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Original Article

The effect of transfixing the hip with Kirschner wire during the operative treatment of hip dysplasia in children after the walking age

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ABSTRACT

Introduction: Transfixing the hip joint during operative treatment of DDH is sometimes necessary.

Material and methods: This study included 30 patients presenting with DDH after the walking age divided into two groups; group 1, the hip joint was transfixed with K-wire. Group 2 no k-wire transfixion.

Results: At mean follow up duration of 30 months. Satisfactory results were obtained in 13 patients in group 1, and 14 patients for group 2. The final radiological results for both groups were satisfactory in 14 patients.

Conclusion: Femoral head transfixing with Kirschner wire has no effect on the final results.

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1. Introduction

The treatment of developmental dysplasia of the hip (DDH) after the walking age group is usually surgical due to the fact that the pathological changes present at this age are so severe to the extent that makes closed reduction very difficult, moreover the force needed might lead to avascular necrosis of the femoral head or redislocation. These pathological changes include severe contracture of the soft tissues around the hip, increased shallowness of the acetabulum, excessive femoral anteversion, hypertrophied inverted labrum, excessive pulvinar, and maldirected acetabulum. This has led many authors to recommend open reduction in this age group.¹

Open reduction is indicated when the femoral head persistently lies above the triradiate cartilage, the arc of reduction redislocation is less than 25° after adductor tenotomy, and if adductor tenotomy fails to bring the femoral head fully inside the acetabulum. Finally, if previous closed reduction has failed.²

The goal of open reduction is to safely reduce the dislocated hip and to surgically recreate normal anatomy. Early restoration of the normal hip biomechanics might halt the progression of degenerative hip disease. To achieve these goals various pelvic osteotomies has long been used. Reshaping osteotomies have been used, such as the Pemberton and Dega osteotomies. Redirectional osteotomies,

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including the single innominate Salter osteotomy and the triple innominate Steel osteotomy. Finally salvage procedures when the joint is irreducible and painful such as Chiari and shelf operations.^{3,4}

Concurrent primary femoral shortening is nearly always necessary in severe cases with a high dislocation rate before open reduction to allow gentle reduction and avoid pressure on the head. Varus and derotational osteotomies are less required as the acetabular dysplasia is more common.⁵

Transfixing the femoral head with Kirschner wire during open reduction has long been thought to provide stability to the hip without damaging the femoral head or the acetabulum. The aim of this work was to assess the effect of transfixing the hip with Kirschner wire during the operative treatment of hip dysplasia in children after the walking age on the final radiological and the clinical results.

2. Patients and methods

This study included thirty patients with typical presentation of DDH after the walking age. The patients were divided into two equal groups with 15 involved hips in each one. **Group 1;** (13 females and 2 males). The right hip was involved in 8 cases (53.3%), while the left in 7 (46.6%). The ages ranged from 18 months to 60 months with an average of 31 months. All hips had a grade 4 dislocation with the Ossification center above the superior acetabular rim according to Tönnis classification⁵ **Group 2;** (10 females and 5 males). The right hip was involved in 6 cases (40%), while the left in 9 cases (60%). The youngest age was 18 months and the oldest was 96 months with an average of 33.5 months.

All patients in this study were subjected to clinical examination preoperatively and at the end of follow up. Clinical evaluation of patients was done according to a combination of modified MacKay criteria and modified Harris hip score [Table 1].^{6,7} The overall clinical result is considered satisfactory when the final score is excellent (91–100) or good (81–90) and unsatisfactory when the score is either fair (71–80) or poor (Less than 70).

Antero-posterior radiographs were used to measure the acetabular index (AI) and the center-edge angle (CEA) preoperatively, post-operatively and at the end of follow up. Changes in the femoral head as regards sphericity and the radiodensity were also assessed. Values of the acetabular index greater than 30° were considered abnormal and indicative of impending dislocation. All patients in this study had an acetabular index above 30 degrees which were considered abnormal. The average acetabular index preoperatively was $43 \pm 2^\circ$ (ranging from 38° to 45°) and 43 ± 5 degrees (ranging from 40° to 45°) in group 1 and 2 respectively. All hips in this work had negative CEA preoperatively, except one hip in group 2 whose CE angle was 10° preoperatively. Radiological evaluation at the end of follow up was done according to the modified Severin radiographic criteria Table 2.⁸

All patients in this study were subjected to one-stage operative treatment in the form of: open reduction, Salter osteotomy and femoral varus derotation and shortening. Followed by a period of immobilization in a hip spica cast for about 2 months. The plan of treatment in this work was based

Table 1 – Modified MacKay criteria and modified Harris hip score.

Pain	
No pain	40
Mild pain, no effect on ordinary activities	30
Moderate pain, moderate limitation of ordinary activities	20
Severe pain, severe limitation of ordinary activities	10
Pain at rest	0
Limp	
No	10
Limp	0
Trendelenburg sign	
Absent	10
Present	0
Stability of the hip in the supine position	
Stable	10
Unstable	0
Deformity	
Absence of deformity	10
Presence of deformity where any of the following is present:	0
More than 30° fixed flexion deformity.	
More than 10° fixed adduction contracture.	
More than 10° fixed internal rotation in extension.	
Limb length discrepancy more than 2 cm.	
The range of motion	
Full range	20
Mild limitation	15
Moderate limitation	10
Severe limitation	0

The range of motion is calculated according to the following

	Arc of motion	Index	Maximum possible
Flexion	0–45° (45°)	1.0	45
	45–90° (45)	0.6	27
	90–110° (20°)	0.3	6
	110–130° (20°)	0.0	0
Abduction	0–15° (15°)	0.8	12
	15–20 (5)	0.3	1.5
	20–45 (25)	0.0	0
External rotation	0–15	0.4	6
	Over 15°	0.0	0
Internal rotation	Any	0.0	0
Adduction	0–15	0.2	3
	Over 15	0.0	0
Extension	Any	0.0	0

Total maximum possible value = 100.5

Overall range of motion = Total maximum possible value × 0.05

Overall range of motion = 5 → full range of motion, 4–<5 → mild limitation, 3–<4 → moderate limitation, finally 2–<3 → severe limitation.

Table 2 – Modified Severin radiographic criteria.

Class I (excellent)	Normal hip with a center-edge angle >25°
Class II (good)	Concentric reduction, abnormal shape of head, neck or acetabulum with CEA >25°
Class III (fair)	Dysplastic hip with maldeveloped acetabulum roof. CEA <20°, no subluxation
Class IV (poor)	Subluxation (femoral head displaced cranially and laterally)
Class V (poor)	Femoral head articulates with a false acetabulum
Class VI (poor)	Complete redislocation

on the preoperative clinical and imaging findings, together with intra-operative findings. In group 1, the femoral heads were transfixated into the acetabulum by a Kirschner wire, while in group 2 the same procedure was done without transfixing the femoral head to the acetabulum.

The plan of treatment in this study was based on the preoperative clinical and imaging findings, together with intra-operative findings. In group 1, the femoral heads were transfixated into the acetabulum by a Kirschner wire. All the procedures were done by the same surgical team, in the same hospital.

2.1. Surgical techniques

All operations were done under general anesthesia. Adductor tenotomy was done as a first step in all patients (Fig. 1A). Open reduction was done through a curved antero-lateral incision starting at the middle of the iliac crest 1 cm below it and extended anterior, inferior and medially upto a point where the anterior superior iliac spine become centered midway in the incision, it was done in all patients in this study (Fig. 1B and C). Femoral shortening, varus and derotation osteotomy was done through a separate lateral femoral incision and was internally fixed with a small fragment dynamic compression plate in all patients (Fig. 2).

All patients in this study had a mild to moderate acetabular dysplasia (AI<45°) so that Salter osteotomy was the pelvic osteotomy of choice. It was done through the anterior incision of open reduction. It was completed by a gigli saw and the graft was taken from the iliac crest (Fig. 3A). The grafts were fixed by 2 smooth Kirschner wires (1.2 mm diameter) under image guidance (Fig. 3B and C). These wires were cut and buried under the skin.

A smooth Kirschner wire (1.6 mm) was used to transfix the femoral head into the acetabulum (Figs. 2 and 3). The entry point of this wire was the lateral aspect of the greater trochanter and passes through the neck and the head to the acetabulum under image guidance. This wire was used to transfix the femoral head into the acetabulum in a position of internal rotation before the step of the femoral osteotomy to prevent the external rotation of the proximal segment of the osteotomy with the distal one.

During the Salter osteotomy graft fixation, the femoral head transfixing wire was withdrawn from the acetabulum and the head is dislocated out to allow checking the acetabulum to avoid penetration of the graft fixing wires into the

acetabulum then the wire was introduced again in group 1 patients (15 hips) under image guidance. At the end of the procedure, the transfixing wire was cut and bended about 90° outside the skin.

A small sterile dry dressing was placed between the skin and the bended part of the wire to prevent ulceration and wire migration. Capsuloraphy was done in all cases. After a period of 8–10 weeks, the hip spica cast and Kirschner wires were removed under general anaesthesia. The transfixing wires were removed by rotation and a slight pull to avoid pulling the femoral head outside the acetabulum.

2.2. Method of statistical analysis

Statistical analysis was done using the statistical program for social sciences (SPSS) version 20.

3. Results

The patients were followed both clinically and radiologically for mean duration of 30 months (range from 12 to 60 months). At the end of follow up, final clinical and radiological results were evaluated (Figs. 4 and 5). **The radiological end results** in group 1 were Class I (excellent) in 11 patients (73.3%), Class II (good) in 3 (20%), Class V (poor) in one (6.7%), satisfactory (excellent and good classes) in 14 (93.3%) patients and unsatisfactory in 1 (6.7%) patient. In group 2, they were Class I (excellent) in 10 patients (66.7%), Class II (good) in 4 (26.7%), Class V (poor) in 1 (6.7%), satisfactory (excellent and good) in 14 patients (93.3%) and unsatisfactory (fair) in 1 (6.7%) Table 3.

The overall **final clinical** results in group 1 were excellent in 4 patients (26.7%), good in 9 (60%), fair in 2 (13.3%), satisfactory (excellent and good) in 13 patients (86.7%) and unsatisfactory (fair) in 2 patients (13.3%), in group 2, they were excellent in 6 patients (40%), good in 8 (53.3%), fair in 1 (6.7%), satisfactory (excellent and good) in 14 patients (93.3%) and unsatisfactory (fair) in 1 (6.7%) Table 4.

3.1. Complications

Group 1, two patients had major complications, one had supracondylar fracture of the femur on the operated side during removal of the cast two and half month after the operation, This fracture was treated by above knee plaster

Fig. 1 – A) Adductor tenotomy, B) and C) Anterior iliofemoral incision for open reduction.

Fig. 2 – A) Lateral skin incision used for femoral shortening, and derotation osteotomy, with the femoral head transfixing K-wire in place. B) Small set DCP used for internal fixation after the femoral osteotomy.

Fig. 3 – Salter Osteotomy. A) Gigli saw is shown completing the osteotomy. B) Showing Graft harvest. C) Shows graft placement and fixation. D) Post-operative X-ray showing the K-wire transfixing the femoral head, and the wire used for fixation of the graft after Salter pelvic osteotomy.

cast, the final clinical outcome in this patients was fair (Score: 80) due to moderate limitation of hip movement and limping, the final radiological outcome was graded as Severin class III due to abnormalities in the shape of the head and neck of the femur (AVN), CEA (25°) and was classified as grade 4 according to Kalamchi and McEwen classification.⁹ The other patient had a subluxed hip after one year, final radiological outcome was graded as Severin class V and a fair final clinical outcome (score = 80). All patients had mild pin tract infections at the entry point of the transfixing femoral head wire on the lateral aspect of the thigh, these infections were treated by serial dressing with complete healing in all cases.

Group 2, one patient had a subluxed hip, final radiological outcome was graded as Severin class V and a fair final clinical outcome.

4. Discussion

The most important finding of this study is that femoral head transfixing Kirschner wire despite providing better intra-operative stability to the hip without injuring the femoral head or the acetabulum had no effect on the final clinical and radiological results.

Fig. 4 – Example of a case of DDH belonging to the first group with K-wire transfixing the femoral head in the acetabulum during operative reduction. A) 3-year old patient with right DDH, Acetabular index (40°), Grade 4. B) Immediate post-operative X-ray after open reduction, femoral shortening varus derotatin and Salter's innominate osteotomy. C) 18 month post-operative X-ray showing improvement of the acetabular index (25°), good position of the femoral head. CEA (30°), Severine class I, Clinical score 100.

Fig. 5 – Example of a case of DDH belonging to the second group without K-wire transfixing the femoral head in the acetabulum during operative reduction. A) 8 years old patients with left DDH, AI 45°, grade 2. B) Immediate post-operative X-ray after open reduction, femoral and Salter osteotomies. C) X-ray after 2 years, good head position, AI 23°, CEA 40°, Severine class I, good final clinical score.

There are multiple factors that may affect the growth and development of the hip joint in DDH treatment. The most important factor is concentric relocation of the femoral head in the acetabulum. If a concentric reduction could not be obtained and maintained, normal growth and development will be unlikely. The acetabulum develops in response to the presence and motion of the spherical femoral head. The depth of the acetabulum increases during development as a result of interstitial growth in the acetabular cartilage, appositional growth in the periphery of the cartilage, and periosteal new bone formation at the acetabular margin. The acetabulum usually has the potential for recovery and resumption of normal growth and development; however, the potential decreases with age. Despite concerns that open reduction leads to joint stiffness and increased incidence of avascular necrosis, the merits of open reduction in the ambulatory age group are clear. It provides visual confirmation of the adequacy of reduction while generally exposing the femoral head to less trauma. In addition, open reduction gives the surgeon the opportunity to assess the amount of acetabular dysplasia.⁶

In this age group, Zionts and MacEwen⁷ found that closed reduction was associated with a high rate of avascular necrosis (23.7%) and a high incidence of secondary procedures for recurrent subluxation or persistent acetabular dysplasia. They found that nearly 66% of their patients treated with traction, adductor tenotomy, and closed reduction under general anesthesia required secondary surgical procedures. Similarly, Mardem-BeyandMacEwen 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.^{7,10}

Several types of pelvic osteotomies to stabilize the reduced hip in older children have been described. In this work, Salter osteotomy was procedure of choice. Galpin et al¹¹ cautioned

against posterior instability with Salter osteotomy when it is combined with derotation femoral osteotomy. In this study there were two hips with resubluxation associated with Salter osteotomy, one in each group, the cause of resubluxation was attributed to failure of remodeling of the acetabular wall. The best time to perform an osteotomy of the acetabulum for DDH patients is still debatable.^{11,12}

Saleh et al¹³ demonstrated that the acetabulum remodels quickly after the Salter innominate osteotomy in a range of age groups. There is debate about the lower limit of surgical timing, e.g., at a younger age. Many studies found that it could be done safely for children between 12 and 18 months of age without major disadvantages.^{12,13}

The value of a shortening femoral osteotomy has been described by numerous authors. Simply, this osteotomy decreases the resting tension of the soft tissues across the hip joint, which decreases the joint reactive force and the risk of AVN. In this work, it was performed for all hips.¹⁴

Excessive femoral neck anteversion is usually present in cases of DDH but it is not clinically apparent in these patients when the hip is in a subluxed or dislocated position, but it becomes so when the hip is reduced during open reduction whereby the head is usually reduced and becomes stable after internally rotating the hip. This was found to be true in this work, as all hips included were found to require a femoral derotational osteotomy after reducing the femoral head in the acetabulum under vision.

A few investigators have evaluated the long term functional and radiographic outcome of a one-stage operation for the treatment of DDH in children after the walking age. Galpin et al in a study of 33 hips in 25 patients, 2 years of age or older treated by one-stage surgical method (open reduction, Salter and femoral osteotomies), they reported satisfactory results clinically in 85% of their patients and radiographically in 75% in this work, we reported satisfactory clinical (86.7%, 93.3%)

Table 3 – The final radiological results.

Final radiological	Group 1		Group 2	
	Frequency	Percent	Frequency	Percent
Class I (excellent)	11	73.3%	10	66.7%
Class II (good)	3	20%	4	26.7%
Class V (poor)	1	6.7%	1	6.7%
Total	15	100%	15	100%

Table 4 – The overall final clinical results.

Final clinical	Group 1		Group 2	
	Frequency	Percent	Frequency	Percent
Excellent	4	26.7%	6	40%
Good	9	60%	8	53.3%
Fair	2	13.3%	1	6.7%
Total	15	100%	15	100%

and radiographic (93.3%, 93.3%) results in group 1 and 2 respectively.¹¹

The decision of performing Salter osteotomy with open reduction was according to preoperative radiographs (AI<45°) as well as intra-operative stability after open reduction. However, satisfactory stability could not be achieved after progressive soft tissue releases and the innominate osteotomy in 50% of hips in this work (group 1).

This coincides with Lin C J et al,¹⁵ who found that, satisfactory stability could not be achieved after good soft tissue releases in 53 of 84 hips (63%). There are many causes of this instability e.g. the cartilaginous component which cannot be easily evaluated without the help of arthrography, magnetic resonance imaging, and computed tomography, also the presence of extensively inverted labrum, excessive femoral neck anteversion. Also, the (AI) might not be a good correlating factor because it represents only the two-dimensional radiographic projection of the three-dimensional bony alignment, without taking the cartilage component into account.¹⁵

Due to the previous causes of intra-operative instability, we had to transfix the femoral head with Kirschner wire in group 1 hips to keep the head in place till complete healing of the capsuloraphy and molding of the remaining soft tissue inside the acetabulum, we found only mild pin tract infection that was treated by daily dressing. Two hips had major complications in this group; one hip had AVN of the femoral head, this was not attributed to the transfixing wire but to the prolonged hip immobilization in this case as she had a supra-condylar fracture femur immediately after cast removal which was treated by above knee plaster cast for 1.5 month, the other one had a re subluxation. We found no significant difference in the final clinical and radiological results between both groups.

5. Conclusion

One-stage surgical treatment of DDH after the walking age is an excellent method for successful surgery, open reduction with removal of all soft tissues impairing reduction as well as optimal positioning of the head into the acetabulum together with a proper capsuloraphy should be done. The femoral head transfixing Kirschner wire despite providing better intra-operative stability to the hip without injuring the femoral head or the acetabulum, had no effect on the final clinical and radiological results. Salter osteotomy does not adversely affect acetabular remodeling and could be performed in children upto age of 8 years with excellent results. Finally, femoral shortening and varus derotation osteotomy is important to help an easy and a stable reduction.

Conflicts of interest

All authors have none to declare.

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