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Therapeutic Outcomes of Salter Osteotomy Vs Varus Derotational having Femoral Shortening in Patients with Developmental Dysplasia of the Hip

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Abstract

Surgical treatment of patients with Developmental Dysplasia of Hip (DDH) always remains controversial in cases with late diagnosis or unsuccessful in nonsurgical treatment. This cross-sectional and retrospective study was conducted on 52 patients aged over 18 months with late diagnosis of DDH. The patients were treated either with Salter osteotomy or Varus derotational with femoral shortening methods. The patients' data were collected from the medical records of the hospital archive and the patients who underwent surgery more than 1 year ago were called to attend the clinic for assessment. For each patient, acetabular index (AI), hip dislocation or subluxation were graded using Tonnis classification and congruity of the hip using Severin classification. The AI score reduction in the Salter osteotomy group was significantly greater than the Varus derotational group. But, in the last clinical evaluation, no significant difference between the distribution of patients according to the Tonnis classification was found. In general, the prevalence of complications in Salter group was statistically higher. No statistical difference was evidenced in terms of the distribution of patients according to the disease class and Severin classification after treatment. Finally, both approaches could be useful and safe for the treatment of children with DDH with late diagnosis.

Introduction:

Developmental Dysplasia of Hip (DDH) presents a range of abnormal developmental disorders of the hip, which may appear at any time such as at embryonic course, infancy, or childhood. In all the cases, Surface acetabulum, subluxation, or dislocation are seen. The prevalence of hip instability is 10 per 1,000 live births, of which 80% are female (Harris, 1986). The exact cause of DDH is still not clear, but certain factors such as sex, birth order, family history, intrauterine placement, type of delivery and joint stiffness are some of the established factors contributing to the development of DDH (USPSTF, 2006; Sionek *et al.*, 2008; Stein-Zamir *et al.*, 2008; Wynne-Davies, 1970; Dezateux & Rosendahl, 2007; AAOP, 2000). Usually, the DDH in the left side is 3 times more common than the right side, most likely due to the normal anterior position of the left oxypot in the uterus, leaving the left hip joint in front of the mother's back and away from its range (AAOP, 2000). Treatment for

this complication should begin immediately after diagnosis which varies as per the age and extent of dysplasia. The purpose of the treatment is to access and maintain the proper position of the hip joint in order to improve its normal development (Dezateux & Rosendahl, 2007; French & Dietz, 1999; Pemberton, 1974; Millis *et al.*, 1994). A late diagnosis of DDH can lead to lameness and toe walking (Elbourne *et al.*, 2002; Gray *et al.*, 2005).

The most important issue in patients with DDH is to achieve a stable reduction (Karakurt *et al.*, 2004). For the treatment of DDH after 18 months of age, varus derotational osteotomy with femoral shortening or hip osteotomy with open reduction is prescribed (Spence *et al.*, 2009). Selection of appropriate acetabular osteotomy is depended on age, pathological anatomy of the acetabulum, proximal femoral neck and surgeons' experience (Pemberton PA, 1974; Millis *et al.*, 1994). Pemberton and Salter osteotomy are the most common hip osteotomy (Pemberton, 1974; Millis *et al.*, 1994; Gray *et al.*, 2005;

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Faciszewski *et al.*, 1993; Harcke & Kumar, 1991; Clarke *et al.*, 1989; Utterback & MacEwen, 1974). Surgical treatment of patients with DDH has always been controversial due to its late diagnosis or unsuccessful in nonsurgical treatment (Subasi *et al.*, 2008). Simultaneous open reduction and femoral shortening are appropriate therapies for such patients (Subasi *et al.*, 2008; Vallamshetla *et al.*, 2006; Karski, 1982; Wenger *et al.*, 1995). Acetabular dysplasia is another problem in treating these patients that can be corrected by hip osteotomy (Nakamura *et al.*, 2004; Danielsson, 2000). In Iran, common surgery and treatment is open reduction and Salter osteotomy. On the other hand, varus derotational with femoral shortening is an easy and reliable treatment. Performing hip osteotomy with varus derotational can lead to hip dislocation, which is why it is not recommended to do it together (Kelly, 2013). This study aimed was a comparison of therapeutic and radiographic results of Salter osteotomy and Varus derotational with femoral shortening method in patients with DDH.

Methodology:

It is a cross-sectional, retrospective study conducted on 52 patients aged over 18 months with DDH that were late diagnosed. After the diagnosis of DDH, patients were surgically treated by a candidate orthopedic surgeon. Subjects were treated with one of the Salter or varus derotational with femoral shortening methods in Ahvaz Imam Khomeini Hospital during spring 2015 to spring 2018. After extracting patient information from the records in the hospital archives, patients who had undergone surgery for at least 1 year earlier were called to attend the clinic. All patients were evaluated by an orthopedic specialist in terms of clinical and radiographic examinations. The patients under study group-1 included 30 patients (patients underwent surgery with Salter's osteotomy method) and group-2 of 22 patients (patients underwent surgery with varus derotational with femoral shortening). In all patients in group 2, along with pelvic reduction, varus derotational with femoral shortening was performed. Open reduction was performed via Iliofemoral approach. After performing open reduction, in the case of front dislocation in the extension of the thigh, varus derotational and femoral shortening and capsulorrhaphy were performed. The level of varus and femoral shortening was that where the femoral head was completely located in the acetabulum without pressure. After the operation, femur spica cast was taken and after 6 weeks, the spica cast was removed and the casting was performed in the abduction and inner thoracic rotation and maintained for another 6 weeks. Before and after surgery, the patient had a radiograph of the hip joint. Patients were in a complete union and full weight bearing, until complete removal of plaster, and then were followed up. In patients with bilateral dislocation, the second operation was performed at the earliest possible time (from 3 weeks after the first operation to 3 months later). Photos

before and after surgery (after removal of the plaster) were evaluated for the degree of change in the acetabular index (AI) and the degree of congruency of the joint. In addition, for the latest evaluations, patients were asked for attending the clinic, and their current status was evaluated clinically and radiographically. All patients were examined clinically and according to McKay (1974) criteria for the presence of hip pain, lameness, hip range, and the presence or absence of a Trendelenburg sign, during the surgical procedure through the information contained in the case and at the time of the last visit. The pre-operative graphs were available for all patients. For each patient, the AI, hip dislocation or subluxation were graded using Tonnis (1976) classification and congruity of the hip using Schramm *et al.*, (2004) classification. To determine the AI and dislocation of the hip joint, the Tonnis grading system was used to evaluate the post-operative graph. Treatment outcomes were evaluated based on radiographic findings using Schramm classification method. In order to know the presence of femoral head avascular necrosis according to the classification criteria of Kalamchi & MacEwen (1980) during the follow-up, all of the patients' existing graphs were evaluated and the results were recorded. Other complications of patients were also recorded if they were present. At the last time of follow-up, patients were evaluated with McKay (1974) clinical criteria.

Clinical evaluation of patients was performed as follows:

Excellent: stable joint, painless, no lameness, negative Trendelenburg marker, & complete joint movements
Good: stable joint, painless, low lameness and a brief reduction in joint movements
Fair: stable joint, painless, Trendelenburg positive & limited joint movements
Poor: unstable joint with or without pain & Trendelenburg positive sign.

Inclusion criteria included patients aged 18 months and under 8 years old, AI higher than 30, and patients who failed non-surgical treatment. Exclusion criteria included patients with connective tissue disease, low acetabulum volume, unsuccessful surgery history, paralysis disorders, congenital teratology dysplasia, dislocation caused by impact and septic arthritis. Finally, the differences between clinical and radiographic parameters were compared. The data were analyzed by SPSS software version 22 with significance level lower than 0.05 ($p < 0.05$).

Results:

Fifty two patients including 62 eligible hip joints were included in this study, who underwent osteotomy surgery with Salter ($n = 30$) (hip = 36) and varus derotational ($n = 22$) (hip = 26) method. No significant difference between the mean age of the patients in the two surgical procedures was evidenced. Although in both groups there were more females than males, there was no significant difference between gender distribution in the two groups. The

involved side was more closely related to the left side, but statistically, the distribution of patients in terms of position did not differ regarding. In patients with bilateral involvement, both hip joints were treated with a similar surgical procedure according to the timetable considered by the surgeon with a time interval from the side joint surgery. There was no statistically significant difference between the mean time of the follow-up in the two groups (from surgery to last assessment; Table 1).

These studies are presented in the following table.

Table-1: Demographic and clinical characteristics of the study population

Variable	Salter method (n=30)	Varus Derotational(n=22)	p-value
Age (year) (Mean±SD)	2.12±0.88	3.05±1.01	>0.068
Gender			
Female	24 (66.67%)	17 (65.38%)	>0.62
male	12 (33.33%)	9 (34.62%)	
Involved side			
Left	21 (58.33%)	16 (61.54%)	>0.21
Both	9 (25%)	6 (23.8%)	
Right	6 (16.67%)	4 (15.38%)	
Time of followup (month) (Mean±SD)	18.72±6.12	19.90±5.52	>0.11

The mean scores of the AI before and after surgery were statistically decreased in both groups. There was a significant difference between the mean of the AI in the two groups *i.e.*, the decrease in the score in the Salter-treated group was statistically more than that in varus derotational group (Table 2).

Conclusively, the overall review reveals that various factors are involved in the emergence of this type of anxiety such as the role of librarians, library space, information seeking and notification. More accurate studies in the future are necessary to take positive and important steps in order to eliminate the factors involved in the emergence of library anxiety and the role of librarians in its reduction.

Table-2: Comparison of pre- & post-surgery values of acetabular index (AI) in two groups.

Groups (AI)	Before	After	p value	Mean diff.	p value
Salter	41.12±3.05 (18 - 32)	20.61±3.92 (36 - 45)	<0.0001	17.09±3.82	<0.011
Varus Derotational	39.47±2.16 (34 - 46)	22.70±3.08 (20 - 33)	<0.0001	15.09±3.82	

Patients in both groups were in fair and poor classes before surgery and there was no significant difference in their placement in each of the classes. After treatment and during the last clinical evaluation, most of the patients were in excellent and good classes. Although the percentage of patients treated with varus derotational in the excellent class was higher, in general, there was no statistically significant difference in their placement in each of the classes, and there was a clinically acceptable advancement in patient improvement (Table 3).

After surgery, the results obtained from Tonnis grading

showed statistically and clinically significant improvements in the stability and congruency of femoral head and acetabulum in terms of hip joint dislocation and lateral subluxation compared to preoperative in both groups, but they didn't differ statistically (Table 4).

Table-3: Comparison of clinical outcomes based on McKay scale in two groups

Grade	Before surgery (%)		Post'surgery (%)	
	Salter	Varus	Salter	Varus
Excellent	-	-	24 (66.67%)	19 (73.08%)
Good	-	-	8 (22.22%)	5 (19.23%)
Fair	24 (66.67%)	16 (61.54%)	2 (5.56%)	1 (3.85%)
Poor	12 (33.33%)	10 (38.46%)	2 (5.56%)	1 (3.85%)
P-value	>0.52		>0.088	

Table-4: Comparison of pre- and post-surgery of congruency of femoral head and acetabulum in two groups

Group	Grade	Pre surgery	Post surgery	P-value
Salter	Class I	-	30 (83.33%)	>0.62
	Class II	-	3 (8.33%)	
	Class III	20 (55.56%)	2 (5.56%)	
	Class IV	16 (44.44%)	1 (2.78%)	
Varus	Class I	-	21 (80.77%)	
Derotational	Class II	-	3 (11.54%)	
	Class III	17 (65.38%)	1 (3.85%)	
	Class IV	9 (34.62%)	1 (3.85%)	

In general, the prevalence of complications in Salter group was statistically higher. In the group treated with Salter's osteotomy method, there was leg length discrepancy on the side under surgery with a healthy side in 3 patients, which was measured in 2 patients at about 1 cm, and in 1 other the limb shortening was measured at the side under operation to be 2.5 cm, who also had gait abnormality and lameness during walking. It should be noted that all patients with complications were girls (Table 5).

Table-5: Comparison of post-surgery complications between two groups

Complication	Salter	Varus
AVN	2 (5.56%)	1 (3.85%)
Infection	0 (0%)	0 (0%)
LLD	3 (8.33%)	0 (0%)
p-value	<0.041	

Both groups showed significantly improvement after the surgery. Before treatment, in both groups, all patients were divided into two of Class IVb and Class V. The number of patients in Class IVb was higher, but the two groups did not have a significant difference in terms of distribution according to the disease class and Severin classification. In both groups, post-treatment evaluations based on the obtained graphs during the final examination reported the highest number of patients in Class Ia, but in general, there was no statistically significant difference in terms of the distribution of patients according to the disease class and Severin classification (Table 6).

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Table-6: Comparison of pre- and post-surgery of patients distribution according to Severin scale.

Grade	Pre surgery N (%)		Post Surgery N (%)	
	Salter	Varus	Salter	Varus
Class Ia	-	-	26 (72.22%)	20 (76.92%)
Class Ib	-	-	7 (19.44%)	3 (11.54%)
Class II	-	-	2 (5.56%)	2 (7.69%)
Class IVa	-	-	1 (2.76%)	1 (3.85%)
Class IVb	25 (69.44%)	17 (65.38%)	-	-
Class V	11 (30.56%)	9 (34.62%)	-	-
P-Value	>0.22		>0.45	

Discussion:

In the present study, there was a significant difference between the mean scores of the AI before and after the operation groups, which evidenced the score of the AI decreased significantly after surgery. There was a significant difference between the mean of the AI in the two groups which shows that the decrease of this index in the Salter group was significantly higher than that in the Varus Derotational group. Spence *et al.* (2009) compared the results of osteotomy varus derotational and innominate and femoral osteotomy during the 2.6 years of follow-up and found AI improved after osteotomy in both groups, although they identified the Acetabular reconstruction with open reduction and innominate and femoral osteotomy to be more effective in reducing acetabular dysplasia and maintaining hip resistance than the open reduction and varus derotational methods. In the study of Ünsal *et al.* (2015) the mean scores of AI after Salter's surgery in the last follow-up were 18.5 (10-30) degrees, which was close to that found in the present study. Patients in both groups before and after surgery were placed in the fair and poor classes after treatment, and most of the patients were in the excellent and good classes at the McKay criteria and there was a clinically acceptable improvement in both groups. In their study, Salter's treatment in the last follow-up consisted of 22 excellent hips (49%), 17 good hips (38%), and 4 satisfactory hips (9.88%), however, our study reported better results. Nakamura *et al.* (2004) reviewed the long-term results of the combination of open reduction and varus derotational with femoral shortening in patients with DDH. Based on McKay's criteria, 73% of patients had good and excellent results, which was lower than the present study (92.31%). The reason for this difference can be due to a longer follow-up period in their study. In the present study, postoperative results showed statistically and clinically significant improvement in the stability and congruency of the femoral head and Acetabulum compared to the preoperative according to Tonnis classification in both Salter and Varus Derotational groups. The incidence of complications including femoral head avascular necrosis, infection, and leg length discrepancy was significantly higher in the Salter-treated group. Before treatment, according to Severin classification, all patients

were in Class IIb and Class V in both groups, and in the last follow-up, the highest number of patients in both groups was in Class Ia. The study by Lehman & Grogan (1985) compared the Varus Derotational Osteotomy and Innominate and Femoral Osteotomy methods in treating DDH. Patients in the Innominate and Femoral Osteotomy group showed a weaker long-term outcome (33% radiographic improvement and 50% improvement in joint development) than those in the Osteotomy Varus Derotational group (55.6% radiographic improvement and 38.5% improvement in joint development). In the study of Nakamura *et al.* (2004) radiographic findings in patients treated with varus derotational with femoral shortening were based on Severin's method for long-term follow-up (45%), which were lower than the present study (76.92%), and this difference may be due to a longer follow-up period in their study.

Conclusively, as per our results, the mean AI was lower than in the Salter-treated group and the incidence of complications in the two treated group was less than that in varus derotational group, but there were no statistical differences between the two groups in terms of other clinical and radiographic evaluations. An important finding in the varus derotational group was the decrease of varus in the femur. After device removal from the site of the osteotomy, a decrease in the varus level in the femur was observed, which led to improved quality of walking in patients. It could be recommended that both the treatments can be useful and safe for the treatment of children with DDH with late diagnosis and are not significantly forego to each other.

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