arthroplasty surgery for this group of patients. We aim at introducing our results and arthroplasty technique in management of such technically demanding and challenging cases. 22 patients with 25 hips suffer from hip dysplasia Crowe type IV were operated by total cementless unconstrained hip arthroplasty with subtrochentric derotation osteotomy without fixation of osteotomy site, The mean age group was 37.9. All patients were operated through lateral approach. The acetabular component is located in the true acetabulum. Postoperatively the patient can weight bear fully unaided within 3 months. The preoperative limb length discrepancy improved from a mean 46.36 mm to 7.3 mm. One case of stem subsidence occurred and underwent revision to cemented stem 1years later. The Harris hip score improved to 85.9 at end of follow up in comparison to38.09 preoperatively. The osteotomy site healed within 5.1months in average .No cases of osteotomy non union occurred. The mean follow up was 28.3 months. We concluded that hip arthroplasty in patients with hip dysplasia Crowe type IV is technically demanding surgery. Recreation of normal biomechanics and anatomy through implantation of acetabular component in the true acetabulum and femoral shortening and derotation offers the patient painless and adequately functioning hip

Keywords : hip dysplasia; derotation osteotomy; subtrochentric osteotomy; cementless hip; hip dysplasia; derotation osteotomy.

INTRODUCTION

The developmental hip dysplasia is a common disorder and its prevalence ranges from 1% to 12% among different ethnic groups. *(1)* Many cases are missed and left untreated especially in developing countries due to lack of efficient screening programs. The end result of these cases is secondary osteoarthritis of the affected hip with significantly altered anatomy.

These patients are usually presented with pain, impaired hip range of motion and limb length discrepancy. Most of these patients are young and such disability decreases their ability to lead a normal life.

Instituation at where the study was carried Ain Shams university hospitals, Cairo, Egypt
Compliance and Ethical standards:
The authors declare that they have no conflict of interest.
There is no funding sources.
Informed consent was obtained from all individual participants included in the study.
The study was done according to the ethical committee regulations in our institute.

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In the past few decades, it was impossible to do hip arthroplasty for this group of patients and early results were unsatisfactory *(2)*. Understanding of the pathoanatomy of the hip dysplasia with correlation to the modern biomechanics and industrial progress of the hip arthroplasty encourage the surgeons to develop better surgical techniques to overcome the obstacles for a durable painless long-lasting endoprosthesis.

In our research ,we reviewed the technical and functional results of a series of patients with Crow type IV hip dysplasia treated with cementless total hip arthroplasty with subtrochentric osteotomy.

MATERIALS AND METHODS

This is a retrospective study that was done on a series of patients operated in between 2013 to 2017. It included 22 patients, 8 male and 14 females. The mean age group was 37.90 years old , it ranges from 22years to 48 years old. .

By history and clinical examination, patients were presented by painful hip, limited range of motion and limb length discrepancy. All patients underwent plain x-rays pelvis showing both hips in the antero-posterior projection and lateral views. Computed tomography in axial, coronal and three dimension reconstruction is essential for preoperative planning.

The operative technique was discussed and entailed description of the possible complications and outcomes was clarified to the patient. An informed consent was taken from every single patient.

The functional assessment of the patients was done by Harris Hip score preoperatively and at the end of follow up.

All patients were operated in the dead lateral position. We used modified lateral approach of the hip. The Gluteus meduis and minimus are identified. They are nearly in a horizontal direction in this group of patients. We incised them from their attachment to the greater trochanter starting from the base of the trochanter to its tip. Both Glutei are suspended by using stay sutures. The Gluteus meduis and minimus are dissected sub-periosteally from the iliac bone for sufficient area to allow their mobilization leaving them attached at their origin. Near total capsulectomy was done together with resection of the femoral head.

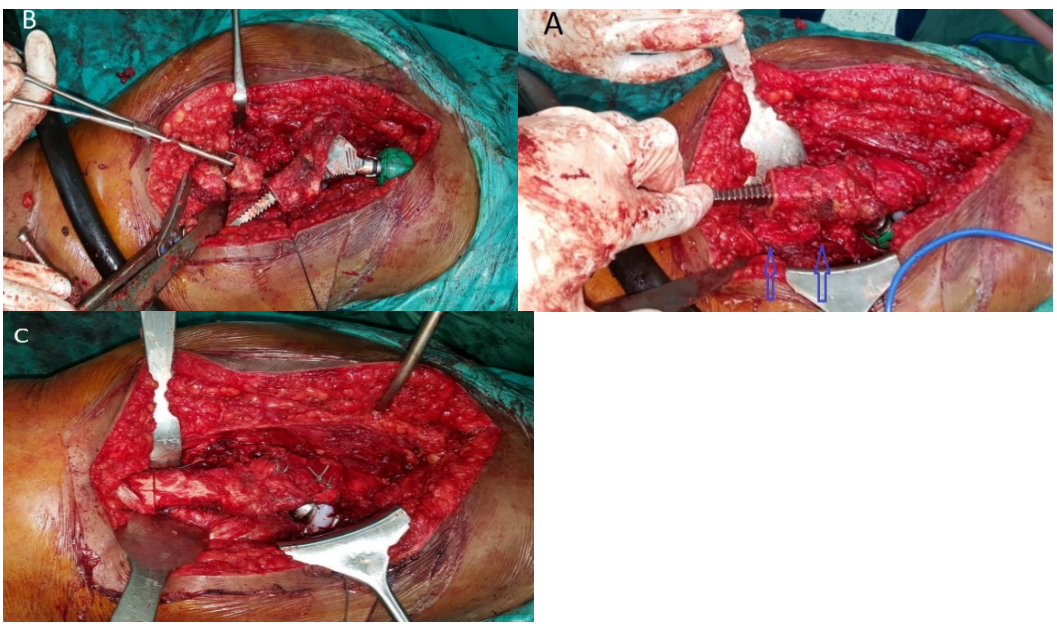

Fig. 1. – Intraoperative photographs of THA in a patient with Crowe type-IV DDH. (A) The overlapped segment between the proximal and distal femur. (B) Resection of overlapped segment of distal femur. (C) Coapted well fixed proximal and distal segments without plate fixation.

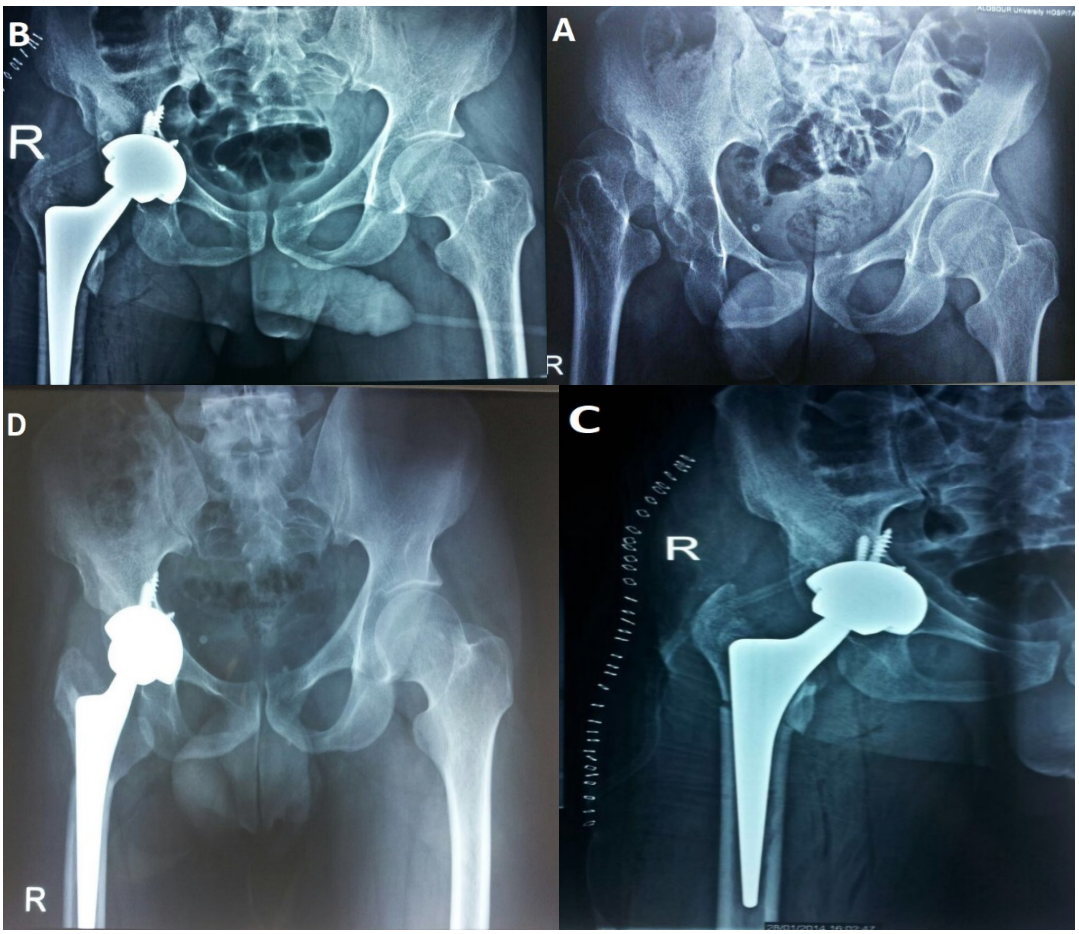

Fig. 2. – Case no 1. (A) preoperative x ray of male patient 32 y with dysplastic RT hip. (B) &(C) Immediate post-operative x ray. (D) Follow up 6 months postoperative x ray with full union of osteotomy site.

The following step is identification and preparation of the acetabulum. The true acetabulum is identified by careful dissection following the ligamentum teres which is attached from the femoral head till the transverse ligament of the true acetabulum. Intraoperative image intensification can be used as a double check for acetabular location in marked anatomical `distortion.

Preparation of the acetabulum starts with small reamer 36 mm that sequentially increased with medialization of the acetabulum to increase component coverage. The preparation is done in the proper position (40°-55° inclination and 10°-20° anteversion). We used small cementless cups (size: 42-48) with highly cross linked polyethene liners in all patients. The head was 28 mm either ceramic or metal in most of patients. All acetabular cups were press fitted in the true acetabulum and additional fixation by screws was used in some patients. The acetabular coverage was more than 75 % in all cases.

After acetabular component implantation, the proximal femur is reamed with straight reamers. Sequential rasping of the femoral medulla was carried out until the proper rotationally and axially stable stem size is reached. The osteotomy site is exposed by dissection of the vastus lateralis muscle from the lateral intermuscular septum. The femoral canal is marked at the level of predicted osteotomy site to adjust femoral rotation at the final stem implantation. Transverse osteotomy is done 1 cm below the lesser trochanter by an oscillating saw.

The last fitting rasp is applied in the proximal femoral fragment and trial reduction is done by

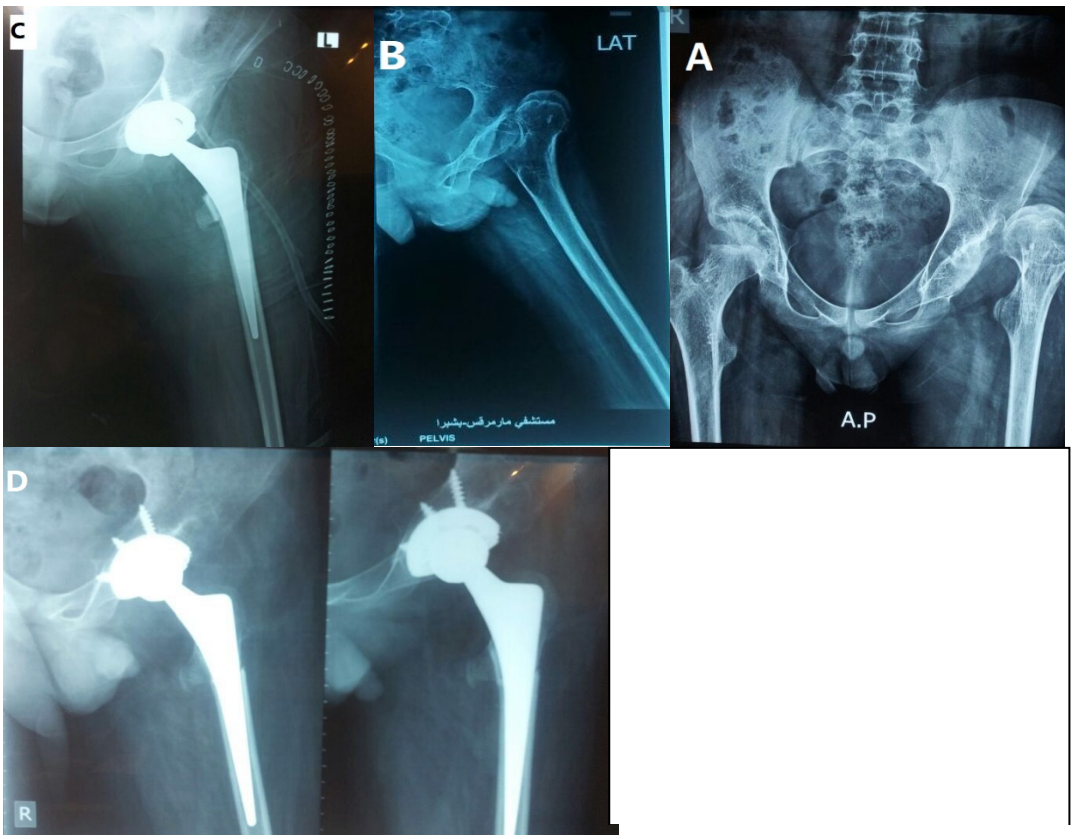

Fig. 3. – Case no 12. (A) & (B) preoperative x ray of male patient 22 y with dysplastic LT hip. (C) Immediate post-operative x ray. (D) Follow up 6 months postoperative x ray with full union of osteotomy site.

medium sized head into the acetabulum. The assistant distracts the distal fragment with the lower limb in full extension, the overlapped segment between the proximal and distal femur is the amount of shortening needed. This segment is excised from the distal fragment by the oscillating saw. Alignment and rotation of both proximal and distal fragment is done over femoral trial and full trial is done to test for stability, tightness and rotation. The rotation is adjusted according to the marks done over femoral medulla to allow approximately 10°-20° anteversion of femoral component in relation to patella.

Actual femoral stem, fully HA coated stem , is applied in the femoral medulla and full reduction of the hip is done. We tested for both components stability as well as for osteotomy site stability. We believe that cone prosthesis offers better diaphyseal fitting and stability but unfortunately it was not available in our country during this study. We ensured proximal and distal fixation by the stem we used . There was no complications recorded related to stem design used in this study.

In 2 cases the proximal femur was obstructing the corridor for the acetabulum , so femoral osteotomy was done before acetabular preparation.

A second day postoperative haemoglobin level is essential. A second day plain x-rays was done in the anteroposterior projection only . The patients discharged 48 hours after surgery on oral anticoagulant for 5 weeks. The follow up schedule is after 2 weeks for removal of sutures, every 4 weeks till union of osteotomy site and then every 3 months for first 2 years.

The patient could walk toe touch assisted with a walker for 6 weeks followed by partial weight bearing assisted by a single crutch for another 6 weeks. After rehabilitation program with muscle

Table I. – Patients data

	age	sex	site	Preop. LLD In mm	pre. Harris Hip Score	Postop LLD	Postop. Harris Hip Score	Time for union (months)
1	32	M	RT	55	42	10	88	4
2	46	M	bilateral	10 RT>LT	37	5 RT>LT	91	LT=4 RT=5
3	28	F	RT	65	41	10	88	4.5
4	36	F	bilateral	0	33	5 LT>RT	86	LT= 4.5 RT=4
5	32	F	LT	50	31	0	82	4.5
6	46	F	LT	60	29	15	78	5
7	40	F	LT	70	44	20	89	6
8	27	M	RT	50	37	10	88	7
9	44	F	LT	45	48	0	90	4
10	41	F	LT	60	45	15	83	5.5
11	36	F	RT	40	37	5	76	8
12	22	M	LT	40	41	5	91	5
13	33	M	LT	35	38	0	88	6
14	37	F	LT	40	39	0	85	4.5
15	29	F	LT	55	37	10	90	5
16	41	M	LT	40	42	5	84	6
17	48	F	bilateral	20 LT>RT	35	0	78	RT=5 LT=4.5
18	47	F	RT	80	37	15	88	4.5
19	43	F	LT	65	39	15	84	4
20	44	F	LT	45	41	5	90	5
21	47	M	RT	55	32	10	85	4.5
22	35	M	LT	40	33	0	88	5
Mean	37.90			46.36	38.09	7.3	85.90	5.1

strengthening, the patient could weight bear fully after 3 months of the operation.

RESULTS

Our series included 22 patients with 25 hips operated. Female patients and left sided hip were predominant than male and right sided hips. There were three cases operated for both hips. All cases were adult and suffer from hip dysplasia type IV according to Crowe classification.

Intra-operatively, 1 case had crack in the proximal femoral fragment and a cerclage wire above the lesser trochanter was applied with no affection of stability. Another case had fracture of greater trochanter also has been treated by tension band cerclage wiring and grafting. In both cases weight bearing was delayed for 3 weeks.

One patient has prolonged postoperative discharge for 1week due to oral anticoagulant that was stopped after shift to enoxaparin injection. No cases of sciatic nerve injury were recorded in our series.

We did not use any fixation type for the osteotomy site. We depended on the stem fitting for torsional and axial stability of the osteotomy site. All the osteotomies healed within average 5.1months. No

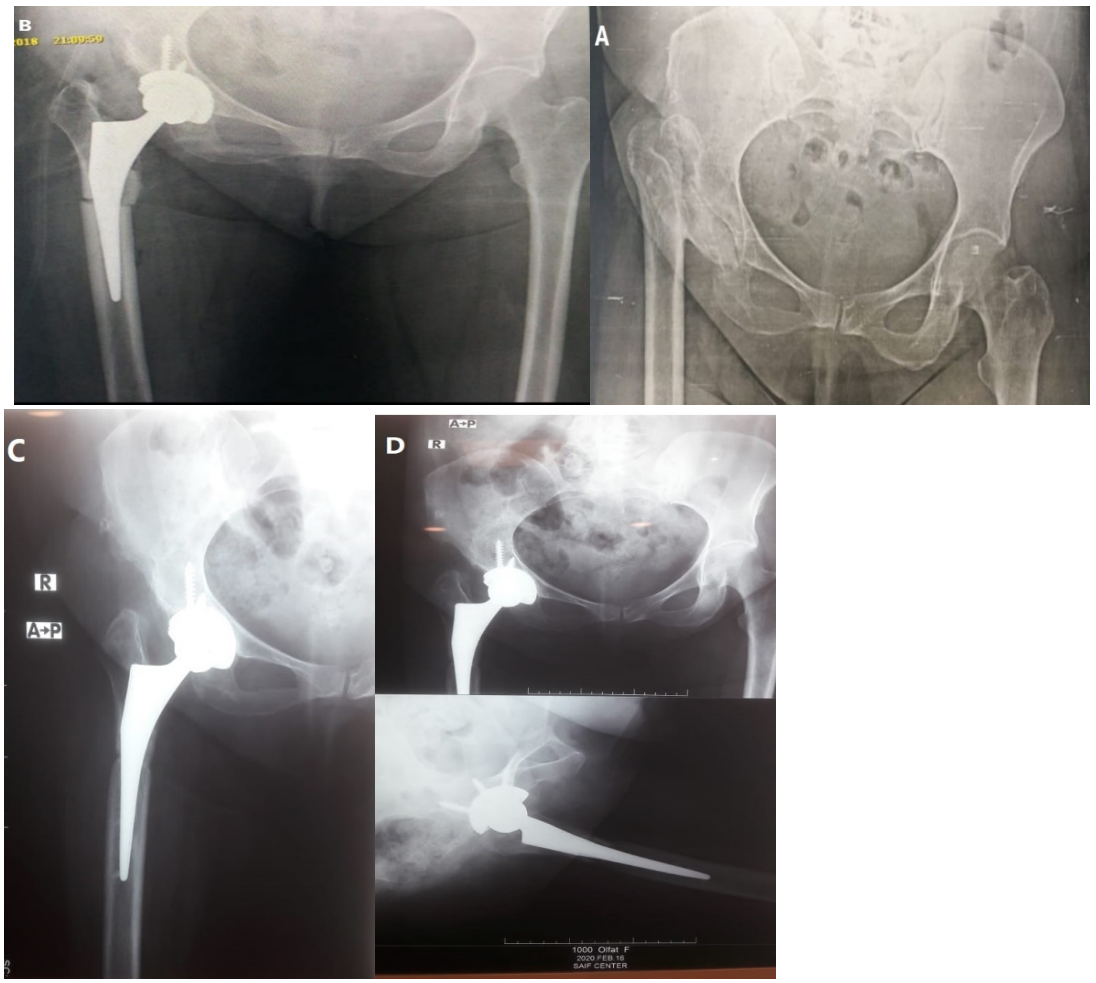

Fig. 4. – Case no 18. (A) preoperative x ray of female patient 47 y with dysplastic RT hip. (B) Immediate post-operative x ray. (C)&(D) Follow up 6 months postoperative x ray with full union of osteotomy site.

cases of non- union were noticed during the follow up. The average follow up for our cases was of a mean 28.3 months.

The preoperative limb length discrepancy was of a mean 46.36 mm that had been corrected to 7.3 mm postoperatively. On case showed subsidence of the cementless stem and it was revised to cemented stem 1 year after operation.

The preoperative Harris hip score for our cases was of a mean 38.09 that was improved to 85.90 at the end of follow up. All our cases were satisfied by the range of motion and hip function at the end of follow up.

DISCUSSION

There are different classification systems for the developmental dysplasia of hip in adults .The most common classification used is the classification according to Crowe *(3)*.It depends mainly on the vertical displacement of the hip in relation to the acetabulum. In the most severe form, Crowe type IV, there is vertical displacement of the femoral head more than 100% of its vertical diameter and for more than 20% of the pelvic height. Pseudo acetabulum is common in severe forms.

The pathoanatomy of Crowe type IV represents multiple technical obstacles to obtain stable painless hip arthroplasty concerning both the femoral and acetabular components as well as

the abductor mechanism. The main issue of the acetabular side is to locate the component in the true acetabulum which may not offer good bone stock for component coverage and fitness. The abductors are usually short and maloriented. They run in a transverse or rather in an infero-superior orientation in contrary to their normal orientation. The femoral neck has more valgus and anteversion alignment than normal with a greater trochanter more posteriorly oriented *(4)*. The surgeon should address each of the above mentioned anatomical and biomechanical obstacle to offer his patient a well-functioning long lasting arthroplasty.

The acetabular component containment and incorporation is a major challenge for the surgeon. Proximal location of the hip center increases the load over the acetabulum by 0.1% for every 1 millimeter *(5)*.High hip center leads to short abductor lever arm and increases the shearing force over the acetebular component . This leads to earlier loosening of the cup *(6)*.The transverse acetabular ligament is an anatomical landmark of the true acetabulum that is not affected by the anatomical distortion resulted from the deformity. Tracing the elongated ligamentum teres directs the surgeon to the transverse acetabulum ligament and therefore to the true acetabulum. The three dimension CT scan helps to evaluate the acetabular bone stock especially the medial wall. Preparation of the acetabulum starting by small reamers sequentially with medialization allows good bone stock for incorporation of the cup. 30% uncoverage of a stable well fitted cementless cup is highly accepted.*(7,8)* In our series, all our acetabular components were located in the true acetabulum. This helps to correct the limb length discepency of the patients especially in unilateral cases .We did not use any augments or vascularized grafts.

The femoral shortening procedures aid easy reduction of the femoral head into the acetabulum without much traction over the soft tissue. The soft tissue tension is restored without tightness which is essential for the component stability, mobility and durability. The shortening procedure protects the shortened sciatic nerve from stretch and injury. We did not have any case of sciatic nerve injury in our series.

Many authors described the transverse subtrochentric osteotomies in Crowe type IV hip dysplasia. Their results shows similar torsional stability in comparison to chevron or step cut osteotomies. The union rates are highly satisfactory. *(9-13)* We did not have any case of osteotomy non union in our series.

The subtrochentric osteotomy allows correction of the anteversion of the proximal femur. This relocates the greater trochanter to its normal lateral position which improves the abductor mechanism.

The lever arm of the abductors improved significantly in this group of patients as a result of the above procedures. Locating the acetabular component in the true acetabulum redirects the abductor fibers again to the normal alignment from supero-medial to infero-lateral position. Femoral shortening and reduction of the femoral head to the new acetabulum site lengthen and stretch the abductor muscle fibres. The anterversion correction and lateral relocation of the greater trochanter increase the abductor tension. All thetechniques mentioned above results in efficient abductor mechanism which contributes to component stability and function.

Patients by this surgical technique are offered painless and adequately functioning hip that was proved by the great difference in postoperative Harris hip score in comparison to the preoperative score. The correction of limb length discrepancy to small differences improves much their gait and pelvic muscle balance .

Our study limitation is that it is a retrospective and our follow up period is short. We aimed at elaboration of the technique and technical tips in these challenging cases. Longer follow up is needed.

CONCLUSION

Patients with Crowe type IV hip dysplasia can be offered painless hip arthroplasty that improves their life quality. It is technically difficult arthroplasty surgery. Recreation of normal biomechanics and anatomy contributes much to the satisfactory results.

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