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# Outcome of Triple Procedure in Older Children with Developmental Dysplasia of Hip (DDH)

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## Abstract

**Objective:** To evaluate the radiographic and functional results of the triple procedure (open reduction, femoral shortening and Salter's Osteotomy) in the treatment of Developmental Dysplasia of the Hip (DDH) disease in older children.

**Methods:** This case-series comprising 23 patients (29 hips) underwent the triple procedure of open reduction, femoral shortening and Salter osteotomy, at Aga Khan University Hospital between June 1995 and June 2005. Patients were classified pre-operatively according to the Tonnis class. Postoperative functional evaluation was performed using Modified MacKay's scoring system and radiographic assessment using Severin's scoring method.

**Results:** The mean age of patients at presentation was 6.84 years and the average follow-up was 19.6 months. The MacKay score was 'Good' to 'Excellent' in 25 hips; we had a failure in 1 hip joint. The Severin's class was I in 15 (51.7%) hips at the time of final evaluation as compared to none at the time of presentation. Patients younger than 5.6 years of age had a better radiological and clinical outcome as compared to older patients (p-value < 0.05).

**Conclusions:** The triple procedure of open reduction, femoral shortening and Salter osteotomy gives best results in younger children. Early diagnosis and intervention is therefore imperative in the successful treatment of patients suffering from DDH (JPMA 57:591;2007).

## Introduction

Developmental Dysplasia of hip (DDH) is relatively rare in the developed world due to a well-functioning neonatal screening procedure.<sup>1</sup> However it is not uncommon to see an older child who has untreated DDH in our current clinical practice. Tertiary level care and proper screening programmes are lacking in many parts of the country and along the adjoining war-torn country of Afghanistan. Most of the patients from these areas are older children whose parents spend a lot of time and effort in gathering necessary resources to travel to any big hospital.

Treatment of DDH varies with the age of patient.<sup>2</sup> The principles of treatment of dislocated hip joint for an older child are quite different from that of a neonate.<sup>3</sup> As the

patient enters walking age and beyond, treatment becomes problematic and controversial.<sup>4-6</sup> This is because contractures of the capsule and musculotendinous structures surrounding the hip joint prevent reduction of the femoral head into the acetabulum, and may produce pressure on the femoral head during or after reduction, leading to ischaemia.<sup>7-9</sup> Left untreated these dysplastic changes lead to osteoarthritis in early adulthood.<sup>10</sup>

Traction has been used before reduction of a dislocated hip to reduce the prevalence of ischaemia of the femoral head but data supporting use of this treatment is inconsistent.<sup>4-6,11</sup> Closed or open reduction without a bony realignment procedure is associated with residual dysplasia.<sup>12,13</sup> Femoral shortening has been used to facilitate reduction and reduces the risk of

osteonecrosis.<sup>6,14,15</sup> Many authors have reported success with a single-stage procedure consisting of open reduction, capsulorrhaphy, femoral shortening and pelvic osteotomy.<sup>14,16-20</sup> We aim to evaluate the radiographic and functional results of triple procedure of open reduction, femoral shortening and Salter osteotomy in 23 patients (29 hips) with delayed diagnosis of DDH who were treated at our hospital.

### Patients and Methods

The study design was a retrospective case series, which included 23 patients with a total of 29 hip joints with DDH and all above 18 months of age. Patients with known neuromuscular and chromosomal disorders and those with prior surgical procedures of a pelvic or a femoral osteotomy was excluded. All patients had a minimum of one year of follow-up.

Clinical data regarding pain symptoms, gait pattern, range of hip joint motion and status of Trendelenburg sign were recorded for each patient pre-operatively and on the latest follow-up using the modified McKay's criteria.<sup>21</sup> Tonnis classification system was used to assess the degree of dislocation of the femoral head.<sup>22</sup> Radiographic evaluations included examination of preoperative and follow up plain radiographs to classify patients according to the Severin's grading system.<sup>23</sup> Avascular necrosis was assessed using Bucholz and Ogden's classification.<sup>24</sup>

We followed the recommendations of Salter and Dubos<sup>5</sup> for the innominate osteotomy surgical technique and the femoral osteotomy was similar to that described by Predrag Klisic.<sup>25</sup> The operative procedure started with the Smith Petterson approach followed by release of iliopsoas, excision of pulvinar, release of ligamentum teres, and incision of transverse acetabular ligament. Adductor tenotomy was done through a small separate incision before this procedure. Redundant capsule was excised when necessary and capsulorrhaphy performed with interrupted absorbable sutures. Shortening of the femur was accomplished at the intertrochanteric region through a separate straight mid-lateral incision. The first cut in the femur was followed by open reduction. The amount of overlap in the femur was evaluated to determine the amount of femoral shaft to be resected. The osteotomy was then fixed with a four-hole plate. A derotation component was added to the osteotomy at the time of surgery. A pelvic osteotomy was performed as described by Salter using a Gigli saw. Fixation of this osteotomy was done with two K-wires.

Post-operatively, the hips were immobilized in a 1 ½ hip spica for 6-8 weeks. This was changed to an abduction splint for a further 4 weeks during which time the hips were

mobilized progressively under the guidance of a physiotherapist. Progressive walking and gradual range of motion exercises were advised. Kirschner wires were removed after consolidation of the osteotomy site. Patients with bilateral dysplasia had the procedures on both hips at a mean interval of 5.3 months (range 4 to 9 months).

A standardized pre-coded questionnaire was designed to collect the aforementioned clinical and radiological data. The data was then entered into Microsoft Excel 2000 and imported into SPSS version 13.0 for further analysis. Frequencies, percentages, means and standard deviations were computed where appropriate. To determine factors for better outcomes, we divided our patients into two groups: Group A Severin Stage change of 1 or less and Group B - Severin Stage change of 2 or more (better outcome group). Student's t-test was used to compare continuous variables between these groups. Chi-square test or the Fisher's exact test where numbers were low was employed for categorical variables. A double-sided p-value of less than 0.05 was considered statistically significant.

### Results

There were a total of 23 patients and a total of 29 hip repairs. Seven (24.1%) were males while 16 (55.2%) were females. The mean age of the patients at the time of operation was 6.84 ± 4.5 years (Range 1.5-17 years). The mean follow-up was 29.6 ± 10 months.

According to Tonnis classification of the degree of dislocation severity (pre-operatively), there were 5 patients (17.2%) in Grade 1, 13 (44.8%) in Grade 2 and 11 (27.9%) in Grade 3.

The average acetabular index was 23 degrees ± 4.1degrees; it decreased pre-operatively from 43 degree ± 6.2 degrees to 20 ± 2.8 degrees post-operatively. The average post-operative central-edge angle was 24 degrees (Range 21 - 28).

Table 1 and Table 2 show the pre-operative and post-

**Table 1. Results according to Severin's classification of congruity.**

Severin		Pre-op (n)	Pre-op (%)	Post-op (n)	Post-op (%)
I	Ia			11	37.9
	Ib			4	13.8
II	IIa			4	13.8
	IIb				
III				5	17.2
IV	IVa	1	3.4	4	13.8
	IVb	13	44.8	1	3.4
V		15	51.7		
VI					
<b>Total</b>		<b>29</b>	<b>100</b>	<b>29</b>	<b>100</b>

**Table 2. Results according to McKay's criteria for clinical evaluation.**

McKay <sup>1</sup>	Pre-op (n)	Pre-op (%)	Post-op (n)	Post-op (%)
Excellent			11	37.9
Good			14	48.3
Fair	22	75.9	3	10.3
Poor	7	24.1	1	3.4
<b>Total</b>	<b>29</b>	<b>100</b>	<b>29</b>	<b>100</b>

<sup>1</sup>Excellent - Stable painless hip; no limp; negative Trendelenburg sign; full range of motion; Good - Stable painless hip; slight limp; slight decrease in range of motion; Fair - Stable painless hip; limp, positive Trendelenburg sign and limited range of motion or a combination of these; Poor - Unstable or painful hip or both; positive Trendelenburg sign



Figure 1A.



Figure 1B.



Figure 1C.



Figure 1D.

operative distribution of patients according to radiological (Severin's criteria) and clinical (McKay's criteria) criteria respectively.

One hip developed avascular necrosis (grade III) following treatment.

The criteria described by Severin commonly are used to assess the radiographic end results after treatment of congenital dislocation of the hip. Fifteen (51.7%) patients were Severin grade V prior to surgery and 14 (48.2%) were Severin grade IV. Post-operatively none of the patients were Severin grade V, 5 (17.2%) were Severin grade IV, 5 (17.2%) were Severin grade III, 4(13.8%) were Severin grade II and 15 (51.7%) were Severin grade I. The clinical results according to Mackay's scoring system were also favourable. At pre-operative evaluation, 22 hips (75.9%) were in fair condition and 7 hips (24.1%) were in poor condition. At the end of the study there were 11 hips (37.9%) in excellent condition, 14 (48.3%) in good

condition, 3 (13.8%) in fair condition and 1(3.4%) in poor condition. In our subset of patients, no advancement in the Severin's stage was noted.

To see if any factors influence the outcome, we arbitrarily divided patients into two groups: Group A - Stage change of 1 or less and Group B - Stage change of 2 or more. Using chi-square's test for categorical variables and Fisher's test where numbers were low, we found no significant differences in the pre-op McKay and Tonnis grade between the two groups. However, using independent samples t-test, there was a statistically significant difference (p-value - 0.014) between the mean ages of the two groups i.e. patients who had better outcomes were younger (5.6 3.6 years) as opposed to patients who had poorer outcomes (10.1 5.3 years).

In the multivariate analysis, we used pre-operative variables that had p-values of less than 0.25. Age was still a statistically significant predictor of outcomes in our subset of patients (p-value - 0.04).

## Discussion

The primary goal of treatment of congenital dislocation of hip is concentric reduction. Failure to treat at early age may lead to gait abnormalities, limitation of motion of the hip, joint pain and osteoarthritis at an earlier age. However, the age beyond which surgical treatment is contraindicated has been the subject of debate due to the risk of serious complications. Concentric reduction in older children may be a challenge more so when the femoral head is flattened or when the acetabulum is dysplastic. Reduction may be hindered by soft tissue contracture with undue pressure on the femoral head. This may result in poor development of hip joint and avascular necrosis of the femoral head. Femoral shortening has been shown to facilitate reduction in children who are more than three years old.<sup>6,14</sup> It was concluded that a one-stage operation consisting of open reduction, femoral shortening, and correction of an acetabular deficiency with the appropriate pelvic osteotomy is the best option.<sup>15</sup>

There have been numerous reports discussing the merits of a more aggressive surgical approach that includes a single procedure combining an open reduction with a femoral or pelvic osteotomy. Galpin et al<sup>15</sup> have reported 75-85% of satisfactory results both radiologically and clinically. Haidar<sup>26</sup> et al had excellent to good clinical and radiological results in 97.3% and 83.8% of patients, respectively, while Salter and Dubos had results showing 93.6% of good to excellent results in children of younger age group.<sup>5</sup> In a study on 10 hips in older patients with mean age of 6.18 ± 1.13 years, Bhatti et. al experienced excellent to good functional results in 70% hips and fair in 30% hips

using open reduction, femoral shortening, varus derotation and pelvic osteotomy (when required), with no post-operative complications such as avascular necrosis, septic arthritis or sciatic nerve palsy.<sup>27</sup>

We reviewed the results of the Salter's osteotomy for treatment of DDH in 29 hips treated after 18 months of age. Salter's osteotomy was found to be useful for stabilizing openly reduced hips. The results of our study showed a significant improvement in the radiological features of the operated hip joints according to Severin's classification. At follow up, none of the patients had grade V severity compared to 51% of hips prior to surgery and only 17% of hips had Severin grade IV severity compared to 48% before surgery. Notably, 51% of hips achieved an improvement of grade I at follow up compared to none before surgery. Similarly, favourable results were also observed when clinical parameters were compared before and after surgery. Thus, at follow up, excellent results were noted in 38% of hips compared to none before surgery. Also, only 1(3%) hip joint demonstrated poor condition at follow up compared to 7(24%) before surgery. The clinical stage had not advanced in any hip.

There seems to be conflicting reports regarding the final outcome when different surgical procedures were used in children with DDH at different age groups. Thus, in a series of 25 hips with an average age of 6 years and four months, open reduction and femoral shortening resulted in good to excellent results at a follow up of 10 years.<sup>25</sup> However, in another review article majority of children with DDH after the age of 3 years treated with open reduction and femoral shortening required revision surgery because of subluxation and ended in poor results. In the same article, majority of the patients treated by triple procedure showed good to excellent results both clinically and radiologically.<sup>26</sup> Our results clearly showed that the final outcome of triple procedure is greatly influenced by the age of the child at the time of the treatment as assessed by the radiographic analysis at the latest follow-up examination. Thus, younger children ( $5.6 \pm 3.6$  years) presented with better outcomes as opposed to older children ( $10.1 \pm 5.3$  years) who had poorer outcomes. It is important that children with DDH should be diagnosed early and treated with triple procedure for long-term satisfactory results.

Avascular necrosis (AVN) and posterior subluxation/dislocation are well-known and serious complications following surgical treatment of DDH in this age group.<sup>28</sup> In our study, we observed myositis in one patient who underwent the triple procedure. The same patient later on developed AVN of the head of the femur.

This study demonstrates our experience with Salter's osteotomy for DDH in children of more than 18 months of

age. Although this is a retrospective study with a small sample size, a younger age at surgery clearly predicts better clinical and radiological outcomes. We did not add a varus component to our femoral osteotomy at the time of femoral shortening. This was based on our own clinical judgment. We cannot however, substantiate this with the measurement of neck shaft angle at the time of final follow-up. Indirect support to this decision of not doing a varus can be seen by the fact that majority of our patients obtained good to excellent scores according to both Severin's and Mackay's scoring systems. A longer duration of follow-up would certainly be necessary to determine the eventual outcome of not adding a varus component to this treatment. This is, in fact, a limitation of the current study.

## Conclusion

Based on our experience we recommend the triple procedure of open reduction, femoral shortening and Salter osteotomy for treatment of DDH in older children.

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