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Outcome Analysis of SCFE Managed By Ganz Safe Surgical Dislocation

*Dr.K.Velmurugan[1], Dr.Hemanthakumar[2] Dr.Sathish[3]
[1,2,3]*Institute of Orthopaedics and Traumatology,*
Rajiv Gandhi Government General Hospital, Chennai.
*Corresponding Author: *Dr.K.Velmurugan*

Abstract: *Slipped capital femoral epiphysis (SCFE) is a common adolescent hip disorder presenting as a painful hip in the adolescent population. The major management concern is the precarious blood supply to the femoral epiphysis. A surgical procedure fulfilling the requirement was brought by Ganz as a method of safe surgical dislocation of hip into limelight. This procedure gives credential to the vascular supply of femoral head at all stages. Ganz safe surgical dislocation made possible 360 degrees' visualization of theacetabulum and the femoral head. This also helps in anatomical realignment of femoral epiphysis over the metaphysis. In this study weanalyse the patients with slipped capital femoral epiphysis (SCFE) treated by Ganz safe surgical dislocation and subcapital realignment of epiphysis and assess the functional, radiological outcome and complications of the surgical procedure.*

Keywords: *SCFE, Ganz procedure, Safe Surgical Dislocation.*

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I. Introduction

Slipped capital femoral epiphysis (SCFE) is a common adolescent hip disorder. It is defined as a posterior and inferior slippage of the proximal femoral epiphysis relative to the metaphysis. Any child with SCFE needs treatment. Untreated SCFE leads to chondrolysis, avascular necrosis and early degenerative arthritis. The principle of treatment in SCFE is attaining thebiomechanical arc of motion of the hip. According to Watson-Jones[1] (1962) "the treatment of displacement of upper femoral epiphysis is not a very happy chapter in the history of orthopaedic surgery". This is because of the difficult surgical procedures involved in correction of SCFE and the unfruitful outcomes of those procedures, which determine the long-term functional and social outcome in a child.

Surgical corrections in SCFE are aimed at the following factors:

1) Anatomical realignment of physis
2) Maintenance of blood supply to the physis
3) Prevention of recurrence of slippage

The major concern is the precarious blood supply to the femoral epiphysis. Thus a surgical procedure fulfilling all these needs is essential. This brought Ganz safe surgical dislocation of hip into limelight. This procedure gives credential to the vascular supply of femoral head at all stages. Ganz safe surgical dislocation made possible 360 degrees visualization of theacetabulum and the femoral head. This also helps in anatomical realignment of femoral epiphysis over the metaphysis. According to Howorth,Paré[31], should be given credit for the first description of SCFE as early as 1572, in Cinq Livres de Chirurgie, Paris. He describes SCFE as the condition in which "the epiphysis of the head of the femur sometimes becomes disjointed and separates in such a way that the surgeon is misled, thinking that it may be luxation and not separation of the epiphysis of this bone."

In 1909, Whitman reported the first series of osteotomies for SCFE. In 1949, Boyd [33]reported the first stabilization of SCFE with pins. Kordelle et al. in their study have not found any difference in acetabular morphology in the affected and unaffected hips of children with SCFE. They explained that the lack of such acetabular differences is likely because SCFE generally occurs at an age at which little potential remains for acetabular remodelling.

Ganz and colleagues, in 2000, described the detailed anatomy of blood supply to the femoral head. They accounted the importance of medial femoral circumflex artery (MFCA) to the vascularity and its protection by intact obturator externus. The most renowned publication of Ganz et al, "Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis" in 2001 reported their experience using safe surgical dislocation approach in 213 hips over the course of seven years. They reported no cases of avascular necrosis in their study.

In 2008, Leunig M, Slongo T, Ganz R. in their article "Subcapital realignment in slipped capital femoral epiphysis: surgical hip dislocation and trimming of the stable trochanter to protect the perfusion of the epiphysis "described in detail their technique of safe surgical dislocation. They obtained excellent results with subcapital realignment of the slipped physis with no complication of avascular necrosis. In 2003, Lavigne ,leunig and colleagues described the techniques of joint preserving surgeries. In 2006, Samantha spencer and Millis analysed retrospectively the early results of treatment for hip impingement syndrome in slipped capital femoral epiphysis and idiopathic pistol grip deformity of the femoral head-neck junction using the surgical dislocation technique. They found that osteoplasty done for SCFE has better outcome than idiopathic pistol grip deformity. Shin et al, in 2009, in their study credited Ganz surgical hip dislocation as a useful method in the management of several paediatric hip diseases, providing an unobstructed view of the femoral head and acetabulum. In their series of 23 children with different hip diseases one case of avascular necrosis was reported.

In 2009, Kai Ziebarth and colleagues showed that capital realignment using a modified Dunn procedure gave anatomical reduction of the physis. In their study on 40 hips, they used Kirshner wires for fixation of the physis. They encountered no avascular necrosis, but, three cases of delayed union of trochanteric osteotomy is reported. In 2013, Jeremy and Anderson in their article in journal of paediatric orthopaedics analysed the role of subcapital correction osteotomy for malunited slipped capital femoral epiphysis resulting in pistol grip deformity. They reported 2 cases of avascular necrosis.

II. Methods

A prospective study was done in slipped capital femoral epiphysis patients operated from November 2014 to August 2016. 8 patients (10 hips) with SCFE are operated by Ganz safe surgical dislocation and subcapital realignment of epiphysis. 6 patients had unilateral SCFE and 2 patients had bilateral SCFE. Preoperative assessment of the patients done and Southwick's slip angle measured with the radiographs. At risk patients (obese and bilateral slip) are also investigated for any endocrinological abnormalities. Patients are classified according to the Southwick's slip angle into mild, moderate and severe slipped capital femoral epiphysis.

Inclusion Criteria:
- patients with chronic SCFE
- patients with moderate SCFE (Southwick's angle: 30 - 60 degrees) and severe SCFE (Southwick's angle: > 60 degrees)
- patients with open physis

Exclusion criteria:
- patients with acute SCFE
- patients with mild SCFE (Southwick's angle: <30 degrees)
- patients with closed physis

All 8 are male patients. All patients are in the age group of 10-16 years. All slips are of chronic type and moderate and severe type. 10 hips under study were operated by Ganz safe surgical dislocation and subcapital realignment of epiphysis with trimmingof theoverhanging trochanter done. The realigned epiphysis was fixed with a single 6.5 mm cannulated cancellous screw. The trochanteric osteotomy was fixed with two 3.5 mm cortical screws. Postoperatively[3] passive hip mobilization was started on day one as tolerated by the patients. Assisted toe touch walking was started on the third day. At 2 weeks' patients are reviewed for any wound infection and sutures are removed. At 6-8 weeks, trochanteric union is seen and full weight bearing is allowed. Abductor strengthening exercises are added in the rehabilitation protocol.

All the patients were reviewed at 2 weeks, 6 weeks, 3 months ,6 months and further for functional outcomes, radiological outcomes and complications of the surgery. The follow-up was scheduled at these predetermined intervalsmainly to assess:

1) 2 weeks - wound infection
2) 6 weeks - trochanteric union
3) 3 months - range of motion
4) 6 months – avascular necrosis changes

III. Functional Outcome

The functional outcome of the patients is assessed by the improvement in the range of movements, particularly internal rotation, abduction and flexion. These are the movements most commonly affected in slipped capital femoral epiphysis due to the femoroacetabular impingement. The decrease in pain, which is the main symptom of the patients is also assessed.

Patients ability to perform his daily activities and social activities are also considered. The grading of the functional outcome is done by Harris Hip Score(HHS)[33].

Harris Hip Score(HHS) has 100 points which include,

1) pain (44 points)
2) function (47 points)
3) absence of deformity (4 points)
4) range of motion (5 points)

Score assessed after surgery:

1) Excellent - 90 to 100
2) Good - 80 to 89
3) Fair - 70 to 79
4) Poor - below 70

IV. Radiological Outcome

Anteroposterior and frog-leg lateral radiographs were taken to assess:

1) Correction of the Southwick slip angle
2) Recurrence of slippage
3) Trochanteric union

All the complications following the surgery like wound infection, trochanteric non-union, hardware related complications are assessed in all patients. But, the most dreaded and crippling complication of the surgical dislocation of hip, avascular necrosis is given particular importance in this study.

V.RESULTS

In our institute, 8 patients (10 hips) with moderate and severe SCFE were operated during November 2014 to August 2016. All the patients were in the age group of 10 – 16 years (average - 14 years). 3 patients (37.5 %) were obese. Among them bilateral involvement is seen in 2 patients (25 %). The duration of patients' clinical symptoms ranged from 3 weeks to 10 months (average duration of 10 weeks). 8 hips were of moderate slip type and 2 hips were of severe type. The degree of slip as graded by Southwick slip angle ranged from 40˚ to 70˚ (average slip of 48˚) Theanatomical realignment ofthe epiphysis ledto asignificantly beneficial correction of the slip angle ranging from 8˚ to 15˚ (average of 10.7˚). Follow-up ranged from 12 months to 19 months (average of 14 months). During the follow-up, no cases of wound infection was seen. 1 case of avascular necrosis occurred. In the same patient intraoperative drill hole bleeding was absent. At six months the patient had radiological changes of avascular necrosis. But symptomatically patient only had a mild limp. This patient alone had a fair outcome in Harris Hip Score. All the other patients in our study had good and excellent scores. No cases of trochanteric non-union was reported. All trochanters united at 6 to 8 weeks with an average of 6.6 weeks. Full weight bearing was allowed in a gradual manner following trochantericunion and functional outcome was assessed. Abductor strengthening exercises were given. The normal abductor power was regained at 12 to 14 weeks.

The improvement in range of movements particularly internal rotation, abduction and flexion were assessed. Patients showed improved range of movements as follows:

1) internal rotation - 15˚ to 40˚ (average of 22˚)
2) abduction - 15˚ to 45˚ (average of 30˚)
3) flexion - 15˚ to 45˚ (average of 32˚)

The overall functional outcome is graded according to the Harris Hip Score(HHS). 7 out of 8 patients (87.5 %) had excellent and good outcomes in HHS. 1 patient had fair outcome. This patient developed osteonecrosis at the sixth month follow-up. Intraoperatively, bleeding from the drill hole was also absent.

V. Discussion

Even mild slipped capital femoral epiphysis leads to premature osteoarthritis resulting from femoroacetabular impingement[7]. Surgical methods aimed at correcting this have a high risk of osteonecrosis. Our study gives major consideration to anatomical realignment of the physis thereby, reducing the

femoroacetabular impingement while maintaining the vascularity of the femoral head. The chance of avascular necrosis is also influenced by the mechanical instability of the slip.

In the procedure described in our study, both the vascularity of femur head and the mechanical instability of the physis are addressed. Intraoperative monitoring of perfusion of the femoral head is done by drilling holes both before dislocation and after reduction. Also, while realigning the physis using osteotome active bleeding from the undersurface of the epiphysis also indicates a viable head. Gill and Sledge[35] in their study on 44 hips found that among the 38 femoral heads with a bleeding drill hole 1 developed avascular necrosis (2.6%).

All the 6 femoral heads without drill hole bleeding developed avascular necrosis. Although it may be argued that bleeding from a drill holein the femoral head after dislocation does not exclude the possibility of subsequent avascular necrosis, a high correlation has been shown between this and the presence of a viable head in a study on fractures of the femoral neck. According to Ganz et al, Laser Doppler flowmetry[36] has been found to be more useful for real time assessment of dynamic control of perfusion throughout the surgery. But this method is not followed in our study.

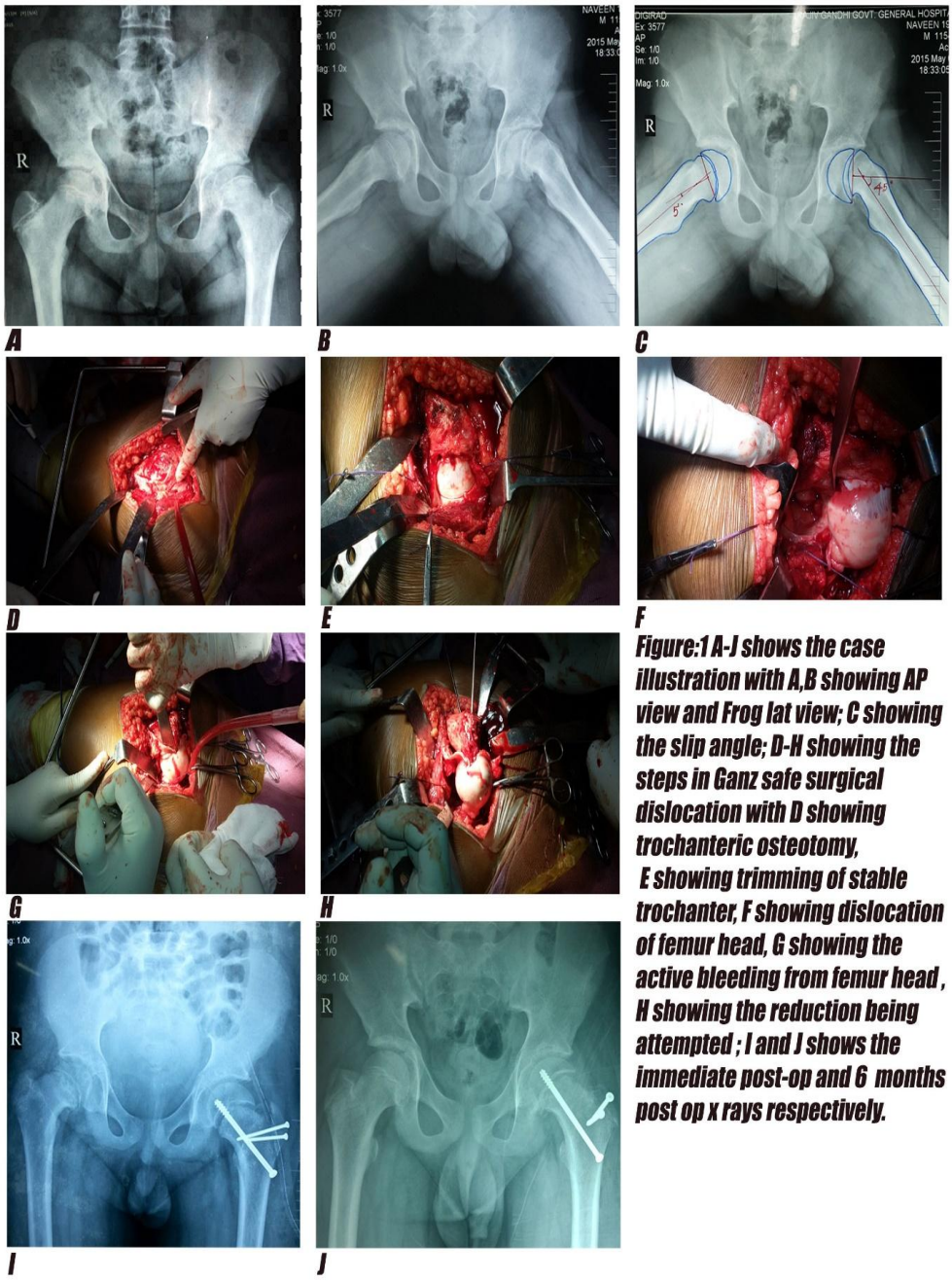

Figure:1 A-J shows the case illustration with A,B showing AP view and Frog lat view; C showing the slip angle; D-H showing the steps in Ganz safe surgical dislocation with D showing trochanteric osteotomy, E showing trimming of stable trochanter, F showing dislocation of femur head, G showing the active bleeding from femur head , H showing the reduction being attempted ; I and J shows the immediate post-op and 6 months post op x rays respectively.

In ourstudy, one case of avascular necrosis is reported. In this patient,at the time of surgery there was no bleeding visible after drilling the femoral head, even though retinacular vessels appeared intact. This indicated that the vascularity of the femoral head has been lost even before the surgical intervention itself. This patient developed osteonecrosis at 6 months. So, in our study we considered drill hole bleeding as a sensitive predictorof the vascularity of the femoral head.

Barring this single complication, excellent results have been obtained in our study with regards to functional outcome and slip recurrence. The normal Southwick angle (average 10.7˚) isattained in all the ten hips. Functionally, all the patients showed an excellent improvement in internal rotation, abduction and flexion of the hip, which are the movements primarily restricted in SCFE due to impingement. The development of premature arthritis due to femoroacetabular impingement is also averted. Yet long term studies are needed to assess the accurate decrease in incidence of the early arthritis.

In our study the following controversies in SCFE are addressed.

1) The number of screw placement
2) Postoperative weight bearing
3) When to do in-situ pinning
4) Prophylactic fixation of contralateral normal hip
5) Time for screw removal

In our institute, we used single 6.5 mm partially threaded cannulated cancellous screw for fixation. No cases of recurrence of slippage or epiphyseal perforation occurred. Percutaneous in-situ fixation was done in one patient with mild slip of the contralateral hip with mild symptoms. Older et al[37,38] in 2012 confirmed that in-situ pinning is useful in a chronic, stable and mild SCFE. Also, considering epiphyseal perforation and irritation with subsequent chondrolysis with multiple screws, use of single screw[39] gives satisfactory results. Ganz et al[30], in his study of subcapital realignment in 30 hips fixed with two fully threaded Kirschner wires, reported failure in 3 hips. This is due the loss of correction caused by the bending of the Kirschner wires. In our study, we used a single 6.5 mm cannulated cancellous screw for epiphyseal fixation. In none of our patient's loss of the correction of the slip occurred. Regarding postoperative weight bearing, there is a difference in opinions among surgeons - one group following a strict non-weight bearing for 16-20 weeks and the other group following early hip mobilization and weightbearing as tolerated. In our study we followed a standard protocol for the 10 hips. Passive hip mobilization exercises are started on the immediate postoperative day and assisted toe touch walking is allowed from the third day. Weight bearing is allowed at 6- 8 weeks on seeing the trochanteric union in the follow-up radiograph. No cases of recurrence of slippage or implant failure occurred.

According to Adam and Wilson et al[29], routine fixation of contralateral hip is not recommended. It can be done as a prophylactic measure only in at risk children:

1) young age at presentation
2) severe slip at presentation
3) non-specific obesity
4) children with endocrinological disorders
5) children on growth hormone therapy

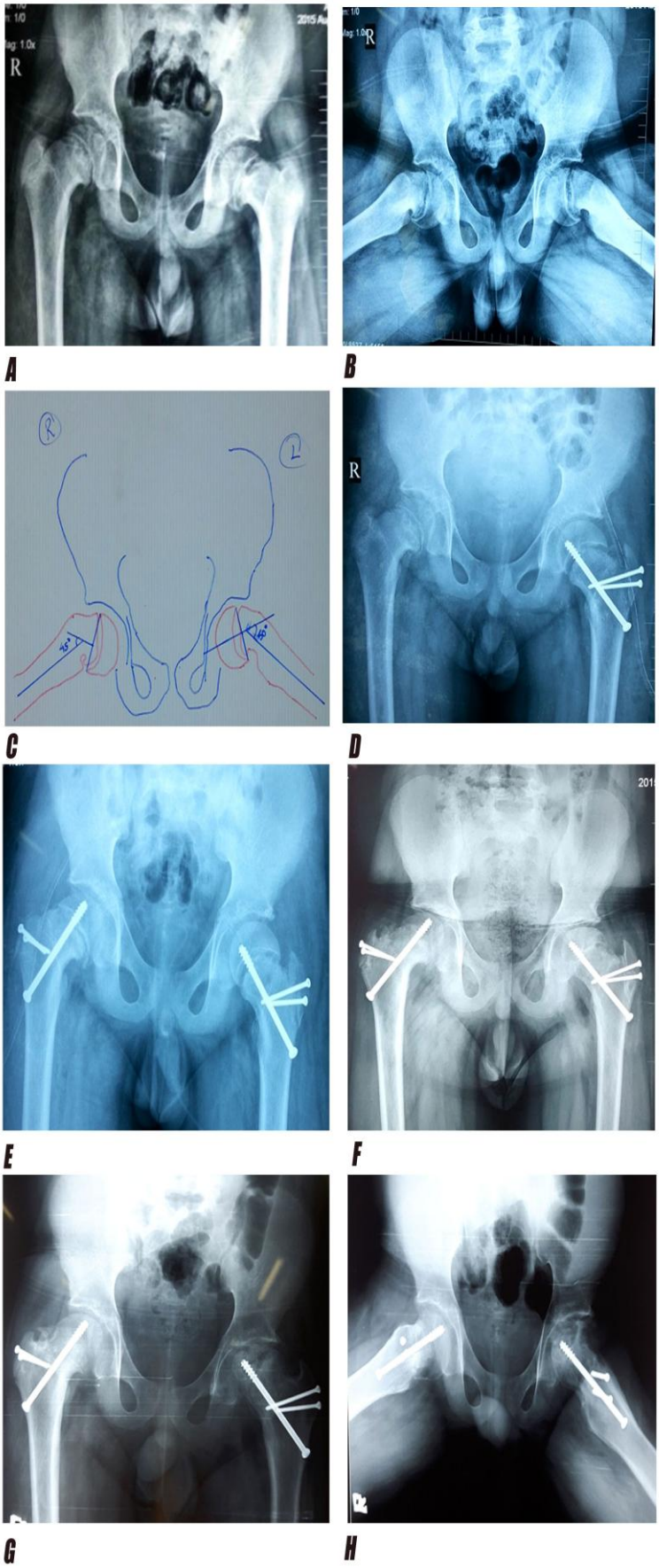

Figure 2: A-H shows case Illustration with A-C showing th e pre-op x rays in AP, Frog lat views, pre op Southwick angles; D&E showing the immediate post op x rays; F shows 6 months post op x ray; G&H shows 10 months post op x ray with avascular necrosis of the left hip

In our institute prophylactic fixation of the other hip is not routinely done. Among the 10 patients, 2 obese patients had bilateral slip and subcapital realignment isdone on both sides. Other than this one patient had only obesity as his single risk factor and so, prophylactic fixation is not considered. Some surgeons prefer routine screw removal[40] while others prefer it to be retained. According to the study by Ilchmann and Parsch et al in 2006, implant removal is not mandatory unless symptomatic. If at all done should not be before 1 year. In our study, screw removal is not done routinely and no patient had any hardware symptoms requiring screw removal.

Thus the surgical technique in our study achieved the goals of stablecorrection of position of epiphysisat the level of the tilt, undisturbed hip motion and prevention of further mechanical damage to the joint cartilage.

VI. Conclusion

Our study results support that a perfect anatomical reduction of the slipped physis can be achieved by safe surgical dislocation method. Complete correction of the slip angle is made possible by this technique. Subcapital realignment corrects the femoroacetabular impingement and minimizes the development of secondary arthritis thereby, increasing the longevity of the hip joint perse. A perfectly done surgical procedure as described in our study makes vascular injury to the femoral head a very rare occurrence. To conclude, although this procedure is technically demanding, it is worth the effort and skill for a condition that could have lifelong consequences in an otherwise young and active population.

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