

CLINICO-RADIOLOGICAL EVALUATION OF PERTHES DISEASE PATIENTS TREATED BY SHELF ACETABULOPLASTY

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ABSTRACT

Introduction: The most important prognostic factors of Perthes disease are age of onset and lateral extrusion of the femoral head. Shelf acetabuloplasty can be used as a containment procedure in early stages and as a salvage procedure in the late stages of Perthes disease. Shelf procedure in growing age will act as labral support procedure and will stimulate growth of lateral acetabular epiphysis. The purpose of the study was to evaluate the functional and radiological outcome of patients treated by shelf acetabuloplasty and to assess the percentage resorption of iliac graft with time.

Materials and Methods: It was a prospective cohort study with 22 patients. Patients were followed up at 6 months, 9 months, 1 year and 2 years. Functional assessment using Harris hip score was done pre operatively and at each follow up while radiological outcome was assessed by the percentage of femoral head coverage and Stulberg classification at 2 years.

Results: The extra-osseous portion of the shelf initially was 15 mm which showed a significant decrease in length (11.7 mm) at 2 year follow up. The femoral head cover at final follow up significantly increased to 100.1% from the initial 81.3%. The addition of shelf decreased the acetabular angle to 37.6° from 48° preop. Satisfactory radiological outcome according to Stulberg classification were obtained in 17 cases, while 5 cases had unsatisfactory results. 3 out of 22 had excellent functional outcome while the rest had good outcome.

Conclusion: Shelf acetabuloplasty fulfills the principles of Perthes disease management by correcting the lateral subluxation and containment of the femoral head. Shelf acetabuloplasty definitely improves the functional and radiological outcome of late onset Perthes disease patients.

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INTRODUCTION

Perthes disease is characterized by idiopathic avascular necrosis of the capital femoral epiphysis.¹ The most important prognostic factor of Perthes disease is the age of onset. Onset before the age of 6 years is usually associated with good prognosis although some may behave poorly. Onset after age 9 usually has poor outcome compared to better prognosis of 6 to 9 age group.² The

other important factor is the lateral extrusion of the femoral head out of the acetabulum.³ Lateral extrusion causes irregular femoral head due to edge loading and uneven transmission of the load. The primary aim of various therapeutic options in Perthes disease is, containment of the femoral head in the acetabulum thereby allowing natural remodeling of hip and prevents late osteoarthritis.⁴



Till the early fragmentation stages of the femoral head, containment methods like casting or bracing,⁵ varus derotation osteotomy,⁶ or pelvic osteotomies⁴ are the options. In late stages, salvage procedures^{7,8,9} are preferable. Shelf acetabuloplasty can be used as a containment procedure in necrosis and fragmentation stages of Perthes disease¹⁰, and also as a salvage procedure in the reossification and remodeling stages.¹¹ Shelf procedure in growing age will act as labral support procedure and will stimulate growth of lateral acetabular epiphysis to improve the femoral head coverage and prevents lateral extrusion.¹² The purpose of the study was to evaluate the functional and radiological outcome of patients treated by shelf acetabuloplasty and to assess the percentage resorption of iliac graft with time.

MATERIALS AND METHODS

It was a prospective cohort study done in the Department of Orthopedics, Calicut Medical College, during the period December 2011 to November 2014. 22 patients were included in the study. All Perthes disease patients presented to our OPD in the age group of 8 to 11, with Modified Elizabeth Town classification IIB or IIIA (late fragmentation or early regeneration), femoral head extrusion & insufficient coverage of femoral head and those with a minimum follow up of 2 years were included in the study. Those not willing for the procedure were excluded. SPSS version 18 was used for statistical analysis of data. Pearson correlation test was used to assess the relation between the Harris hip score and the percentage femoral head cover.

SURGICAL PROCEDURE

The patient is positioned supine on a radiolucent table. A sand bag is placed in the lumbar region to elevate the affected hemipelvis. A bikini-type incision is made about one third the distance from the iliac crest to the greater trochanter, curving anteriorly. The interval between the sartorius and the tensor fascia femoris muscles are developed. Lateral femoral cutaneous nerve, which exits through the interval and becomes superficial to the sartorius muscle is protected. The tensor fascia lata and gluteal muscles are elevated from the outer pelvic table sub-periosteally down to the capsular margin. Hemostasis was obtained with either bone wax or cautery.

The reflected head of the rectus femoris is identified and detached from the acetabulum. The groove from which it arises is the absolute lateral acetabular margin and is located directly above the capsular attachment. Complete lateral, anterolateral, and posterolateral exposure of the capsule is performed. For greater capsular exposure, the tendon of the rectus femoris may need to be tagged and cut about 1 cm distal to

the insertion. Any redundant capsule attached to the ilium needs to be elevated from the outer pelvic wall and hence capsule gets thinned out.

Several upwardly inclined drill holes are made in the periacetabular area in line with the tendon of the reflected head attachment. These drill holes are then interconnected with a straight osteotome and widened to create a deep trough with 15° cephalad angulation. Fluoroscopy may be used to avoid joint penetration. The area to be covered by the graft is measured. An extra centimeter is added to accommodate graft insertion into a trough. A trapezoidal iliac graft from outer cortex is obtained and provisionally inserted into the trough; a fluoroscopic image is taken to assess femoral head coverage. The hip is abducted to allow at least 45° with the graft in place. Hip flexion is also checked to avoid anterior impingement. The graft is then trimmed to ensure enough coverage. Strong non-absorbable sutures (ethibond-0) are used to anchor the graft to the capsule. The graft is then impacted into the supra-acetabular trough, and the sutures are tied from posterior to anterior. The detached rectus femoris tendon, is re-sutured to the anterior inferior iliac spine. The gluteus minimus and medius will lie on top of the graft to maintain it in place. The wound is closed in layers over drain.

The drain was removed and X-rays were taken on the second postoperative day followed by hip spica cast. Follow up visit was made at 4 weeks for cast removal after confirming graft healing with another X-ray and the patients were started on physiotherapy and weight bearing — at 5 weeks for cast removal after confirming graft healing with another X-ray and the patients were started on physiotherapy and weight bearing.

Range of movement of the affected hip is assessed in all patients prior to the procedure and if there was any limitation in movements, especially abduction, they were put on traction before surgery. X-rays of pelvis with both hips, antero-posterior and frog leg lateral views, AP views with hip in abduction were taken. Preoperative radiological assessment included measuring Sharp's acetabular angle, medial joint space, percentage of femoral head covered by acetabulum, evidence of any subchondral fracture and head at risk signs. All patients were classified based on Catterall classification.

Patients were followed up at 6 months, 9 months, 1 year and then at 2 years. Post-operative radiological assessment included measuring acetabular angle, medial joint space, length of the shelf, percentage of femoral head coverage, evidence of improvement in subchondral fracture & head at risk signs and Stulberg classification of the femoral heads. Functional assessment using Harris hip score was done pre operatively

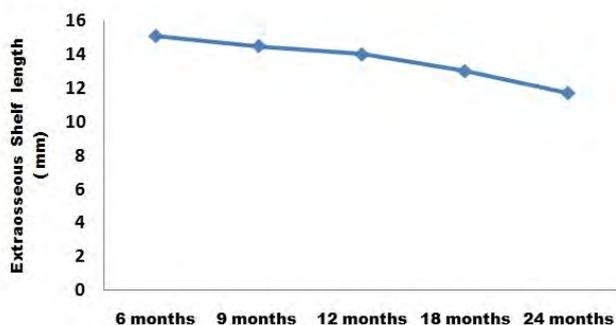


FIGURE 1. line diagram showing reduction of extra-osseous shelf length on follow up.

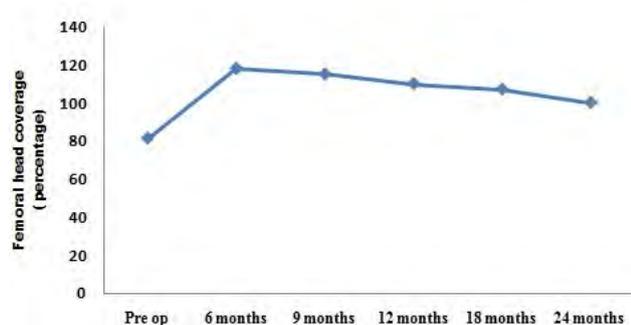


FIGURE 2. line diagram showing improvement in femoral head coverage and its maintenance on follow up.

and at each follow up. Radiological outcome was assessed by the percentage of femoral head coverage and Stulberg classification. Stulberg classification was done at the final follow up of 2 years. By two years, all patients achieved healing status. Mose’s template was used to assess the sphericity of femoral head. Children fulfilling the criteria for the Stulberg groups 1, 2 and 3 were considered satisfactory outcome while a Stulberg 4 or 5 considered unsatisfactory.

RESULTS

The age group of patients was in between 8 to 11 years, with majority (63.6%) around 8 years. Most of the patients involved were males (77.3%) — around 9 years. Most of the patients involved were males (77.3%). All patients had unilateral hip involvement. The right hip was affected in majority (63.6%). Passive smoking was the highest accountable risk factor, in 12 patients (45.5%).

Evidence of subchondral fracture was present in only 18% of the patients. Catterall’s head at risk signs were looked for in all patients in the study. Lateral subluxation was present in all affected hips. The overall shelf length was 28.3 mm (±4.1) which did not change significantly over the study period (Table 1). The

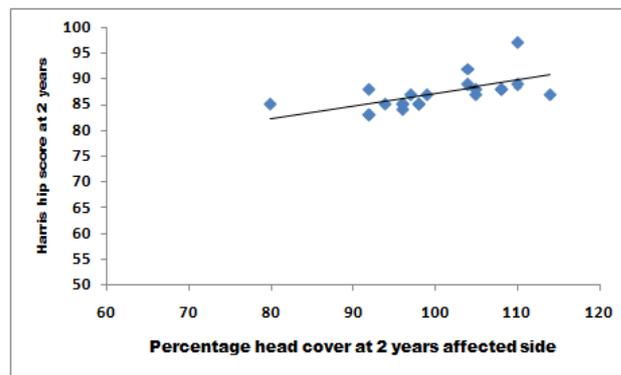


FIGURE 3. Pearson correlation between Harris hip score and Percentage head cover.

extra-osseous portion of the shelf was 15 mm which showed a significant decrease in length (11.7 mm) on 2 year follow up (Figure 1). This would mean that the shelf must have been absorbed into the acetabulum, indirectly indicating the surgical procedure didn’t hamper the growth potential of the acetabular labrum. The preoperative medial joint space in the normal side was 8.8 mm compared to 11.5 mm in the affected side. There was no further significant increase in the joint space during the study period. The lateral subluxation has led to decrease in the percentage of femoral head cover in the affected side (81.3%) compared to the normal side (92.8%). The femoral head cover at 2 year follow up after the procedure significantly increased to 100.1% (Figure 2). The addition of shelf decreased the acetabular angle to 37.6° from 48° in the affected side postoperatively.

Satisfactory radiological outcome according to Stulberg classification were obtained in 17 cases, while 5 cases had unsatisfactory results. Table 2 shows the distribution of Stulberg classification among study population.

Harris hip score of 80–89 was considered good functional outcome while 90 and above considered excellent. 3 out of 22 had excellent results while the rest had good functional outcome. Pearsons correlation test (Figure 3) to assess the relation between the Harris hip score and the percentage femoral head cover showed good to excellent functional outcome at 2 years while those with a percentage femoral head cover less than 100% tends to have a Harris hip score slightly lesser than others. Figures 4 and 5 shows acceptable radiological outcome while Figure 6 shows poor radiological outcome following the procedure.

DISCUSSION

Although the natural history of Perthes disease is, in general, benign, most authors agree that when it begins after the age of eight years it has a poor

TABLE 1. Statistical significance of radiological parameters at pre-op and 2 year follow up.

	No.	Pre-Op		2 year Post-op		T	P value
		Mean	Sd	Mean	sd		
Overall shelf length	22	28.3	4.1	27.8	4.8	1.349	0.192
Extra osseous portion of shelf	22	15.0	2.5	11.7	2.8	10.429	<0.001
Percentage cover of femoral head normal side	22	92.8	3.7	92.7	3.5	0.157	0.877
Percentage cover of femoral head affected side	22	81.3	7.7	100.1	7.9	-12.657	<0.001
Medial joint space Normal side	22	8.8	0.7	8.9	0.6	-1.000	0.329
Medial joint space Affected side	22	11.5	1.8	11.6	1.7	-1.821	0.083



FIGURE 4. (a) Pre op X-ray. (b) Immediate post op X-ray. (c) X-ray at 2 years with satisfactory result (Stulberg 3).

prognosis in the long term.² Outcome of surgical treatment is not always successful. Femoral osteotomy yield is less rewarding due to the persisting coxa vara and shortening, as evidenced by the study done by Coates *et al.*¹³ Salter reported that innominate osteotomy at this age group has higher chance of failure and can reduce the range of movement.¹⁴ Shelf

acetabuloplasty was introduced to overcome these problems, as the procedure does not hamper the hip biomechanics. The primary indication¹⁵ for shelf augmentation is in patients with hip incongruity not amenable to redirection osteotomy. A shelf procedure is secondarily warranted for inadequate femoral head coverage achieved by pelvic osteotomy. It is also

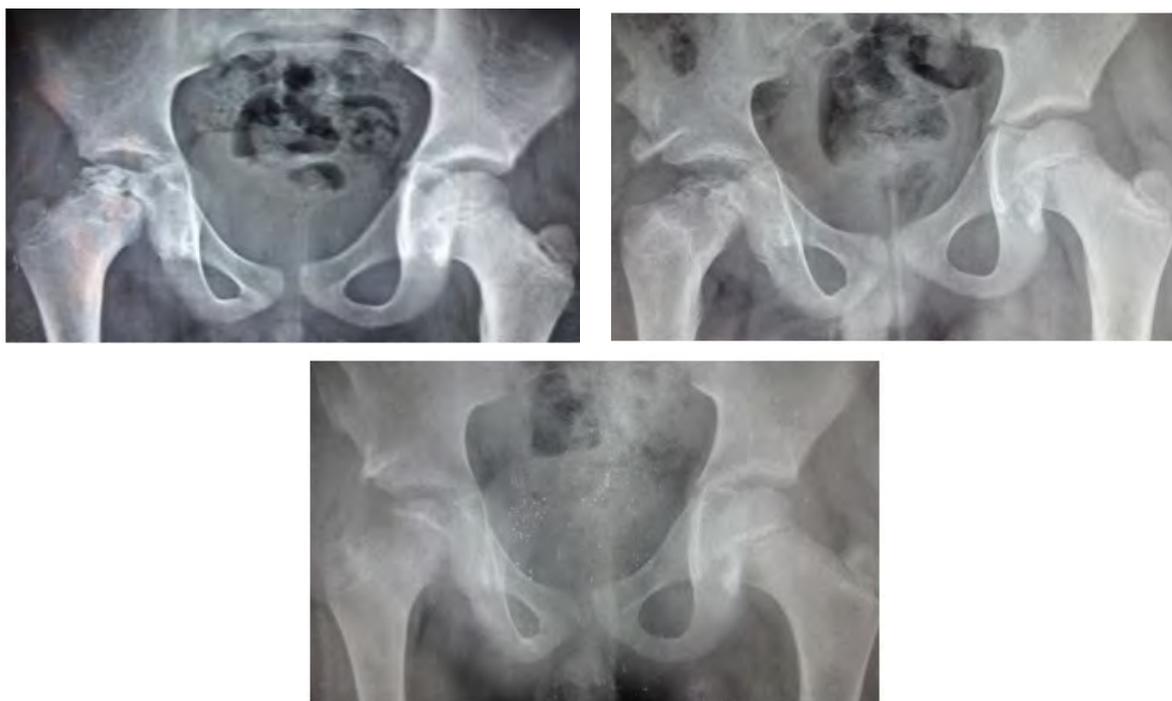


FIGURE 5. (a) Pre op X-ray. (b) Immediate post op X-ray. (c) X-ray at 2 years with satisfactory result (Stulberg 2).

TABLE 2. Showing the distribution of Stulberg classification among study population.

Radiological outcome	Frequency	Percent
Stulberg 1	0	0
Stulberg 2	2	9
Stulberg 3	15	68.2
Stulberg 4	4	18
Stulberg 5	1	4

indicated in Perthes patients aged 8 years or older with coxa magna and early lateralization of the femoral head.

The overall shelf length in our study was 28.3 mm with an extraosseous length of 15 mm at final follow up, which decreased to 11.7 mm while maintaining the overall shelf length. The overall shelf length reported by K Daly *et al.*¹⁶ was around 24 mm with an extra-osseous length measuring approximately 12 mm. The extra-osseous length at the mean final follow up of 6 years was close to 8 mm, while the total length remained almost the same. This apparent resorption reflects incorporation of the graft into the pelvis as a result of continued growth of the lateral acetabular structures.¹⁶ This answers one of the fundamental concerns raised by placing such a shelf on the edge of the growing acetabulum. Similar study by Ismat Ghanem *et al.* had a total shelf length of 25 mm, with a tip to roof length of 14 mm.¹⁷

Lateral subluxation was present in all, leading to a decrease in the percentage femoral head cover (81.3%) compared to normal side (92.8%). The addition of shelf increased the femoral head cover significantly (100.1%). Daly *et al.* reported a similar increase from 83% to 105%, while Van Der Geest *et al.* had a coverage of 108% in a 12 year follow up study.¹⁸ The addition of shelf decreased the Sharp’s acetabular angle from a mean 48° to 37.6° at final follow up in our study. Ismat Ghanem *et al.*¹⁷ and K Daly *et al.*¹⁶ had similar results with 35° and 32° respectively at the final follow up.

Considering Stulberg 1, 2 and 3 as satisfactory, our study had a 77% satisfactory radiological outcome at final follow up. Ismat Ghanem *et al.*¹⁶ reported 84% satisfactory results, K Daly *et al.*¹⁶ had 81% while Van der Geest *et al.*¹⁸ reported a stunning 89% satisfactory results. On functional evaluation 3 out of 22 children reported to have excellent result, while the remaining had good results measured on Harris hip score. Mean score at final follow up was 87. Mean Iowa hip score in the series of Ismat Ghanem *et al.* was 88.6, while a study from Turkey by Muratli H H *et al.*¹⁹ reported a score of 88.2.

A correlation between the Harris hip score and the percentage femoral head cover showed a positive trend but this relation was statistically insignificant. All hips have a functional outcome of good to excellent in the short term while those with a percentage femoral head cover less than 100% tend to have a Harris hip score slightly lesser than others.



FIGURE 6. (a) Pre op X-ray. (b) Immediate post op X-ray. (c) X-ray at 2 years with poor result (Stulberg 5).

A comparison between Stulberg classification and Harris hip score found that 13 hips out of the 17 with satisfactory results had a Harris hip score more than 85, while all 5 hips with an unsatisfactory Stulberg classification have a Harris hip score in the low range, but still above 80, to consider it as a good result. The difference is statistically significant as determined by Fisher's exact test ($p = 0.005$). So in spite of having Stulberg 4 or 5, children have good functional outcome in the short term, but slightly less than their comparable group who have a better Stulberg. Long functional results needs long follow up.

CONCLUSION

Shelf acetabuloplasty fulfills the principles of Perthes disease management by correcting the lateral sub-

luxation and containment of the femoral head. Shelf acetabuloplasty definitely improves the functional and radiological outcome of late onset perthes disease patients.

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