Total hip Replacement in Crowe type IV dysplastic hips – average 5 year follow-up and literature review

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This is a retrospective study of 29 patients (34 hips) of Crowe grade IV dysplastic hips aged between 19 and 75 years who underwent THR for osteoarthritis secondary to DDH. The hips were evaluated radiologically for Sharp's acetabular angle, cup inclination, loosening, and ectopic bone formation. Clinically the results were evaluated by pre and postoperative Harris hip scoring.

The mean acetabular angle was 60.8° (range, 45°-68°) preoperatively. In 18 hips, subtrochanteric femoral osteotomy was performed. Pre-operatively, the mean leg length discrepancy was 5 cm (range, 2-8 cm). Correction within 1 cm was possible in all patients except in 4 patients. The mean Harris hip Score was 40.80 (32-45.90) preoperatively and 87.96 (74.78-94.72) at last follow-up.

THR is successful in high dislocation dysplastic hips. Although there is no gold standard technique of THR in dysplastic hips and treatment of each patient should be individualized.

Level of evidence : IV.

Keywords : total hip replacement ; Crowe's Grade IV ; dysplastic hips ; sub trochanteric femoral osteotomy.

INTRODUCTION

Developmental dysplasia of hip (DDH) is a major risk factor and most common hip disorder in children leading to secondary osteoarthritis of the hip joint [18]. Patients with severe osteoarthritis secondary to DDH often undergo total hip replacement (THR) at a younger age [12,35]. DDH is a spectrum of developmental disorders of the hip which presents with abnormal development of the hip joint with altered anatomy of the acetabulum and proximal femur [5,28]. Anatomical pathology in dysplasia is mostly at the acetabular side of the joint. It is more shallow than usual with thickened medial wall and the femoro-acetabular coverage is not enough. Proximal femur may be hypoplastic with deformed and high riding femoral head. In dislocated hip, the femoral head articulates with iliac bone forming false acetabulum. Direction of the abductor muscle force vector changes from usual vertical to horizontal due to high riding trochanter. Hip abductors are usually shortened and contracted. Short femoral neck with increased anteversion, along with deformed head and altered abductor muscle mechanism may lead to development of secondary osteoarthritis of the hip joint.

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In Crowe grade IV DDH, THR is a challenging surgery. True acetabulum is difficult to locate in these cases. Cup positioning and hip reduction are technically demanding. This can be done by careful soft tissue dissection, capsule release from the proximal femur, release of tight adductors and flexors, pi-crusting of abductors to gain length, and if needed subtrochanteric shortening of femur. It should be kept in mind that due to developmental dysplasia of the hip, the femoral neurovascular bundle and sciatic nerve may not be present at their usual anatomical landmarks. The purpose of the study was to assess the results of THR in Crowe type IV DDH, using a cementless design with selective subtrochanteric osteotomy done by a single surgeon.

MATERIALS AND METHODS

This was a retro-prospective study. We reviewed the medical records of 71 patients (97 hips) with DDH in whom THR was done between May 2002 and April 2011. 29 patients (34 hips) with Crowe's grade IV (Subluxation > 100% or proximal dislocation of > 20% of pelvic height) (6,15) were included in the study. There were 22 females and 7 males. The indications for THR were severe pain and/or functional impairment with difficulty in walking and performing activities of daily living. Preoperatively, all patients were evaluated clinically and radiographically. For each patient, complete medical history was collected, pain and grade of disability was assessed in terms of limitation of the range of motion of the hip, limb length discrepancy, and restrictions on walking and in doing daily activities according to Harris Hip Score (13). For all patients anteroposterior view of the pelvis and lateral view of the involved hip were obtained. On radiographs, for all hips, acetabular angle of Sharp (34) was evaluated preoperatively and post operatively and results were recorded. CT-Scan with 3D reconstruction was done to access the morphology of the proximal femur and acetabulum. CT with 3D reconstruction is very useful in assessing version and available bone stock of the acetabulum. Ectopic bone formation was evaluated according to the criteria of Brooker et al (4). Radiological assessment of osteolysis and implant loosening was done by comparing the post-operative true anteroposterior and lateral X-ray films with most recent radiographs and measuring the radiolucent lines in the prosthesis-bone interface as described by Gruen et al (11). Prosthesis migration and any fracture in bone were recorded. Pre-operative shortening was measured radio-logically between fixed points on pelvis (tear drop) and femur (lesser trochanter). The patients were reviewed clinically and radiographically at 3, 6 and 12 months after surgery and yearly thereafter in outpatient department. All surgeries were done by senior author (RKS) and clinical and radiological assessment at follow up was done by two specialist orthopedic surgeons (remaining two authors) in supervision of the senior author.

Surgical Technique

In all cases, postero-lateral approach was used. Careful soft tissue dissection was done keeping in mind that femoral neurovascular bundle and sciatic nerve may not be present at usual anatomic positions. The femoral neck was resected at its base around 1 cm proximal to lesser trochanter. The true acetabulum was identified by direct palpation of cotyloid notch and transverse ligament and with the help of Image Intensifier (Fig. 1a and b). The acetabulum was gradually enlarged and deepened with serial reaming at desired angle of abduction and anteversion to contain cement less component that could be fixed with two to three screws. Special caution was exercised to avoid overreaming of usually thin anterior and medial wall.

If the acetabular roof was deficient and coverage of acetabular cup was less than 25%, reinforcement was done with Cortico-cancellous structural bone graft from femoral head for superolateral acetabular coverage and fixed with 3.5-mm cortical screws. This structural bone grafting was done in 12 acetabulums (Fig. 2a and b). The acetabular component was impacted against the medial wall and fixed with screws to the circumferential support. In many cases the acetabulum was very small and anatomical acetabular reconstruction was possible only with small size cups.

In 18 hips with long standing proximal migration of femoral head, bringing down of proximal femur to the level of the true acetabulum was not possible due to severely contracted soft tissue structures. A transverse sub trochanteric osteotomy was done in such cases to facilitate the reduction. Decision of subtrochanteric osteotomy was taken intraoperatively if the hip joint could not be reduced even after release of adductors and iliopsoas. Usual site of proximal level of osteotomy was 8-10 cm distal to
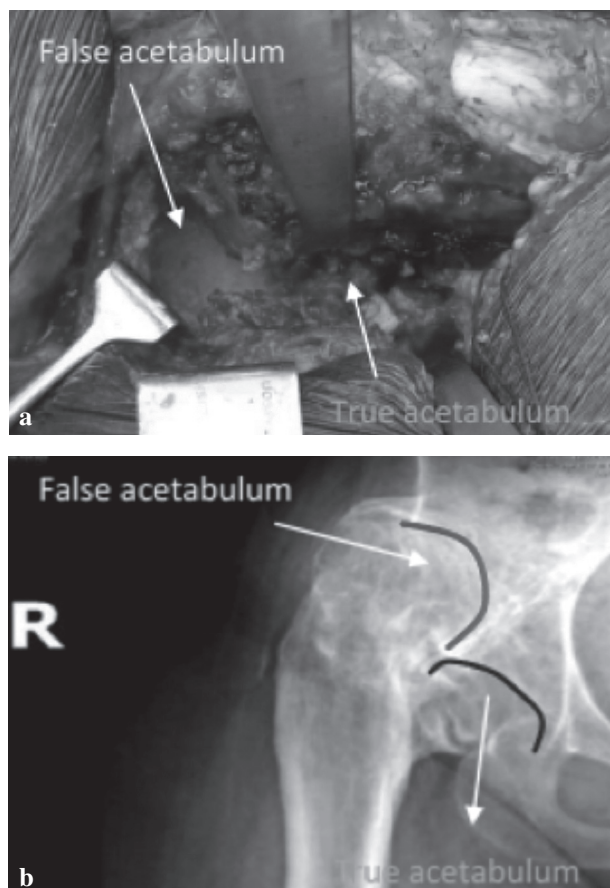
Fig. 1a and b. — Intra-operative (Fig. 1a) and Xray (Fig. 1b) localization of true and false acetabulum.

Fig. 2a and b. — Intra-operative picture showing acetabular roof reinforced with autogenous bone graft from femoral head and fixed with screws.

tip of greater trochanter. Length of osteotomised segment was guided by the length of the proximal femoral segment which overlapped the distal segment after reduction of the hip joint (with moderate tension). The medullary canal was reamed using tapered reamers progressively and stem was inserted aiming to obtain about 15°-20° of anteversion. Proximal femoral fragment was rotated to achieve desirable anteversion (guided by lateral position of greater trochanter). Osteotomised fragment was split longitudinally and used as cortical strut grafts at osteotomy site and stabilized with cables (Fig. 3). To maintain the vascularity of these fragments soft tissue attachments were kept attached, wherever possible. Reduction should be possible with moderate traction only, as excessive traction may injure
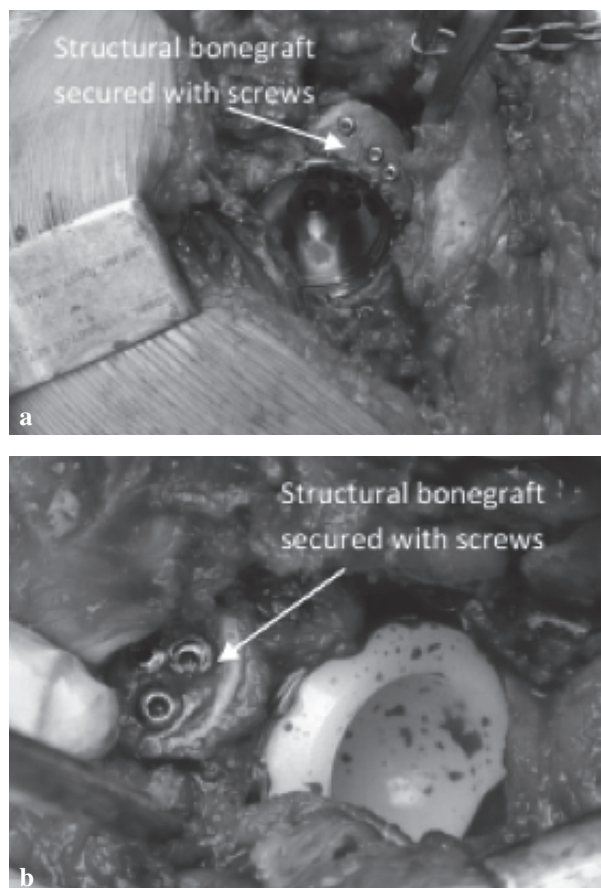

Fig. 3. — Subtrochantric osteotomy to facilitate reduction. Osteotomised segment was vertically split and fixed to osteotomy site with cables.
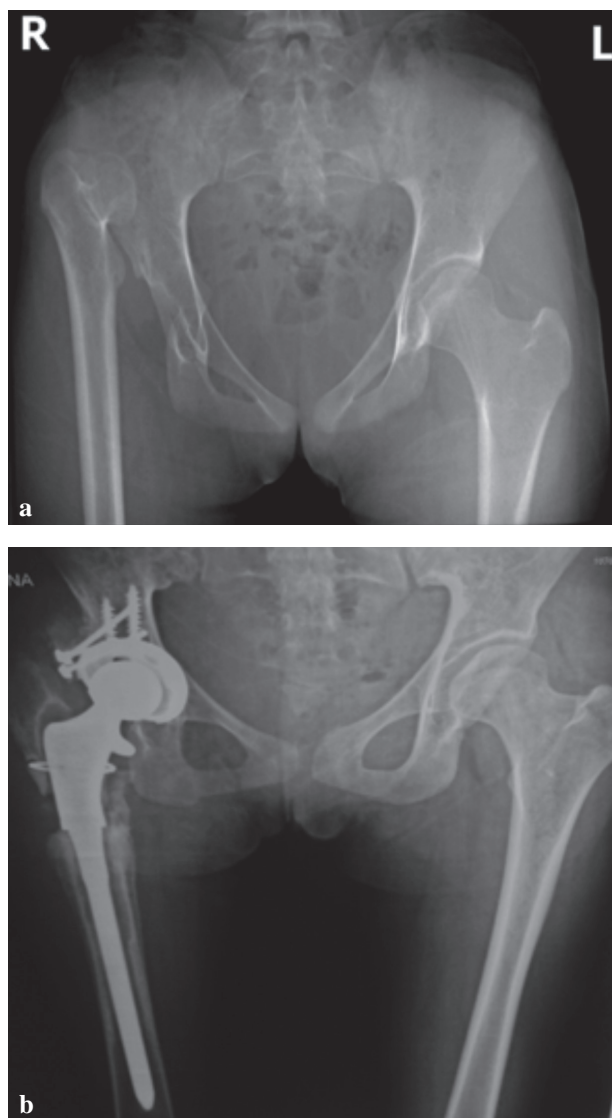
Fig. 4a, b and c. — Pre-operative (Fig. 4a) and post-operative (Fig. 4b) X ray of developmental dysplasia of hip crowes grade IV, with Functional outcome (Fig. 4c) of the patient after 13 months of surgery.

the neurovascular structures. If required additional bone was resected from the distal fragment to achieve reduction.

After reduction of the hip joint, stability and range of motion were assessed, and limb length checked in comparison to the contralateral limb. Physiotherapy was started on 1st Post-operative day. In cases where bone grafting and/or subtrochanteric ostoetomy were done, weight bearing was delayed till the radiological signs of bony union were noted on subsequent radiographs.

RESULTS

Mean age of cohort was 42 years (range, 19-75 years). 24 patients were unilateral and 5 had bilateral THR. All patients were regularly contacted on telephone to prevent loss of follow-up. The minimum follow up was 1 year and maximum was 9 years (mean, 5 years 1 month, Table 1). 4 cases were lost to follow up between 12 to 18 months. These patients were also included in the study as available follow ups for these patients were equal to or more than one year.

10 patients had iatrogenic fracture at the proximal femur (Fig. 5a and b) which was stabilized with en-circlage wire. All the fracture united well over a period of 3-6 months. In these cases full weight

Table I. — Follow up data of patients

Follow up period	No of patients who did not report after mentioned period	Follow up method
1 year follow up	4	OPD follow up for 1 year than lost to follow up
2 year follow up	4	OPD follow up for 2 years than contacted on telephone
3 year follow up	2	OPD follow up for 3 years than contacted on telephone
5 year follow up	5	OPD follow up for 5 years than contacted on telephone
6 year follow up	5	OPD follow up for 6 years than contacted on telephone
7 year follow up	4	OPD follow up for 7 years than contacted on telephone
9 years follow up	5	OPD follow up for 9 years than contacted on telephone

Fig. 5a and b. — Pre-operative (Fig. 5a) and post-operative (Fig. 5b) images of crowes grade IV hip. Iatrogenic proximal femoral fracture was stabilized with cables. Acetabulum was reconstructed proximally near true acetabulum.
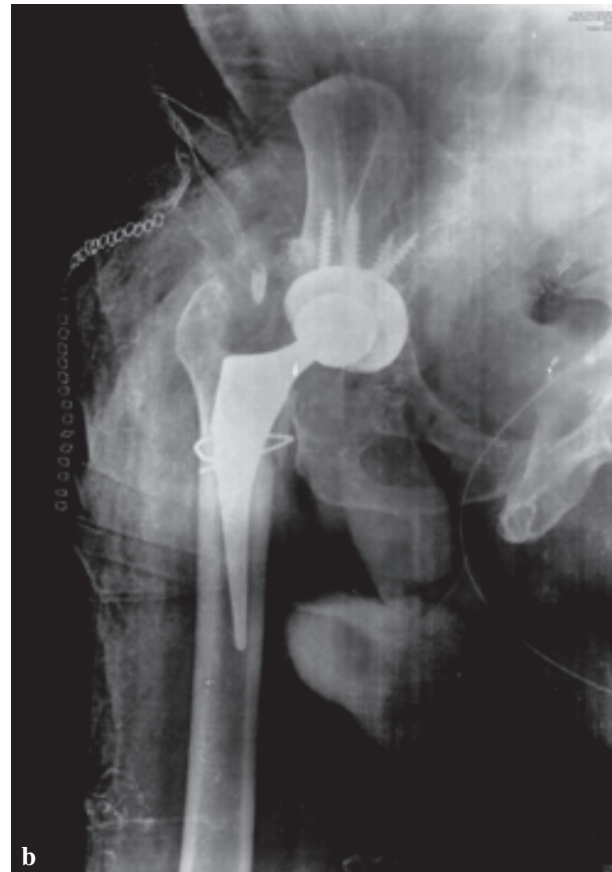
bearing was delayed till the radiographic evidence of union was seen. 2 patients had iatrogenic vascular injury to femoral artery which was abnormally lying very close to anterior lip of acetabulum. This was repaired by vascular surgeon. 4 patients had transient peroneal nerve palsy noted in immediate post-operative period. All patients recovered within 3 months of surgery. No early infection or wound healing problems occurred.

Mean Harris hip Score was 40.80 (32-45.90) pre-operatively and 87.96 (74.78-94.72) at last follow-up. All patients showed clinical improvement after

surgery. All patients were able to walk normally without any assistance at 3 months after surgery. Four patients, who underwent subtrochanteric femoral osteotomy, had limb length discrepancy of about 2 cm and required the use of a shoe lift ;

however, it was well tolerated. Osteotomy site was united by 5 months in all cases. Pre-operatively, the mean leg length discrepancy was 5 cm (range, 2-8 cm). Correction within 1 cm was possible in all patients (within 5 mm in 20 patients) except in 4 patients.

Mean acetabular angle was 60.80° (range, 45°-68°) preoperatively. The mean abduction angle of the socket was 46° (range 35°-55°). The mean height of the hip center was 23 mm (range 15-40 mm), measured vertically from the inter-teardrop line. No septic or aseptic loosening of the implants and implant migration was observed till the last follow-up available. We did not observe any case of heterotopic bone formation in this series.

DISCUSSION

THR in Crowe grade IV DDH is technically demanding. Achieving adequate cup coverage and restoration of near normal hip biomechanics remain the most important goals. Anatomy and biomechanics are altered with hypoplastic true acetabulum, narrow medullary canal, excessive femoral anteversion, proximal migration of femoral head and defective abductor mechanism. A wide range of prostheses should be available, to choose the one which is best suited for hypoplastic bones. THR in DDH has higher complication rate than THR in cases done for other indications [35]. Most common cause of failure is aseptic loosening of acetabular component. Two most important issues, to be considered while dealing with these patients are the site of acetabular cup placement and fixation method.

We reconstructed the acetabulum at true acetabulum level in 30 cases (Fig. 4a, b and c) and proximally near true acetabulum in 4 hips (Fig. 5a and b, Fig 7a and b). Acetabular reconstruction at true acetabulum level restores the biomechanics to near normal and also best bone stock is available here. Other authors have also reported that best osseous stock is available at true acetabular area [5,14] and ideal place for acetabular cup placement is true acetabulum [17,37]. Although some authors like Russoti and Harris [32] favored more proximal but not lateral placement of acetabular cup than relying on large structural bone graft at true acetabular site. On the contrary, Pagnano *et al* found high rate of loosening of prosthetic components with proximal position [29]. Doehring *et al* [8], gave the same opinion that superolateral position of femoral head center should be avoided and superior only location may be mechanically acceptable.

Favorable results have been shown both with uncemented acetabular cup [30,10] and cemented acetabular cup [19,22]. Rozkydal *et al* [38] produced 100% survival rate at 10 years follow-up with cement less shell and femoral head autograft. Kim and Kim [20] recommended use of bone graft to ensure more than 60% cup coverage. However, a high failure rate of nearly 46% was reported at a follow-up of twenty years with the use of the femoral head as an autograft for augmenting the superolateral aspect of the acetabular rim [25]. Reason behind these mixed results is that success in these challenging cases depends not only on implant fixation method but also on location of acetabulum, adequacy of cup coverage, and approach to deformed femur. When femoral head is proximally dislocated bone stock of the iliac bone becomes very deficient. Thus securing the acetabular component at or near the true acetabulum becomes a challenge. Cup coverage can be enhanced by medialization of the acetabulum, using small sized cup and by structural bone grafting. Controlled medial wall comminution for acetabular medial advancement and autogenous bone graft supplementation has been successfully used by some authors [9,14]. Definition of adequate bony coverage of the acetabular implant and the use of bone graft to facilitate coverage is a matter of debate. However most authors agree that if coverage is between 60%-80%, augmentation procedure (structural graft or medialization of acetabulum or both) should be used. Graft coverage should not be more than 30%-40%.

In our study 12 cases had an uncoverage of > 25% and structural bone grafting from the femoral head autograft was done for secure coverage (Fig. 2a and b, Fig. 4a and b). Implant position at true acetabulum was achieved by use of a smaller cup, sufficient medialisation, and good clearance of the medial osteophyte and fibro-fatty tissue from the acetabular floor near the cotyloid fossa. Matthijs [24] and Berghs [2] have shown satisfactory results with
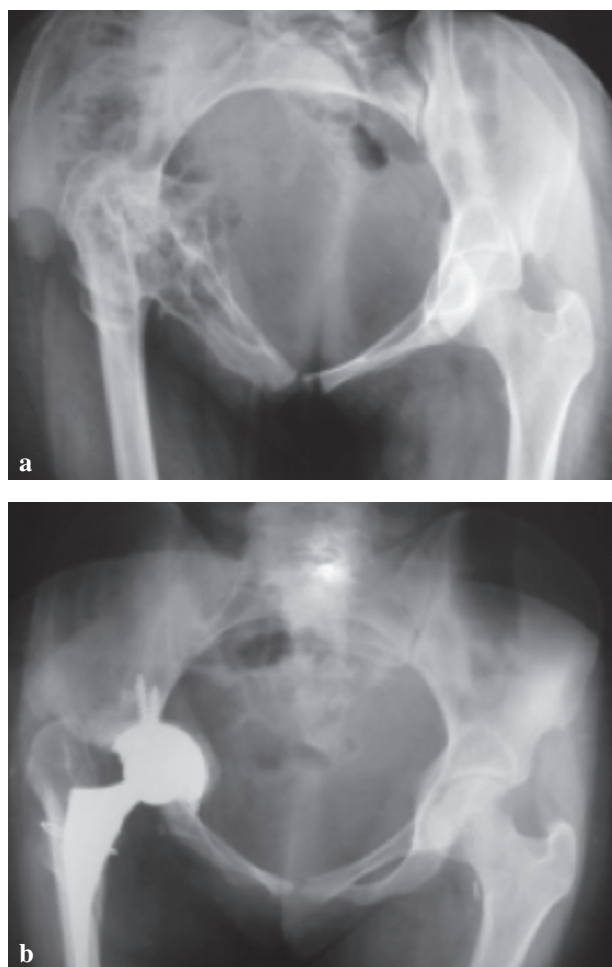
Fig. 6a and b. — Preoperative (Fig. 6a) and postoperative (Fig. 6b) X rays of ankylosed dysplastic hip.

structural grafting for acetabular deficiency in DDH. In this study, the mean acetabular angle was 60.8° preoperatively. A Sharp's acetabular angle of > 35° is consistent with subluxation of the hip (*34*). The mean cup inclination in THR should be 45° ± 5°. In our study, it was 46° (range, 35°-55°).

Shorter neck, excessive femoral anteversion and narrow medullary canal are main deformities in approaching femur in these cases. Anteversion can be easily tackled with cemented stem but this is less favored due to high aseptic loosening rate (*21*). This may be due to excessive stress on cement-bone and cement prosthesis interface due to altered biomechanics. We favor to use uncemented press fit
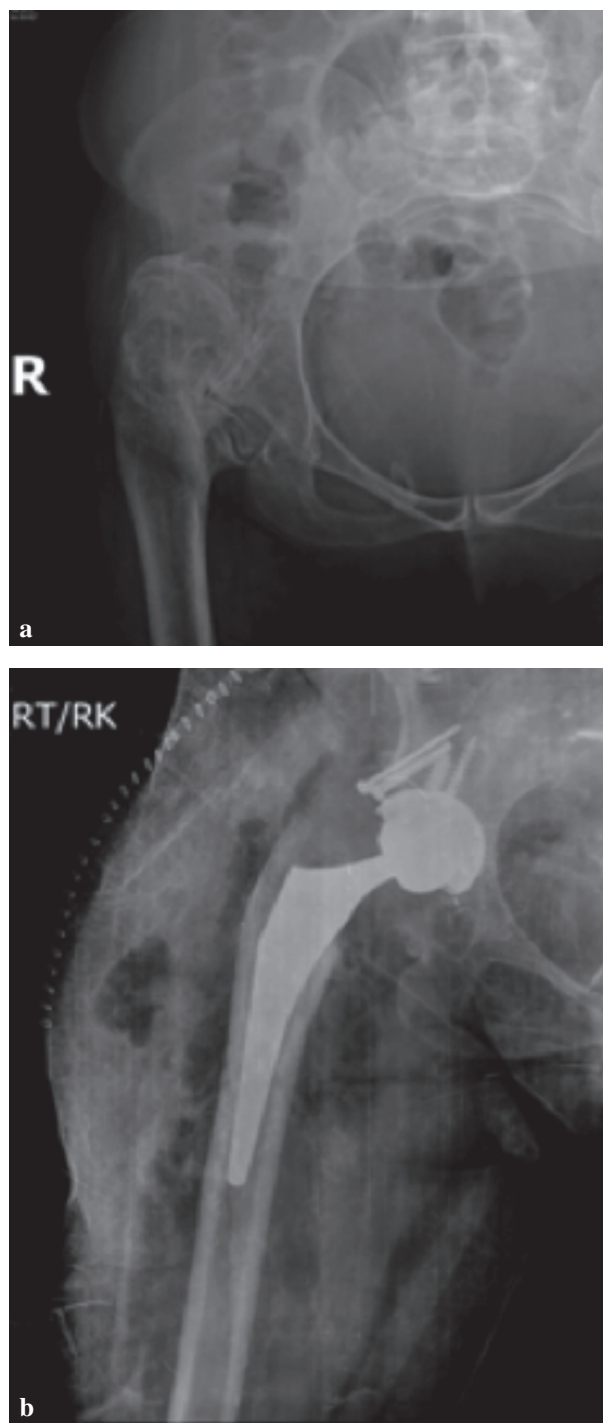

Fig. 7a and b. — Pre-operative (Fig. 7a) and post-operative (Fig. 7b) X rays of Crowe grade IV dysplastic hip. Acetabulum was reconstructed proximally near true acetabulum.

modular tapered and distally fixed stem. Excellent survival has been shown by many surgeons with modular uncemented stem (*3,23,30,36,37*). Using modular cementless S-ROM femoral component, Imbuldeniya *et al* (*17*) reported no femoral revision at minimum 15 years follow up of high dysplastic hips(Crowe type III and IV). However 57% patients in their case series required acetabular component revision at mean 14.6 years.

In this series additional sub-trochanteric osteotomy was required in 18 cases. A subtrochanteric osteotomy along with modular stem allows for correction of excessive femoral anteversion as well as concentric reduction. It also safeguards sciatic nerve against traction injury. Many surgeons have delivered successful result with low nonunion rates of osteotomy site (*26,27,33,36*). Nirong Bao *et al* (*26*) did progressive resection of lesser trochanter (lesser trochanteric osteotomy) to aid in reduction in Crowe type IV dysplastic dislocations.

Yoon (*31*) *et al* used a two stage approach in cases of high dysplastic dislocation. They released the soft tissues only in first stage and did the implantation and reduction in second stage surgery after two weeks of skeleton traction. Even after using this approach they required subtrochanteric osteotomy in 5 out of 6 cases.

In our series, we had a rare case of DDH presented with ankylosed pseudo hip. It posed a great challenge in doing THR. The hip was ankylosed, so we had to osteotomise the proximal femur to mobilize it. True Acetabulum was localized with the help of Image Intensifier. After meticulous soft tissue dissection, we did proper medialization of the acetabular cup with serially increasing size of reamer at the site of true acetabulum. In this case proximal femur was hypoplastic with virtually no femoral canal. We had to reconstruct the canal with burr and power reamers. Then proximal femur was split to accommodate the prosthesis and stabilized with encirclage wiring (Fig. 6a and b).

CONCLUSION

There is no universal gold standard treatment for high dislocation dysplastic hip. Treatment of each case should be individualized. Implanting the ace-

tabular implant to the site of true acetabulum should be tried first. If implanting at true acetabulum is not possible than proximal but not lateral site can be chosen. Small sized cup with or without medialization of acetabulum produces acceptable results. Cup uncoverage more than 20%-25% should be dealt with structural bone grafting. Both cemented and uncemented acetabular cup have been shown to produce long term survival and decision should be individualized. We favor uncemented press fit acetabular cup if coverage is more than 80%. Modular uncemented stem with subtrochantric osteotomy is now universally acceptable to give excellent results. Neurovascular complications need special mention in high dysplastic dislocation. Developmental dysplasia of hip is risk factors for sciatic nerve palsy. Excessive limb lengthening and cement less femoral stem fixation (may be related to forceful impaction) increase the chance neurological injury. Selective subtrochanteric osteotomy helps not only in reduction of hip joint but also allows for correction of anteversion and safeguards neurovascular structure against traction injury.

Conflict of interest : non

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