

## Short-term Results of Open Surgical Intervention in Developmental Dysplasia of Hip Among Nepalese Children Presenting After Walking Age: A Prospective Study

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**Introduction:** Developmental dysplasia of the hip (DDH) generally includes a spectrum ranging from acetabular dysplasia to hip subluxation to complete dislocation of the femoral head from the true acetabulum. Significant numbers of children with DDH still present late for treatment in our scenario, necessitating extensive open surgery on the proximal femur and the pelvis. The present study was designed to evaluate short-term results of operative intervention in DDH in walking age children.

**Materials & Methods:** A complete enumeration method was used, and all walking age patients with DDH who presented to our center between 2012 and 2017 were included in the study. All patients underwent an open relocation of the hip with or without femoral and pelvic osteotomies. Re-dislocation, presence of avascular necrosis (AVN) and acetabular index correction were evaluated. Out of 108 patients who underwent treatment for DDH during the study period, 52 patients (66 hips) met our inclusion criteria. The mean age at presentation was 4.48 years (2-10 yrs). There were 45 females (87%) and 7 males. The right hip was involved in 21 cases, left hip in 17 and 28 cases (42%) were bilateral. The average follow up was 4 years.

**Results:** All 66 hips were treated surgically with open relocation either alone or combined with femoral or pelvic osteotomy. Femoral shortening was done in 30 % of the hips, femoral varus osteotomy in 23% and a femoral derotation osteotomy in 32%. A pelvic osteotomy was carried out in 82% of the cases. Pre-operative skeletal traction was used in 5 hips and a pre-operative

arthrogram was done in 14 hips (21%). An adductor tenotomy was done in 18 cases (34%). Re-dislocation occurred in 5 hips (7%), 4 of whom have undergone re-surgery with a successful outcome till the latest follow-up. Avascular necrosis (AVN) of the capital femoral epiphysis (CFE) has not been encountered in any hip at latest follow up. Pre-operative average acetabular index was 36 degrees, which reduced to 20 degree post-operatively. Capital femoral epiphyses remodeling was observed in all cases.

**Conclusion:** Late presentation with limited capacity for acetabular remodeling necessitates extensive surgery involving the femur and pelvis. Meticulous technique ensuring that all obstacles to concentric reduction are addressed at the time of surgery, and a post-operative protocol of spica casting within the safe hip position, can ensure significant remodeling and low re-dislocation rates in late-presenting DDH. With AVN of the CFE as end-points, excellent results may be expected with surgical relocation and reconstruction.

**Keywords:** children, developmental dysplasia of hip, walking age.

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**D**evelopmental dysplasia of the hip (DDH) includes a spectrum from mild dysplasia and instability of the hip to frank dislocation, primarily caused by growth disturbances in the acetabular side, and secondarily leading to abnormalities in the femoral head.<sup>1</sup> Implicated risk factors include abnormal laxity of the hip joint, abnormal intra-uterine positioning (breech), increased estrogens, oligohydroaminos, as part of “packaging disorders” like torticollis, metatarsus adductus, or secondary to other pathologies like neuromuscular problems such as spina bifida, arthrogryposis etc. The sustained subluxation or dislocation of the femoral head over time lead to abnormal development of the acetabulum and femoral head.<sup>2</sup> Ultrasonography hip screening has been used in developed countries in an attempt to identify and treat hip dysplasias early.<sup>3</sup> In developing

countries, a significant number of cases still present late as a result of late or missed diagnoses.<sup>4</sup>

**Methods:**

A prospective study of 52 patients (66 hips) with developmental dysplasia of the hip in children of walking age who underwent open surgical treatment between 2012 and 2017, was conducted. A complete enumeration of all the patients who met our inclusion criteria was carried out. All patients were submitted to the same surgical technique by the same team of surgeons. A predesigned structured questionnaire included information on femoral procedures, pelvis osteotomy, re-dislocation status, degree of acetabular index correction, and avascular necrosis (AVN) at latest follow-up. Ethical approval and informed consent from participants were taken.

Data was compiled, coded and entered into

the computer database. Data was analyzed using appropriate statistical tools in SPSS 20.

**Results**

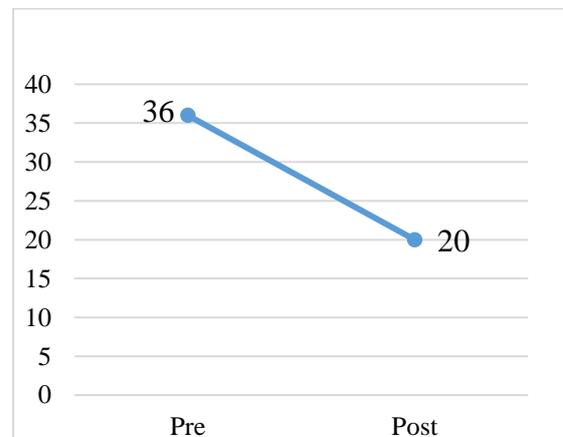
There were 52 patients with 66 hips, all of whom were treated surgically. The mean age at surgery was 4.48 years (2-10 yrs). 45 patients (87%) were females and the DDH was bilateral in 42% (**Table 1**). The average follow up was 4 years (16-72 months).

Avascular necrosis (AVN) of the capital femoral epiphysis (CFE) has not been encountered in any of the hip at latest follow up. The average acetabular index reduced from 36<sup>o</sup> to 20<sup>o</sup> post-operatively (**Figure 1**). Capital femoral epiphyses growth and remodeling was observed in all cases. The patients in this cohort were distributed through 32 districts of Nepal (**Figure 2**). The associated conditions encountered alongside the DDH are listed in **Table 2**.

Side of deformity	Frequency	Percent
Right	21	32.00
Left	17	26.00
B/L (14x2)	28	42.00
<b>Total no. of hip</b>	<b>66</b>	<b>100.00</b>

*Table 1: Distribution of the participants according to side of deformity*

The details of femoral and pelvic osteotomies in addition to open relocation are given in **Table 3**. Pre-operative skeletal traction was used in 5 hips and a pre-operative arthrogram was done in 14 hips (21%). An adductor tenotomy was done in 18 cases (34%). Re-dislocation occurred in 5 hips (7%), 4 of whom have already undergone re-surgery and one was lost to follow-up.



*Figure 1: Average acetabulum index*

Associated conditions	Number
Clubfoot	5
Metatarsus adduction,	1
Torticollis	1
Plano valgus foot	2

*Table 2: Associated conditions*

The re-dislocation rates in our patients reduced dramatically when the post-operative protocol was changed from 6 weeks of hip spica casting to 3 months. At re-surgery for re-dislocated cases (4 hips), the consistent intra-operative finding was a failure to release the tight antero-medial hip capsule at the time of index surgery.

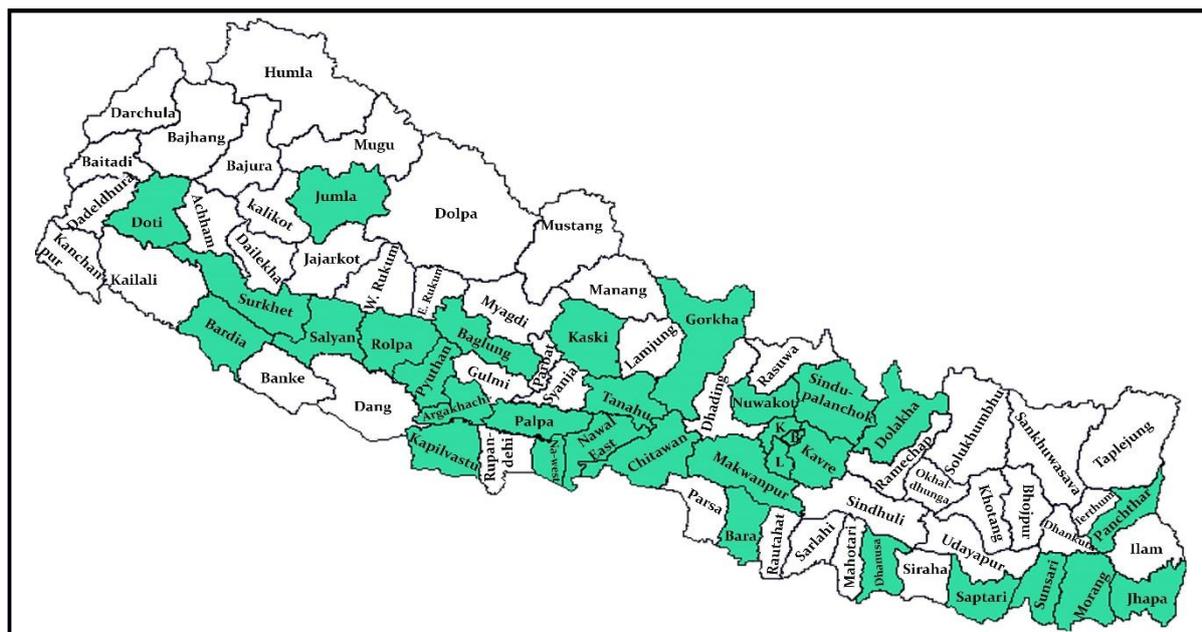


Figure 2: Distribution of the study participants through Nepal

Procedures	No.
Femoral (Shortening+ Varus+ Derotation) + Salter Innominate Osteotomy	1
Femoral (Shortening+ Varus+ Derotation) + Dega Osteotomy	7
Femoral shortening+ Salter Innominate Osteotomy	2
Femoral shortening+ Pemberton Osteotomy	4
Femoral shortening+ Dega Osteotomy	7
Femoral varus osteotomy + Salter Innominate Osteotomy	2
Femoral varus osteotomy + Pemberton Osteotomy	2
Femoral varus + Dega Osteotomy	7
Femoral derotation + Salter Innominate Osteotomy	4
Femoral derotation + Pemberton Osteotomy	4
Femoral derotation + Dega Osteotomy	7

Table 3: Details of femoral and pelvic procedures performed in addition to an open relocation

**Discussion**

Developmental dysplasia of the hip (DDH) encompasses a spectrum of acetabular abnormality ranging from mild dysplasia to frank dislocation. Untreated dysplasia is a precursor to early arthritis necessitating early joint replacement in many cases.

The average age of treatment in our study was 4.48 years. Pre-operative skeletal traction was used only in 5 cases who had

to wait for surgery for unrelated reasons. There is no evidence that traction either facilitates reduction or influences the incidence of avascular necrosis.<sup>1</sup> Pre-operative arthrogram was done in 14 cases, mainly with the goal of better understanding factors obstructing concentric reduction in very high dislocations. The main role of arthrography is perhaps in evaluating the adequacy of

closed reduction as opposed to facilitating preoperative planning.<sup>2</sup> AVN of the capital femoral epiphysis as per Kalamchi's criteria has not been encountered in any of the hips so far in this series. Longer term follow up of this cohort is in progress.

Redirectional or restructural pelvic osteotomies are both successful in correcting anterolateral acetabular dysplasia to up to 15° of acetabular index (AI) as well as anterior center-edge angle, in children with an open tri-radiate cartilage.<sup>9,10,11,12</sup> The choice of osteotomy was made on a case-by-case basis in our series. The average AI in our series improved from 36° pre-operatively to 20° post-operatively. Closed reduction in this age group carries a higher risk of re-dislocation, necessitating open surgery. Bey and MacEwen found that 66% of children of walking age with developmental dysplasia of the hip who had undergone closed reduction required additional surgery, compared with 33% of such patients treated with open reduction.<sup>5</sup> Forceful traction and prolonged immobilization in forced abduction carries a high risk of avascular necrosis of the femoral head (AVN).<sup>6</sup> In such cases, an open reduction is recommended, which is usually combined with femoral and pelvic osteotomies.<sup>7, 8</sup> Salter reported good to excellent radiographic results in patients who were between 18 months and 4 years

of age when the Salter innominate osteotomy was performed with open reduction.<sup>9</sup>

The reoperation rate for redislocation in our series (7.5%) also compares favorably with other reports.<sup>13</sup> Factors predisposing to failed open relocation can be failure to identify the true acetabulum, inadequate antero-medial capsule release, inadequate capsulorrhaphy, and simultaneous femoral & pelvis osteotomy causing posterior subluxation or dislocation. Higher rates of osteonecrosis is noted with re-surgery and results are inferior to primary treatment. Chmielewski et al reported constricted anteromedial capsule in all patients, an inverted transverse ligament in 3 patients and a tight psoas tendon in 3 patients in their series of 8 re-operations for redislocation.<sup>14</sup>

The one-stage surgical treatment for developmental dysplasia of the hip consisting of open reduction combined with femoral and pelvic osteotomy, is a technically demanding procedure that should be carried out only after meticulous planning and appropriate training. Excellent results are seen at short-term follow up in late presenters when open reduction combined with femoral or pelvic osteotomies were carried out to achieve a stable concentrically reduced hip joint with adequate acetabular coverage.<sup>14</sup>



Figure 3: 3-year-old female child with left developmental dysplasia of hip corrected with open reduction combined with a Salter innominate osteotomy. A) Preoperative x-ray; B) 10 month's post-operative x-ray showing good containment of the femoral head with K wire in-situ; C) 2 years post-operative x-ray showing well remodeled acetabular coverage with excellent remodeling of capital femoral epiphysis



Figure 4: 5-year-old female child with right developmental dysplasia of hip treated with open reduction combined with a Pemberton pelvic osteotomy with femoral shortening and derotation osteotomy. A) Preoperative x-ray; B) 6 month's post-operative x-ray showing good containment of the femoral head with recon plate insitu; C) 2 years post-operative x-ray showing well remodeled acetabular coverage with excellent remodeling of capital femoral epiphysis

### Conclusion

Late presentation (mean age 4.7 years) with limited capacity for acetabular remodeling necessitates extensive surgery involving the femur and pelvis. Re-dislocation rates reduced dramatically when the post-operative protocol was changed from 6 weeks of spica cast to 3 months. At re-

surgery for re-dislocated cases (4 hips), the consistent intra-operative finding was a failure to release the tight antero-medial capsule at the time of index surgery.

Meticulous technique ensuring that all obstacles to concentric reduction are addressed at the time of surgery, and a strict post-operative protocol involving an

extended period of spica casting within the safe hip position, can ensure significant remodeling and low re-dislocation rates in late presenting DDH. With avascular necrosis of the capital femoral epiphysis as an end-point, excellent results may be expected at short-term follow up, with surgical relocation and reconstruction, in late presenting DDH.

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