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ORIGINAL ARTICLE

Comparison of role of in-situ fixation and modified DUNN procedure in management of severe SCFE (Slipped Capital Femoral Epiphysis).

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ABSTRACT… Objective: To compare in-situ fixation and modified Dunn procedure in stable sever SCFE by assessing radiological and functional improvement as well as complication rates. **Study Design:** Retrospective Observational study. **Setting:** GTTH, Lahore. **Period:** 1st September 2023 to 29th February 2024. **Methods:** A total of 32 patients were included in the study. Sixteen patients constituted each management group. The radiologic assessment of these patients included calculation of alpha (α) angle on AP and lateral views, femoral head neck offset and Southwick angle both preoperatively and on the last follow-up. Functional assessment comprised of Heyman and Herndon classification on the last follow-up. **Results:** The comparison of degree of improvement achieved showed that significant higher improvement in AP α-angle, Lat α-angle, head-neck offset and Southwick angle (with $p<0.001$ for each parameter) was achieved in the Mod. Dunn procedure subgroup. As per Heyman and Herndon classification, excellent and good outcome were more commonly seen in the group treated by Modified Dunn procedure. Most of the cases in both the management groups had an uncomplicated course **Conclusion:** Hence it can be concluded that the Mod. Dunn procedure is way more efficacious than in-situ fixation in terms of radiologic deformity correction as well as subsequent functional gain. At the same time the complication profile lies within the safe margins.

Key words: Femoro-acetabular Impingement, In-situ Fixation, Modified Dunn Procedure, Slipped Capital Femoral Epiphysis.

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is a pathology that affects overweight children during their teens. The management of SCFE requires stabilizing the epiphysis and achieving early fusion to prevent further slippage of the epiphysis.[1,2] This lowers changes of avascular necrosis of the head and prevents deformity. Thus in-site pinning has been the procedure of choice for mild to moderate cases of SCFE and has resulted in good lowa hip outcome.[3] However in-situ fixation of the femoral head in severe cases of SCFE leads to a deformed femoral head. Though the growing bone has ability to remodel but the remodeling doesn't completely restore the sphericity of the head. This leads to femoro-acetabular impingement (FAI) and early osteoarthritis: hence lowering the functional outcome. This has been presented in literature in terms of poor patient -reported outcome scores.[4,5]

To deal with the residual deformity realignment procedure for proximal femur have been carried out for severe SCFE.[6] These procedures effectively treat the complaints related to FAI and increase the arc of hip range of motion (ROM) but carry risk of osteonecrosis of the femoral head. However, better understanding of femoral head vascular supply has resulted in development of a technique that involve safe dissection of posterior retinaculum: the source of vascular supply of the femoral head.[7] This has led to development of modified Dunn sub-capital realignment procedure. The procedure involves safe dislocation of femoral head followed by corrective osteotomy and stabilization.

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Thus, correction and stabilization are achieved in a single procedure.[8,9] Encouraging results have been published regarding the procedure; however, some authors have reported high rates of avascular necrosis of femoral head and subsequent complications requiring major revision surgeries including total hip replacement (THR).[9] A study has reported femoral head avascular necrosis rate as high as 20% in patient undergoing modified Dunn procedure for stable SCFE. However, they didn't mention details of severity of slip in their study group.[10]

Up till now only a few studies have been done to compare the results of in-situ fixation and modified Dunn procedure. More so, no study from our region has reported any comparison of the two treatment modalities. Thus, aim of this study was to compare in-situ fixation and modified Dunn procedure in stable sever SCFE by assessing radiological and functional improvement as well as complication rates.

METHODS

After taking ethical approval (Ref. No.2024/02/R-29 Dated: 15-02-24) from institutional review board of Ghurki Trust Teaching Hospital, Lahore; a retrospective observational study was performed from 1st September 2023 to 29th February 2024. Data of all the cases of SCFE that underwent surgical fixation since 1st January 2017 was collected.

From these only the cases with (1) severe slip (diagnosed by a Southwick angle of >60 on lateral proximal femur radiograph) (2) stable slips (i-e the ones in which patient is able to bear weight with or without aid) and (3) having a minimal follow-up period of 1 year were included. All the patients who underwent any other procedure than in-situ fixation or modified Dunn, like closed reduction and internal fixation or intertrochanteric osteotomy were excluded. After application of these criteria, a total of 32 patients were included in the study. Sixteen were the patients that underwent in-situ fixation and were assigned to group A and 16 were the ones that underwent Modified Dunn procedure (these were assigned to group B). The radiologic assessment of these patients included calculation of alpha (α) angle on AP and lateral view, femoral head neck offset and southwick angle on the preoperative X-rays as well as the X-rays taken on last follow-up. Functional assessment comprised of Heyman and Herndon classification on the last follow-up. The classification system deems a hip's function is excellent if it has normal ROM, in absence of any limp or pain; and good, if there is no pain or limp with slight restriction of internal rotation (but internal rotation beyond neutral is possible). Function is classified fair if there is slight restriction of internal rotation and abduction in absence of limp or pain; and poor if there is slight limitation of flexion, internal rotation and abduction in presence of mild pain and limp following strenuous exercise. Finally, a hip is considered failed in presence of limp and pain on activity alongside markedly restricted motion that requires a reconstructive surgery or progressive radiologic worsening is evident. In all these cases management details, postoperative complications as well as subsequent surgical history was also recorded.

Modified Dunn procedure was performed as per the technique defined by Leunig et al. 2007 and Ziebarth et al. 2009.[11,12] These patients were kept non-weight bearing for 6 weeks followed by protected weight bearing with walking aids. In-situ fixation involved insertion of guidewire under fluoroscopic guidance from anterior aspect of femoral neck to the center of femoral head in both AP and Lateral views. Then 4.5 mm threaded screws were passed over the wires. These patients were asked to bear weight partially with crutches for 6 weeks.

Statistical Analysis

Statistical package for social sciences (SPSS) 23 was used for data entry and analysis. All the studied variables were compared in between the two groups. Independent sample t-test was used for quantitive variables and ch-square (fischer's exact) test was utilized foe categorical variables. All the results with p value of less than 0.05 were deemed statistically positive.

RESULTS

The study sample was composed of a total of 32 patients: 16 each group. The comparison of demographic variables and follow-up details is presented in Table-I. As is obvious from the table, none of these variables were significantly different among the study groups.

Table-II depicts the radiographic parameters illustrating preop means, postop means and improvement that occurred in each treatment group. The comparison of degree of improvement achieved showed that significant higher improvement in AP α-angle, Lat α-angle, head-neck offset and southwick angle (with $p<0.001$ for each parameter) was achieved in the Mod. Dunn procedure subgroup. Figure-1 presents the results of Heyman and Herdon functional analysis on the final follow-up. As is obvious from the illustration, excellent and good outcome were more commonly seen in the group treated by Modified Dunn procedure. Excellent and good functional assessment was noted in 8 (50%) and 3(18%) patients undergoing mod. Dunn procedure. However, only 4 (25%) and 2(12.5%) cases undergoing in-situ fixation had excellent and good outcome respectively. However, failure was very high in in-situ fixation group. The complications of each of the procedures are summarized in Table-III. Most of the cases in both the management groups had an uncomplicated course, that is 81% of in-situ fixations and 87.5% of Mod. Dunn procedure. Whereas, 2 (12.5%) and 1 (6.3%) of in-situ fixations showed slip progression and implant failure.

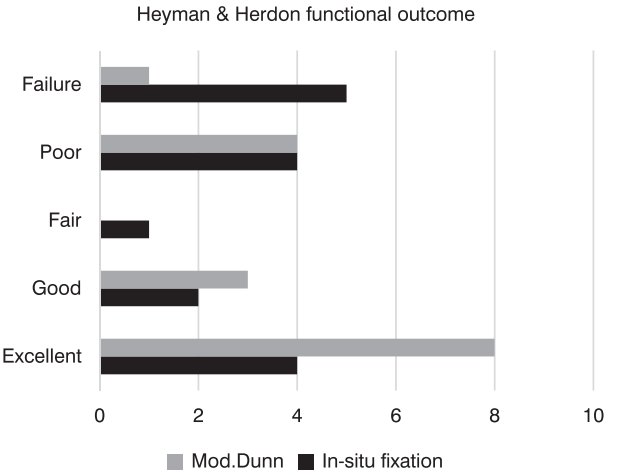

Figure-1. Illustration of functional outcome as per Heyman and Herdon classification.

Variable	In situ fixation	Modified Dunn	t-value/chi-square value*	P-Value
Gender (male/female)	12/4	10/6	0.58*	0.44
Side involved (right/left)	10/6	13/3	1.39*	0.23
Age (mean±SD)	12.75	14.44	-1.38	0.17
Follow-up (months) (mean±SD)	46.37	39.50	0.82	0.41

Table-I. Patient characteristics of both the treatment groups

Variable	In situ fixation	Modified Dunn	t-value	P-Value
AP α angle mean improvement (postop mean – preop mean)	-18.06 (70.62 - 88.68)	-46.06 (47.87 - 93.93)	14.19	<0.001
Lat α angle mean improvement (postop mean – preop mean)	-19.93 (84.12 - 104.06)	-63.06 (51.43 - 114.5)	19.11	<0.001
Head neck offset mean improvement (postop mean – preop mean)	4.56 (-5.25 - -9.81)	18.31 (6.12 - -12.18)	-11.95	<0.001
Southwick angle mean improvement (postop mean – preop mean)	-6.31 (57.50 – 63.81)	-54.12 (13.06 – 67.18)	25.35	<0.001

Table-II. Comparison of improvement in radiologic parameters

Variable	In situ Fixation n (%)	Modified Dunn n (%)	Chi-square Value	P-Value
None	13 (81%)	14 (87.5%)	5.03	0.28
Slip progression	2 (12.5%)	0 (0%)		
Osteonecrosis	0 (0%)	1 (6.3%)		
Implant impingement	1 (6.3%)	0 (0%)		
Implant failure	0 (0%)	1 (6.3%)		

Table-III. Complications observed in either treatment group.

DISCUSSION

In the case of SCFE management, in-situ fixation has a major defined role. In-situ fixation in mild to moderated SCFE has shown good results over the years; however, when it comes to severe SCFE the deformity of the femoral head is an issue. Though the head can remodel in the growing age, but literatures has shown that FAI and resultant osteoarthritis (OA) are major long-term complications. This is where Mod Dunn procedure has management implications. Thus, we studied the role Mod. Dunn in severe SCFE and compared it with in-situ fixation.

Mod. Dunn procedure produces excellent correction in the head deformity.[11-13] However, not much comparative data is available to gauge the efficacy of Mod. Dunn procedure against in-situ fixation. A recent study done by Eduardo N and colleagues however compared radiographic outcome following each of the abovementioned procedure in severe SCFE cases. They reported that median alpha angle on lateral view was 44 following corrections of deformity by Mod. Dunn in comparison to the postop median alpha angle of 87 following in-situ fixation.[14] Similar findings were noted in our study population i-e postop lateral alpha angle in Mod. Dunn group was significantly lower than the angle noted in in-situ fixation group (51.43 in comparison to 114.5). However, the deformity that remains gets better with time due to constant impingement between deformed head and acetabulum.[16] Eduardo N et al. reported that the postop alpha angle improved through remodeling and lesser deformity was noted on the final follow-up.[14] This remodeling process occurs at the metaphyseo-epiphyseal junction but it is not potent enough to completely obliterate the deformity. This can be explained by findings of Castaneda et al. They reported that in the cases they studied 80% of in-situ fixation cases had a pistol grip deformity and associated signs of hip OA, on 20 years follow-up.[16] Similarly, a study done by Wensaas et al. concluded that after long term follow up (i-e 37 years) almost all of the 36 patients that underwent in-situ fixation showed radiographic evidence of deformity and subsequent impingement.[17] Whereas, the Mod. Dunn procedure eliminates the deformity during the surgical procedure. Eduardo N et al. mentioned that statistically significant improvement occurred following Mod. Dunn procedure in all the four radiographic parameters they studied i-e AP α-angle, Lat α-angle, head-neck offset and southwick angle. Similar findings were evident in our surgical cohorts. The comparison of degree of improvement achieved in either surgical cohort showed that significantly higher improvement in AP α-angle, Lat α-angle, head-neck offset and southwick angle (with $p<0.001$ for each parameter) was noted in the Mod. Dunn procedure subgroup.[16]

Functional assessment of the patients following each procedure has also been done previously. Eduardo N et al depicted that almost double number of patients undergoing Mod. Dunn procedure had good or excellent functional outcome as per Heyman and Herndon classification.[14] Masse and co-researchers also reported similar results when they assessed their study population on basis of Harris hip score.[16] Our research findings are in concordance to both the aforementioned publications. Excellent and good functional assessment was evident in 8 (50%) and 3(18%) patients undergoing mod. Dunn procedure. However, only 4 (25%) and 2(12.5%) cases undergoing in-situ fixation had excellent and good outcome respectively.

The most common reason for which Mod. Dunn procedure has been refuted in past is that it is a potential cause of avascular necrosis of femoral head. Thus, the complication rates of both the procedures have been studied by many researchers. Eduardo N et al didn't find any difference in complication rates among the procedures. In their study population, osteonecrosis was evident in 7% of cases undergoing either surgical procedure.[16] Slongo and colleagues also reported only a single case of osteonecrosis among the 9 patients they treated with Mod. Dunn procedure.[14] None of the patients treated by Masse and coworkers with Mod. Dunn procedure developed osteonecrosis.[13] Similarly in our study most of the cases in both the management groups had an uncomplicated course, that is 81% of in-situ fixations and 87.5% of Mod. Dunn procedure. Whereas, 2 (12.5%) and 1 (6.3%) of in-situ fixations showed slip progression and implant, respectively. Thus, it can be postulated that the Mod. Dunn procedure is very effective at treating the deformity and at the same time is safe with a complications profile similar to that of in-situ fixation.

LIMITATION

It was a retrospective unicentric study. A prospective interventional multicentric design would yield more valid results. Similarly, there is a need for a blinded interventional study that would evaluate other surgical management options as well and compare them in all the subtypes of SCFE

CONCLUSION

Hence it can be concluded that the Mod. Dunn procedure is way more efficacious than in-situ fixation in terms of radiologic deformity correction as well as subsequent functional gain. At the same time the complication profile lies within the safe margins. However, higher level multi-centric interventional studies are required to back these findings.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Syed Kashif Shah Bukhari:** Conceptualizaton and framework of study.
2	**Ziarmal Khan:** Data collection.
3	**Jawad ul Haq:** Critical review.
4	**Farman ul Haq:** Data collection.
5	**Atiq uz Zaman:** Critical review.
6	**Sadaf Saddiq:** Data analysis.