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Surgical Treatment of Pathological Developmental Dysplasia of the Hip: A 12-Year Study

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Abstract

Aim: We aimed to assess outcomes of a 12-year longitudinal observational study of developmental dysplasia of the hip (DDH) requiring surgical intervention.

Method: We conducted a prospective study from 2004 to 2015 of all cases of DDH undergoing surgical intervention. In addition to clinical examination, Tönnis acetabular index (AI) method and International Hip Dysplasia Institute (IHDI) grading used. Avascular necrosis of the femoral head (AVN) was assessed by the Kalamchi method.

Results & Discussion: There were 81 hips in 72 patients (12 male, 60 female). Mean age of the first operative procedure was 16.4 months (95% CI, 13.66 to 19.14). Mean follow up was 47.6 months (95% CI, 41.8 to 53.4). 31 children underwent closed reductions, 48 required open reduction; 17 femoral and 39 pelvic osteotomies were performed during the course of the study. Overall, post-surgery 96.3 % were noted to have an acceptable AI (<2 SD of the mean). Five hips were considered to have poor results due to residual subluxation/dislocation (6.2%). Evidence of avascular necrosis was present in 16 of the 81 hips (19.8%). Higher grades of hip pathology were generally associated with a later age of diagnosis and likely to require more extensive surgical interventions.

Conclusion: Operative intervention for DDH results in acceptable clinical and radiographic outcomes in the vast majority of children.

Keywords: DDH, Developmental dysplasia of the hip, Surgery

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Introduction

Developmental dysplasia of the hip (DDH) is an umbrella term for a spectrum of conditions ranging from acetabular dysplasia, clinical hip joint instability to irreducible hip dislocation [1, 2, 3]. Early detection and treatment result in an optimum long-term result. Acetabular and femoral head growth is co-dependent, and the femoral head must be reduced into the acetabulum for it to develop spherically and concentrically [4, 5, 6].

The rate of surgical intervention for pathological DDH varies widely in different countries [3, 7, 8, 9]. The goal is to obtain a stable concentrically reduced hip joint in as early as possible either with the use of a harness, or by closed or open reduction of the hip joint [4, 10]. The principal complications are failure of reduction or re-dislocation of the femoral head from the acetabulum. The risk of AVN of the femoral head following treatment for DDH ranges from 1 to 16% [11, 12, 13].

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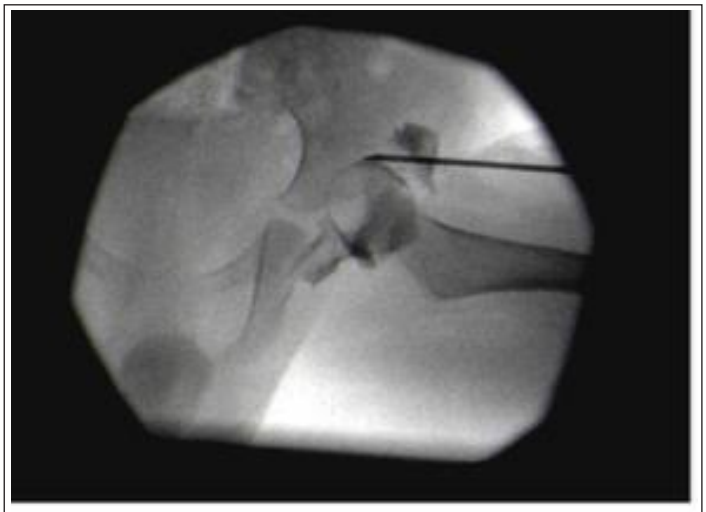

Figure 1: Hour glass constriction of capsule (arthrogram of irreducible left hip in DDH).

The aim of this study was to evaluate the success of the surgical procedures undertaken over a 12-year period in a sub-regional paediatric orthopaedic unit. The radiological degree of severity of the DDH was classified pre-operatively and postoperatively.

Methods

Between 1st January 2004 and 31 December 2015, a prospective, 12-year longitudinal observational study was carried out for all new cases of pathological DDH presenting to the senior author's clinic at our institution. DDH was defined as those diagnosed with an idiopathic aetiology with no known primary cause at the time of diagnosis or surgery (syndromes, neurological or neuromuscular primary condition) [14].

The catchment area has a birth rate of 6,707 live births per year and a total population of 531,000 of which approximately 25% are under the age of 16 years [15]. Demographic data, diagnosis (DDH type) and surgical treatment over the course of the study period were recorded on a spreadsheet (Microsoft Excel TM). Cases were cross-referenced with the senior author's surgical e-logbook (Royal College of Surgeons of Edinburgh). This e-logbook was completed by the senior author on the day of surgery and was an accurate coding record of the surgical procedures required in all cases of pathological DDH. In addition, a prospective card index system recorded those cases diagnosed with pathological DDH identified from the orthopaedic-led local selective sonographic DDH screening programme [3]. This identified cases of clinical hip instability, 'at risk' hips and referrals from general practitioners (GP) at 6 – 8 weeks of age for DDH that progressed to pathological DDH requiring surgical intervention, despite Pavlik harness treatment. Operative records were available for review.

Radiographs were reviewed retrospectively to assess the severity of the DDH at diagnosis according to the International Hip Dysplasia Institute (IHDI) classification (Grade 1 to 4) and Tönnis acetabular index [16, 17]. An abnormal AI was noted if it was greater than 2 standard deviations from the age-related mean. Avascular necrosis of the femoral head was assessed by the Kalamachi method [18].

Inclusion criteria: all cases that required surgical intervention (closed or open reduction of the hip, pelvic and femoral osteotomies) for pathological DDH, including cases that failed to respond to treatment in a Pavlik Harness.

Exclusion criteria: all known neuromuscular and neurological causes of irreducible dislocation/acetabular dysplasia at the time of diagnosis and surgery. All children were thoroughly assessed by the paediatric department for the presence of primary aetiologies prior to surgical intervention (syndromic or neurological cases).

The results of the study were compared with the British Society for Children's Orthopaedic Surgery (BSCOS) recommendations [19]. BSCOS recommendations were based on a systematic review of the literature. The likelihood of successful reduction in the literature varies widely (closed reduction 57–94% success, open hip joint reduction 77–100% success).

Results

From January 2004 to December 2015, all cases of pathological DDH treated surgically by the senior surgeon were evaluated. There were 81 hips in 72 patients including 12 boys and 60 girls (5:1 female to male). The Right hip was affected in 36 children, the Left hip in 45 cases and 9 had bilateral involvement (Table 1).

The mean age at presentation was 11.8 months (95% CI, 9.12 to 14.48) and the mean age at first intervention was 16.4 months (95% CI, 13.66 to 19.14). The mean number of operations per individual was 1.5 (Range 1 - 4). Change of hip spica and removal of metal work were not regarded as surgical procedures for the purposes of this study.

There were 48 open hip joint reductions, 17 femoral osteotomies and 39 pelvic osteotomies. The mean follow up was 47.6 months (95% CI, 41.8 to 53.4). 30 (41.7%) patients were diagnosed at <4 months of age, 42 (58.3%) were diagnosed >4 months and 33 (45.8%) of these cases were diagnosed after 1 year (Tables 1 and 4). 71.7% of those cases presenting later 4 months of age re-quired an open reduction, compared to 42.8% presenting before 4 months of age.

31 closed reductions of the hip were undertaken, from which 7 progressed to open hip joint reduction due to failure to maintain satisfactory reduction. In all, 48 hips required open reduction. Over the 12-year study period, there were 18 cases (22 hips) presenting early with an Ortolani/Barlow positive manoeuvre that failed to respond with Pavlik harness treatment. These hips required: 9 open reductions, 2 femoral osteotomies and 9 pelvic osteotomies. Seventeen of the 18 cases were girls (Table 1).

Table 1: Number of cases, gender and age of surgical presentation

	Overall	O/B +ve	Dx. < 4M 41.6% (total)	Dx. > 4M 58.3% (total)
Number of cases Individuals not hips	72	18	30	42
Female	60	17	26	34
Male	12	1	4	8

(O/B = Ortolani or Barlow positive in clinic. DX diagnoses age in months)

Table 2: IHDI grade and age at diagnosis

IHDI grade	Grade II	Grade III	Grade IV
Overall (hips) % of total hip joints	33 (40.7%)	29 (35.8%)	19 (23.4%)
Diagnosis < 4 Months % of Grade II, III & IV	21 (63.6%)	12 (41.4%)	2 (10.5%)
Diagnosis > 4 Months % of Grade II, III & IV	12 (36.4%)	17 (58.6%)	17 (89.5%)

Table 3: Type of surgical intervention and IHDI grade

IHDI Grade	Overall (Hips)	OR	FO	PO
II	33	9	0	10
III	29	20	9	18
IV	19	19	8	11

(OR - open reduction, FO - femoral osteotomy, PO – pelvic osteotomy)

Table 4: Type of surgical intervention compared with age and other surgical procedures

Hips (n)	Overall	Dx. < 4 M	Dx. > 4 M	CR	FO	PO
	81	35	46	31	17	39
OR	48	15	33	7	16	27
FO	17	3	14	2	-----	14
PO	39	10	29	8	14	--------

(OR - open reduction, FO - femoral osteotomy, PO – pelvic osteotomy, Dx – diagnostic age in months)

There were 39 pelvic osteotomies (in 37 patients) (Table 3). 35 hips (89.7%) had a preoperative AI > 2 SD of the mean on the Tönnis classification. The mean age at diagnosis in this group was 18.9 months (95% CI, 14.8 to 23) and the mean age at the first operation was 22.4 months (95% CI, 18.2 to 26.6).

Of the hips treated initially by closed or open reduction that did not require a pelvic osteotomy, (no residual dysplasia on follow up radiographs) 24 hips had an abnormal pre-operative AI >2 SD of the mean (Tönnis classification). The mean age at diagnosis in this group was 5 months (95% CI, 3.0 to 7.0) and the mean age at the first operation was 9.1 months (95% CI, 7.2 to 11), considerably younger that the surgical group as a whole. Nine hips presenting at 10 to 14 months who required treatment with an open reduction, did not require a pelvic osteotomy at a later date, as the AI was within 2 SD at long term follow up. Mean age at diagnosis was 11.7 months, (range 10 to 14 months). Seven hips presenting at 10 to 14 months who were treated with an open reduction required a pelvic osteotomy at a later date, due to the AI persistently being >2 SD of the mean. Mean age at diagnosis was 11.7 months (range 10 to 14 months). We could not readily account for this difference.

There was a subgroup of 9 cases of late presenting acetabular dysplasia without a preceding history of neonatal hip joint instability or other clinical hip abnormality. There were 9 cases (3 male & 6 female). The IHDI grading was Grade II in 7 and Grade III in 2 children. The mean age at diagnosis was 28.9 months, 95% CI 17.7 to 40.1.

Higher grades of hip pathology (IHDI Grade IV) were generally associated with older ages at diagnosis. Higher grades of hip pathology were more likely to require open reduction, femoral osteotomy and pelvic osteotomy (Table 2 and 3). There were few cases of femoral osteotomy in those cases diagnosed at < 4 months of age (3/35) or in those undergoing a closed hip reduction (2/31). However, there were 8 pelvic osteotomies in the closed reduction group, undertaken for residual pathological acetabular dysplasia (AI > 2 SD) that did not resolve spontaneously. These procedures were undertaken many months or years after the initial closed hip reduction. Most femoral osteotomies were combined with pelvic osteotomies as a 'one stage' intervention in the older age groups.

Of the 81 hips: 70 had AI <1 SD of the mean, 8 were within <2 SD of the mean, and 3 were >2 SD of the mean on the Tönnis classification (mean age at last follow-up 63.8 months, 95% CI 57.7 to 69.9). Out of the 3 hips that were outside the normal range (within 2 SD of the mean): 1 refused surgery, 1 was referred tertiary centre and there was 1 poor result (subluxation/dislocation of the femoral head). In summary, 96.3% were graded with an acceptable AI (< 2 SD of the mean). In addition, there were 5 hips considered to be poor results as they had residual subluxation/dislocation (6.2%). 7/31 hips (22.5%) redislocated in the closed reduction group and the redislocation rate was 6/48 (12.5%) in the open reduction subset. This was close to the rec-ommended outcome measure as advocated by BSCOS (20% and 10% respectively) [19]. The types of surgical intervention in the 81 hips are illustrated in Table 4.

Avascular necrosis of the femoral head was assessed by the Kalamachi method [18]. There was evidence of AVN in 16 of the 81 hips yielding a rate of 19.8%, (14 K1, 1 K2 and 1 K3).

Discussion

Children presenting before the age of 4 months of age can be considered to be identified from the primary DDH screening

programme (neonatal hip abnor-mality, GP referrals and 'at risk' DDH hip screening) [20]. The current hip screening policy in England is of limited value and is at best a surveillance method as the results of late dislocation are no better than those published 20 years ago despite the addition of clinical/ sonographic screening for 'at risk' and neonatal instability [21].

Forty two percent of the surgical cases were diagnosed at < 4 months of age. This is a higher rate than in the study reported by Sanghrajka et al from a ter-tiary centre [22]. This difference may be explained by the fact that our centre is a sub-regional teaching hospital with an established DDH sonographic surveil-lance programme (neonatal & 'at risk' hips). The issue of failure of the Pavlik Harness to successfully treat pathological DDH has been previously noted in the literature [23, 24, 25, 26]. 17 of the 18 cases that were Ortolani/Barlow positive, treated in the Pavlik harness unsuccessfully were female, at variance to the overall female to male ratio in the study of 5:1 (Table 1). However, <50% of the hips required an open reduction or pelvic osteotomy. This gender difference may be due to maternal hormone effects that may affect the hips joints of neonatal females differently than in males, increasing the risk of hip persistent joint instability progressing to irreducibility [27].

There is a tendency to less invasive surgical procedures in those diagnosed early compared to those presenting 'late' (Table 4). Nearly 60% of the surgical cases diagnosed >4 months of age required complex surgical intervention. The age of diagnosis in the 'late' group was similar to other series [22].

Higher grades of hip pathology are associated with later age of diagnosis and more likely to require open reduction, femoral osteotomy and pelvic osteotomy (Table 3 and Figure 2). Conversely, some lower grades of DDH (IHDI Grade II) diagnosed in the neonatal and early infancy, may require complex surgical intervention. Open reduction and pelvic osteotomies were necessary to main-tain a congruent joint and treat acetabular dysplasia (Table 3). Early open re-duction at 10 to 14 months of age can be associated with residual hip dysplasia required a later pelvic osteotomy in 44% percent of cases. This mirrors previous studies [28]. Femoral osteotomy is less likely in IDHI Grade II hips com-pared with IDHI Grades II & IV and in early compared with late diagnosis (Tables 3 and 4).

Most cases diagnosed with AVN of the femoral head secondary to surgical in-tervention were minor in type and the rate was consistent with previous literature [29].

A small sub-group of 9 cases presented late with moderate to severe acetabular dysplasia without dislocation (Figure 3). These cases were not identified from the neonatal or at risk DDH screening programme and presented late in infancy or as a young child. These cases often required complex surgical hip joint reconstructions due to the degree of acetabular deficiency and presence of subluxation of the femoral head.

The overall results from this study compare favourably with the British Society for Children's Orthopaedic Surgery (BSCOS) DDH operative national standards [19].

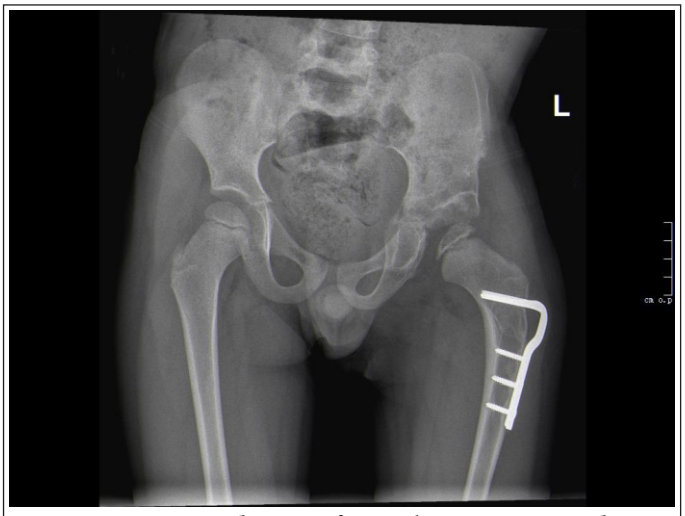

Figure 2: Open reduction femoral osteotomy and peri-acetabular osteotomy left hip.

Figure 3: Late presenting dysplasia with subluxation of the left hip.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed. **Conflict of interest:** Nil; **Source of support:** None

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