IJMA

International Journal of Medical Arts

Volume 6, Issue 9, September 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Orthopedic Surgery]

Original Article

Treatment of Slipped Capital Femoral Epiphysis by Modified Dunn's Procedure [A Systematic Review and Meta-Analysis]

Ahmed Ramzy Elhossiny [1]*, Mohammed Abdallah Hassan [2], Mahmoud Mohamed El-Said [2]

[1] Department of Orthopedic Surgery, Kafr-Saad Central Hospital, Ministry of Health, Kafr-Saad, Egypt.

[2] Department of Orthopedic Surgery, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt.

Article information

Received: 14-07-2024

Accepted: 23-09-2024

DOI: 10.21608/ijma.2024.188849.1605.

*Corresponding author

Email: a.ramzy1718@gmail.com

Citation: Elhossiny AR, Mohamed AH, El-Said MM. Treatment of Slipped Capital Femoral Epiphysis by Modified Dunn's Procedure [A Systematic Review and Meta-Analysis]. IJMA 2024; September; 6 [9]: 4925-4932. DOI: 10.21608/ijma. 2024.188849.1605.

ABSTRACT

Background: The optimal course of treatment for moderate to severe stable slipped capital femoral epiphysis [SCFE] is still up for debate. There are a few acknowledged drawbacks to in situ pinning in these situations. Because of this, a number of writers have begun to contemplate using a modified Dunn technique on such individuals.

Aim: This study aimed to analyze literature comparing modified Dunn's approach and percutaneous in situ fixation in patients with moderate or severe SCFE

Methods: A search strategy was formulated firstly then we used it on different databases such as PubMed, Web of Science, Cochrane Library, and Scopus to reach the studies compared the modified Dunn procedure versus in situ fixation for SCFE. Screening was done followed by data extraction and statistical analysis of the outcomes.

Results: The literature search process yielded 802 records. After primary and secondary screening, the, meta-analysis incorporated six studies. The meta-analysis of avascular necrosis, based on data from four trials including a total of 240 patients, did not show a preference for either of the two groups [RR 2.95, 95% CI [0.55 to 15.72], P=0.21].

Conclusion: The clinical outcomes in the short- to medium-term were comparable between patients with moderate to severe SCFE who underwent in situ fixation and those who underwent the modified Dunn's operation.

Keywords: Slipped; Capital Femoral Epiphysis; Dunn's; In situ fixation.

INTRODUCTION

Slipped capital femoral epiphysis [SCFE] is a prevalent disease, with an incidence of around 8 to 10 cases per 100,000 teenagers in the Western world. Although the main cause is unknown, there are several important risk factors for this condition, including childhood obesity, and being male [1]. SCFE is typically categorized based on the length of time the clinical symptoms last, with acute cases lasting up to 3 weeks, chronic cases lasting more than 3 weeks, and acute on chronic cases. Additionally, SCFE can be classed as stable or unstable depending on the walking capacity of the affected patient. Patients with stable hips may bear weight, either with or without crutches. However, patients with unstable hips are unable to bear weight, even with the assistance of crutches [2]. It can also be categorized as mild, moderate, or severe based on the slip angle. These categorizations assist surgeons in selecting the optimal course of treatment [3]. Surgical intervention is typically necessary to stabilize the slipping capital femoral epiphysis, ensuring the early fusion of the proximal femoral physis and preventing additional displacement and deformity. Screw fixation performed in situ is the prevailing method for treating stable SCFE, irrespective of the extent of deformity [4].

Presently, there is a dearth of agreement regarding the optimal therapy for moderate or severe stable SCFE. In such instances, the technique of in situ pinning is associated with some drawbacks, including the persistence of femoral head-neck deformity, a high likelihood of femoroacetabular impingement [FAI] in the future, potential damage to the articular cartilage, and less than desirable results [3]. As a result, many authors have proposed using a modified Dunn method for these patients. However, it is important to note that this procedure has a greater incidence of avascular necrosis [AVN] in the short term [5, 6]. This method stabilizes the epiphysis and rectifies the deformity in a single surgical procedure by restoring the anatomical structure of the femoral head and neck, perhaps preventing any long-term consequences of femoroacetabular impingement. Moreover, when handled by skilled individuals, Dunn is considered safe, with minimal rates of complications [3,7]. So, this study aims to compare the modified Dunn's method and percutaneous in situ fixation in patients with moderate or severe SCFE.

METHODS

Upon the PRISMA guidelines we performed our systematic review.

Literature search strategy

Three authors act independently to search on network databases including PubMed, Cochrane Library, Web of Science, EMBASE and Scopus to identify randomized controlled trials, retrospective studies and prospective studies published from 1985 to September 2022. A search strategy was established [Dunn OR [Modified Dunn] OR [Dunn's procedure] OR [capital realignment]] AND [[Slipped Capital Femoral Epiphysis] OR [slipped upper femoral epiphysis]] AND [pinning OR fixation OR [in situ fixation]]

Eligibility criteria: We included all RCTs, retrospective and prospective studies match with the following inclusion criteria:

(1) **Populations:** SCFE patients.

(2) **Intervention:** modified Dunn procedure

(3) **Comparator**: in situ fixation

(4) **Outcomes:** alpha angle, Southwick angle, avascular necrosis, chondrolysis, implant fail, osteonecrosis, reoperation and slip progression.

Our exclusion criteria were: 1] Non-English publications, 2] Reviews, editorial, letters, and book chapters, and 3] Other surgical approaches.

Screening: Firstly title/abstract screening was done followed by full-text screening. Searching databases in a total of 802 studies y. We excluded 742 studies due to the following factors: 420 of an irrelevant topic, while did not match all the inclusion criteria of the study design. Additionally, 15 publications were published in none English language. After conducting a thorough analysis of the complete text of the remaining 60 articles, using specific criteria to determine which research to include and exclude, 6 papers were chosen to be included in the current review. Publications published between 2013 and 2022 were chosen for analysis. These publications covered a total of 412 hip cases, with follow-up periods ranging from 0.5 to 10 years. Out of these, 274 were classified as stable, 50 as unstable, and the remaining 88 were categorized as unknown.

Data extraction and Risk of Bias assessment: We extracted the characteristics of each study as following: first author, study design, year of publication, duration of study, country, population number, Operation procedures. The Newcastle-Ottawa Scale tool was used for the quality assessment of the studies.

Outcomes: Outcomes of the study were femoral head avascular necrosis, chondrolysis, implant fail, osteonecrosis, reoperation and slip progression. Continuous variables were expressed as mean ± standard deviation, and dichotomous variables are expressed by event number and total number.

Statistical analysis: The frequency of occurrences and the total number of patients in each group were combined to calculate the risk ratio between the two groups using the Mantel-Haenszel [M-H] random-effects model for dichotomous data outcomes. The statistical analyses were conducted using Stata/MP version 17 for Microsoft Windows. Statistical heterogeneity among studies was evaluated by the Chi-square test [Cochrane Q test]. Then, the chi-square statistic, Cochrane Q, was used to calculate the I-squared according to the equation: $I2=\left(\frac{Q-df}{Q}\right)x100\%$. A Chi-square P value less than 0.1 was considered as significant heterogeneity. I-square values ≥50% were indicative of high heterogeneity.

RESULTS

Literature search results and study selection

The literature search method yielded a total of 802 records. After conducting a thorough review of the titles and abstracts, a total of 60 articles met the criteria for further examination of the full text. Out of the total of 60 investigations, only six papers were selected for the meta-analysis. In addition, the references of the included research were thoroughly examined through manual search, and no more publications were deemed relevant for inclusion. The research selection process is visually represented in the PRISMA flow diagram **[Figure 1].**

Study characteristics: A total of 412 patients with SCFE who underwent surgery with either modified Dunn or in situ fixation were included in all of the trials. All the research considered in the analysis were retrospective observational studies, totaling six in number. Table 1 provides a summary of the features of the studies that were included, while Table 2 displays the summary and baseline characteristics of the people involved in this research.

Risk of bias within studies: Risk of bias in individual studies was analyzed using the Newcastle-Ottawa Scale. The results are displayed in **Table 3.**

Avascular Necrosis: The pooled analysis of the avascular necrosis reported by four studies [n=240 patients] did not favor either of the two groups [RR 2.95, 95% CI [0.55 to 15.72], P=0.21]. The pooled studies were not homogenous [P=0.07; I2=54.5%] **[Figure 2]**.

Chondrolysis: The pooled analysis of the chondrolysis reported by four studies [n=275 patients] did not favor either of the two groups [RR 1.84, 95% CI [0.47 to 7.27], P=0.38]. The pooled studies were homogenous [P=0.22; I2=32.78%] **[Figure 3]**.

Osteonecrosis: The pooled analysis of the osteonecrosis reported by four studies [n=344 patients] did not favor either of the two groups [RR 2.15, 95% CI [0.58 to 7.99], P=0.25, Figure 5]. The pooled studies were homogenous [P=0.70; I2=0%] **[Figure 4].**

Slip progression: The pooled analysis of the slip progression reported by three studies [n=247 patients] did not favor either of the two groups [RR 1.42, 95% CI [0.26 to 7.62], P=0.68, **Figure 5**]. The pooled studies were homogenous [P=0.26; I2=23.73%].

Failure of implant: The pooled analysis of the failure of implant reported by three studies [n=215 patients] did not favor either of the two groups [RR 1.27, 95% CI [0.33 to 4.85], P=0.73,]. The pooled studies were homogenous [P=0.83; I2=0%] **[Figure 6].**

Re-operation: The pooled analysis of the re-operation reported by four studies [n=285 patients] did not favor either of the two groups [RR 1.20, 95% CI [0.38 to 3.81], P=0.76]. The pooled studies were not homogenous [P=0.05; I2=62.39%] **[Figure 7].**

Alpha angle: The overall standardized mean difference [SMD] of the alpha angle reported by four studies [n=182 patients] was less in the modified Dunn's group than in the situ fixation group [SMD -4.36, 95% CI [-6.21 to -2.52], P=0.0001]. The pooled studies were not homogenous [P=0.001; I2=90.60%] **[Figure 8].**

Southwick angle: The overall standardized mean difference [SMD] of the Southwick angle reported by three studies [n=156 patients] was less in the modified Dunn's group than in the situ fixation group [SMD -5.06, 95% CI [-9.45 to -0.68], P=0.02]. The pooled studies were not homogenous [P=0.001; I2=97.90%] [**Figure 9].**

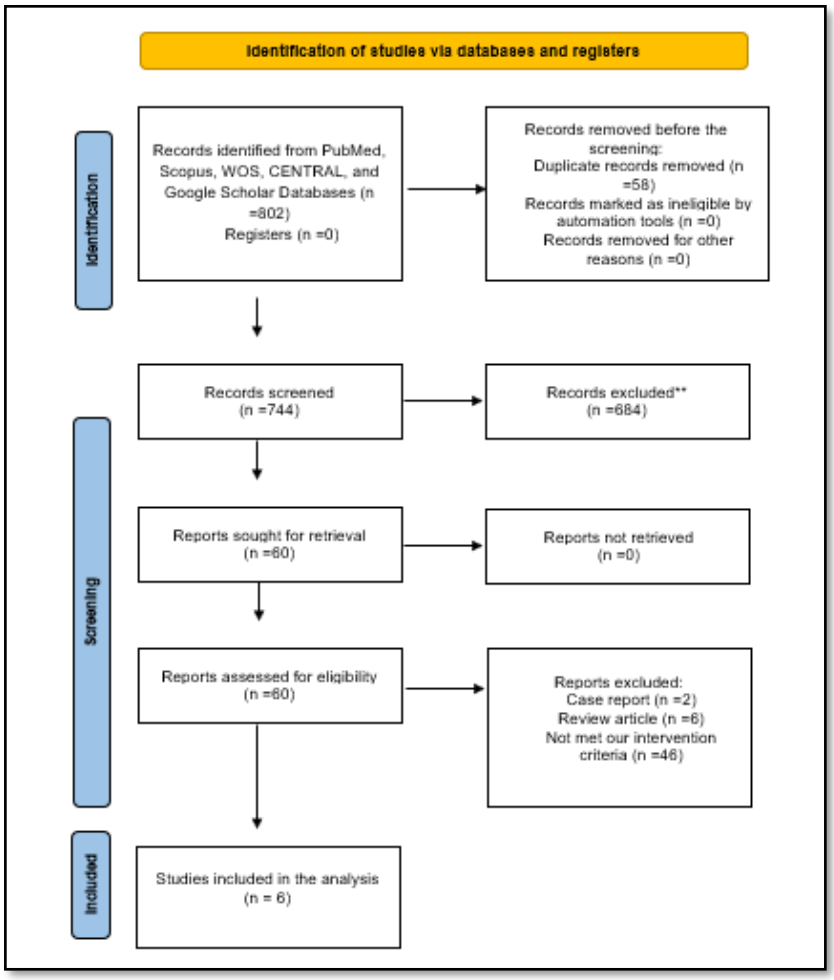

Figure [1]: PRISMA flow diagram.

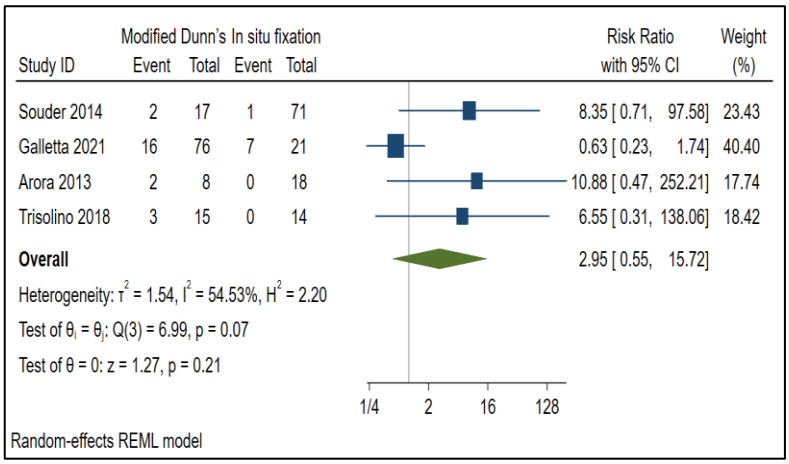

Figure [2]: Pooled analysis of the avascular necrosis in the included studies.

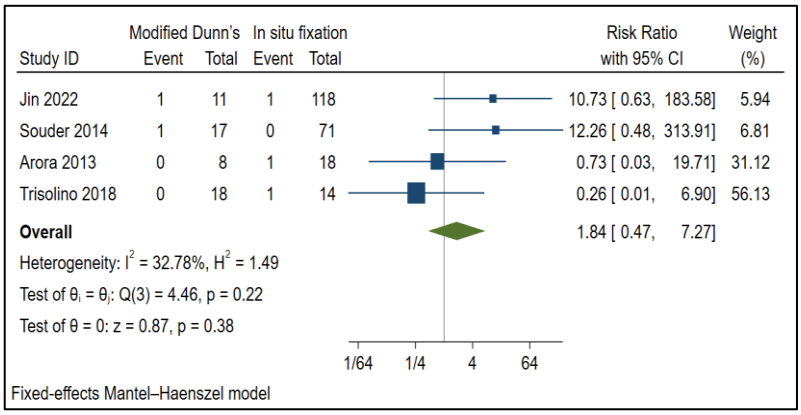

Figure [3]: Pooled analysis of the chondrolysis in the included studies.

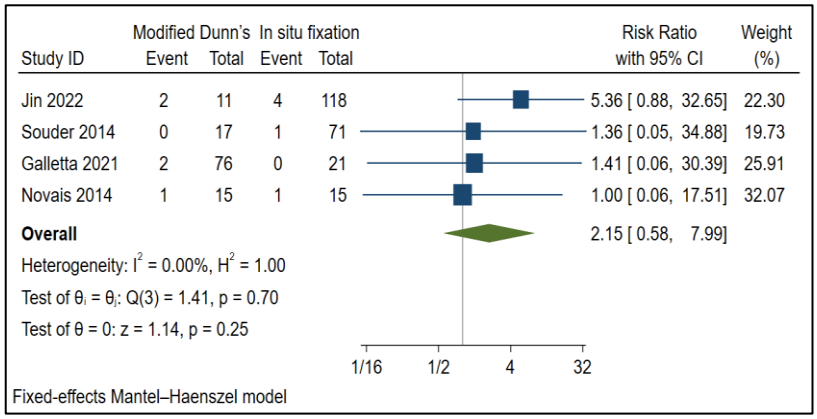

Figure [4]: Pooled analysis of the osteonecrosis in the included studies

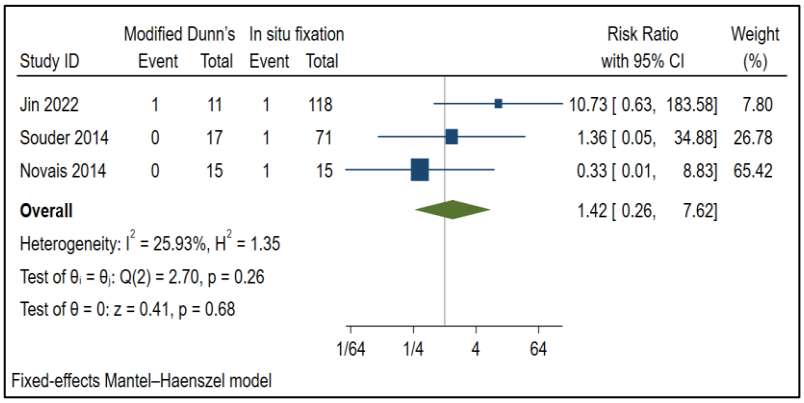

Figure [5]: Pooled analysis of the slip progression in the included studies

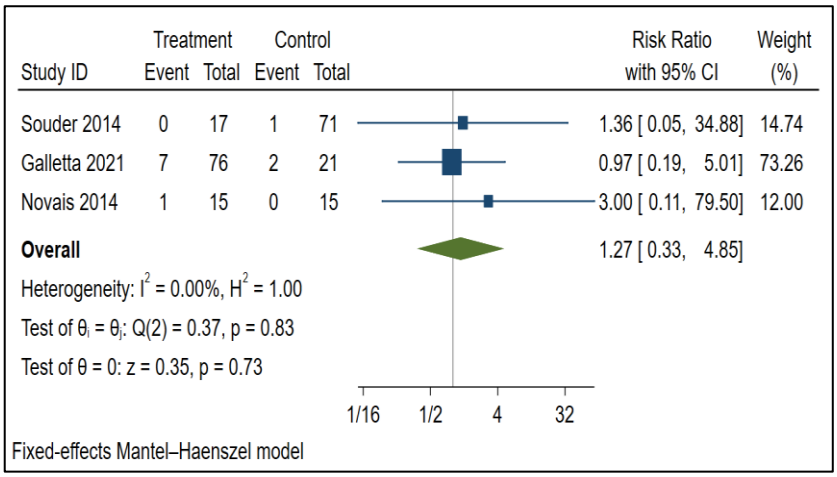

Figure [6]: Pooled analysis of the implant failure in the included studies.

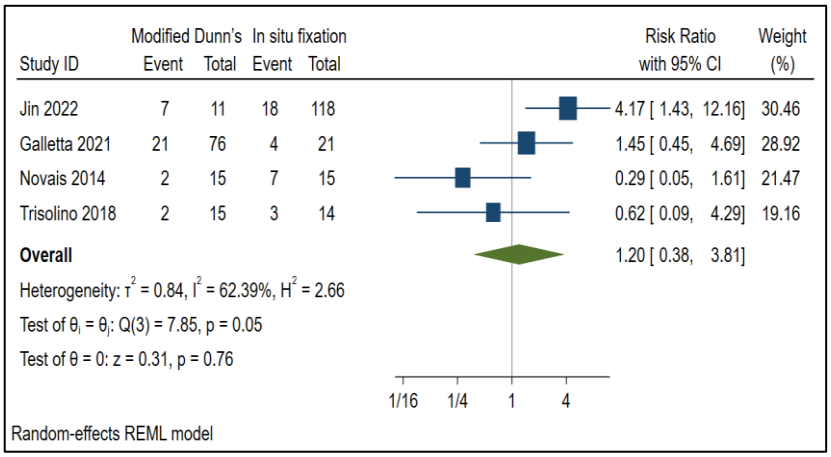

Figure [7]: Pooled analysis of the re-operation in the included studies.

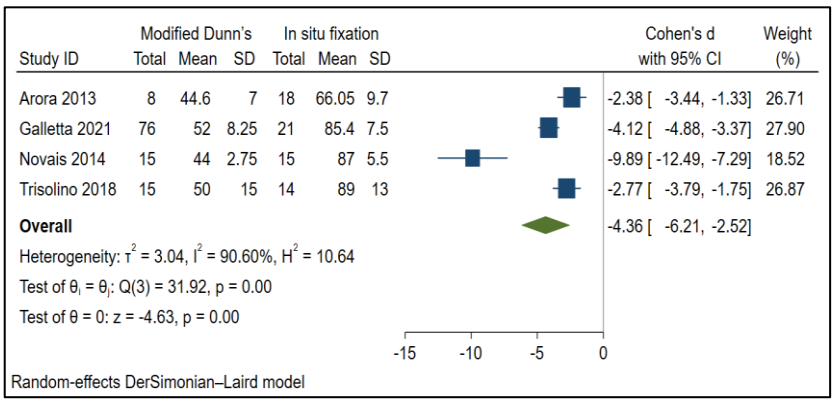

Figure [8]: Pooled analysis of the re-operation in the included studies

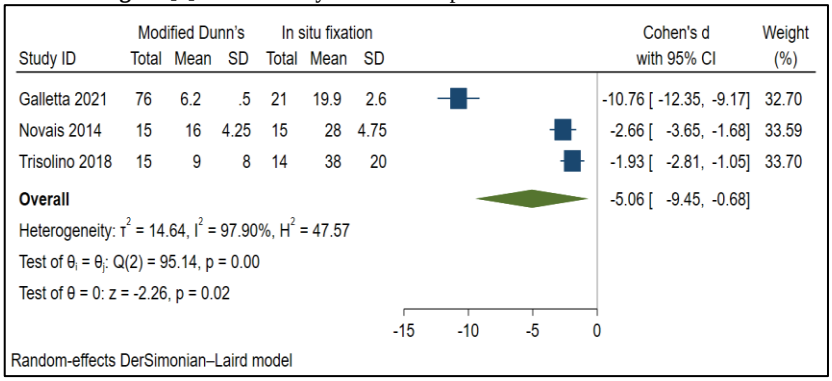

Figure [9]: Pooled analysis of the Southwick angle in the included studies

Table [1]: Baseline characteristics of included studies. In In situ fixation

Author	Trisolino et al	Novais et al	Galletta et al	Arora et al.	Soulder et al.	Jin et al.
Location	Italy	USA	Italy	India	USA	Canada
Study design	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort
N	29	30	110	26	88	129
Final follow-up	7 years	6 years	10 years	4 years	2.5 years	6 months
Number of hips	14	15	22	18	71	118
Gender [M/F]	11/3	9/6	20/1	NA	46/25	83/35
Age at surgery	13±1	13	12.9	NA	12.2±1.6	12.6±2.75
BMI [kg/m2]	24±4	NA	23	NA	NA	NA
Preoperative Southwick angle [°]	62±9	63	NA	59±18	NA	NA
Stability of slip [stable/ unstable]	14/0	15/0	22/0	16/2	NA	90/28

NA: Not Applicable

Table [2]: Baseline characteristics of included studies in Modified Dunn's procedure.

Author	Trisolino et al	Novais et al	Galletta et al	Arora et al.	Galletta et al.	Jin et al.
Location	Italy	USA	Italy	India	USA	Canada
Study design	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort	Retrospective cohort
N	29	30	110	26	88	129
Final follow-up	7 years	6 years	10 years	4 years	1.5 years	6 months
Number of hips	14	15	81	8	17	11
Gender [M/F]	11/3	11/4	59/17	NA	11/6	5/6
Age at surgery	13.9±2.3	14	13.6	NA	12.2±1.6	11.7±1.45
BMI [kg/m2]	24±4	NA	24.2	NA	NA	NA
Preoperative Southwick angle [°]	68±11	65	NA	72±37	NA	NA
Stability of slip [stable/ unstable]	15/0	15/0	81/0	0/8	NA	6/5

NA: Not Applicable

Table [3]: Newcastle Ottawa Scale for risk of bias assessment within the studies.

Author	Selection				Comparability	Outcome		
	Representativeness of modified Dunn's procedure cohort	Selection of in situ fixation cohort	Ascertainment of exposure	Outcome of interest not present at the start of study		Assessment of outcome	Follow-up length	Adequacy of follow-up
Trisolino et al	1	1	1	1	2	1	1	1
Novais et al	1	1	1	1	2	1	1	0
Galleta et al	1	1	1	1	2	1	1	1
Arora et al	1	1	1	1	1	1	1	1
Soulder et al	1	1	1	1	2	1	1	1
Jin et al	1	1	1	1	2	1	1	1

DISCUSSION

Our study indicated that patients with moderate or severe slips who undergo the modified Dunn's approach have similar short-term clinical results to those who have in situ fixing.

As regards the gender distribution of the patients in the included studies, the pooled data revealed that the SCFE more prevalent in male than female. This is in agreement with the previous literature, which reported that the incidence of SCFE in male 1: 7500, and 1: 12500 in female [2]. So, the male gender may be considered a risk factor for occurrence of SCFE. However, this disagree with the results of **Witbreuk et al.** [8] who found no difference between the boys and girls in the incidence of the SCFE.

In terms of AVN; The incidence of AVN was variable, with some studies reporting no cases of AVN in the two procedures, to some with a high incidence of up to 33.3% of AVN in in situ fixation group [3]. A total of 8 [5%] cases of AVN were reported in the in-situ fixation, and 23 [19.8%] cases in the modified Dunn's. Pooled data from four studies that reported AVN revealed that the modified Dunn's riskier to develop AVN than in situ fixation by 2.9 times, however, this difference between the two procedures was not significant. This is in agreement with previous trials which studied the modified Dunn's alone in the treatment of SLCFE.

Davis *et al.* [9] treated thirty-one consecutives unstable SCFEs by modified Dunn's procedure and reported AVN up to 50 % of the cases which is in line with our study findings. However, **Sikora-Klak *et al.*** [10] reported 29 % incidence of AVN in the modified Dunn's procedure in comparison to Femoral Osteotomy as the osteotomy avoids damage to the vascular supply of the femoral head, which disagree with our finding.

Two studies [3,11] conducted intraoperative monitoring of vascularity. In contrast to in-situ fixation, the modified Dunn's method is conducted as an open operation to achieve alignment, resulting in enhanced radiological characteristics.

Although the technique was open, the reported incidence of avascular necrosis was not significantly greater than that observed in patients who underwent in situ fixation. While these studies demonstrate positive radiological results in the modified Dunn's technique group, it is important to note that this may not be applicable to other medical centers due to the presence of a learning curve [1].

It is widely acknowledged that in complex procedures, the skill and knowledge of the surgeon have a substantial impact on the results of the surgery. Furthermore, due to the high prevalence of stable slips among the participants, it is challenging to make any conclusive statements regarding the incidence of problems in unstable hips.

Patients with moderate or severe slipped capital femoral epiphysis [SCFE] who undergo in situ fixation may have a possible risk of developing symptomatic femoroacetabular impingement [FAI]. In SCFE, the epiphysis is displaced posteriorly and medially, causing the femoral metaphysis to be positioned anteriorly and laterally. This might potentially lead to the femoral metaphysis coming into contact with the front part of the acetabulum when the hip is flexed [1].

As regards the implant removal, three of the included studies reported implant removal, in **Galletta *et al.*** [3]; Implant removal was routinely scheduled after ossification of the growth plate and not earlier than 1 year after index surgery, however they removed it earlier for seven complicated cases in modified Dunn's and for two cases in in situ fixation.

In **Souder *et al.*** [13], they reported only one case of implant failure in the in-situ fixation. Unlike to Novais **et al.,** [7] who reported one case of implant failure in the modified Dunn's.

Although our result showed that the implant failure was more prevalent in the modified Dunn's than the in-situ procedure, which agree with **Huber *et al.*** and **Ziebarth *et al.*** [14,15] who reported 13%, 7.5% implant failure in modified Dunn's respectively, this difference in our meta-analysis was not significant statistically.

In terms of radiological outcomes, the Southwick slip angle and Alpha angle] improved significantly, which agree with previous Meta-analysis [1].

Traditional cannulated or completely threaded screws were used for in situ fixation in all of the included trials in our meta-analysis. It is important to note that this does not capture the complete range of treatment choices open to orthopedic surgeons. Unthreaded fixation methods, including the Hansson hook-pin or proximally threaded screws, as well as growing implants like the Pega Medical Free Gliding and Synthes SCFE screws, may promote greater remodeling of the hip and hence prevent coxa breva after fixation [16,17].

There was a 50% chance of remodeling after traditional pinning in cases of moderate to severe slides, according to previous study [18]. However, it has yet to be thoroughly determined how much of an improvement in remodeling can be expected with the use of these devices and how much of an effect that improvement will have on long-term clinical results.

Our study has multiple **limitations**. Initially, there is a scarcity of research that directly compares the two therapies. Most studies have a limited sample size, which might result in a small-study effect, characterized by an exaggeration of the treatment effects.

All the utilized studies were retrospective, potentially introducing bias due to their methodology. Due to the limited size of the groups, it is probable that the surgeon's expertise or personal preference influenced the selection of one intervention over the other.

In addition, with the exception of one study, all other studies just examined steady slips, potentially exerting a significant influence on the outcomes. Moreover, the clinical outcome measures exhibited significant variations, rendering the conduct of a meta-analysis unfeasible.

Furthermore, there was a significant disparity in the radiological findings, which did not correspond to the evaluation of avascular necrosis or chondrolysis rates. This discrepancy may have arisen due to variations in the calculation of radiography values among different observers. Nevertheless, the presence of methodological variability may have also influenced the outcome.

Conclusion:

The clinical outcomes in the short- to medium-term were comparable between patients with moderate to severe SCFE who underwent in situ fixation and those who underwent the modified Dunn's operation

Disclosure: None to be disclosed

REFERENCES

1. Cheok T, Smith T, Berman M, Jennings M, Williams K, Poonnoose PM, et al. Is the modified Dunn's procedure superior to in situ fixation? A systematic review and meta-analysis of comparative studies for management of moderate and severe slipped capital femoral epiphysis. J Child Orthop. 2022 Feb 5;16[1]:27–34. DOI: 10.1177/18632521221078864

2. Gorgolini G, Caterini A, Efremov K, Petrungaro L, De Maio F, Ippolito E, et al. Surgical treatment of slipped capital femoral epiphysis [SCFE] by Dunn procedure modified by Ganz: a systematic review. BMC Musculoskelet Disord. 2022 Feb 7;22[S2]:1064. DOI: 10.1186/s12891-022-05071-9

3. Galletta C, Aprato A, Giachino M, Marre' Brunenghi G, Boero S, Turchetto L, et al. Modified Dunn procedure versus percutaneous pinning in moderate/severe stable slipped capital femoral epiphyses. HIP Int. 2022; 32[6]:813-819. DOI: 10.1177/11207000211004862.

4. Trisolino G, Stilli S, Gallone G, Santos Leite P, Pignatti G. Comparison between modified Dunn procedure and in situ fixation for severe stable slipped capital femoral epiphysis: A retrospective study of 29 hips followed for 2–7 years. Acta Orthop. 2018;89[2]:211–6. DOI: 10.1080/17453674.2018.1439238.

5. Sankar WN, Vanderhave KL, Matheney T, Herrera-Soto JA, Karlen JW. The Modified Dunn Procedure for Unstable Slipped Capital Femoral Epiphysis. J Bone Jt Surg. 2013 Apr 3;95[7]:585–91. doi: 10.2106/JBJS.L.00203.

6. Sikora-Klak J, Bomar JD, Paik CN, Wenger DR, Upasani V. Comparison of Surgical Outcomes Between a Triplane Proximal Femoral Osteotomy and the Modified Dunn Procedure for Stable, Moderate to Severe Slipped Capital Femoral Epiphysis. J Pediatr Orthop [Internet]. 2019 Aug; 39[7]:339–46. DOI: 01241398-201908000-00003

7. Novais EN, Hill MK, Carry PM, Heare TC, Sink EL. Modified Dunn Procedure is Superior to In Situ Pinning for Short-term Clinical and Radiographic Improvement in Severe Stable SCFE. Clin Orthop Relat Res [Internet]. 2015 Jun;473[6]:2108–17. DOI: 10.1007/s11999-014-4100-1.

8. Witbreuk MM, van Royen BJ, Van Kemenade FJ, Witte BI, van der Sluijs JA. Incidence and gender differences of slipped capital femoral epiphysis in the Netherlands from 1998–2010 combined with a review of the literature on the epidemiology of SCFE. J Child Orthop [Internet]. 2013 Mar 1;7[2]:99–105. DOI:10.1007/s11832-012-0479-y.

9. Davis RL, Samora WP, Persinger F, Klingele KE. Treatment of Unstable Versus Stable Slipped Capital Femoral Epiphysis Using the Modified Dunn Procedure. J Pediatr Orthop. 2019;39[8]:411–5. DOI: 10.1097/BPO.0000000000000975.

10. Sikora-Klak J, Bomar JD, Paik CN, Wenger DR, Upasani V. Comparison of Surgical Outcomes between a Triplane Proximal Femoral Osteotomy and the Modified Dunn Procedure for Stable, Moderate to Severe Slipped Capital Femoral Epiphysis. J Pediatr Orthop. 2019;39[7]:339–46. DOI: 10.1097/BPO.0000000000000968.

11. Arora S, Dutt V, Palocaren T, Madhuri V. Slipped upper femoral epiphysis: Outcome after in situ fixation and capital realignment technique. Indian J Orthop. 2013;47[3]:264–71. DOI: 10.4103/0019-5413.111492.

12. Novais EN, Hill MK, Carry PM, Heare TC, Sink EL. Modified Dunn Procedure is Superior to In Situ Pinning for Short-term Clinical and Radiographic Improvement in Severe Stable SCFE. Clin Orthop Relat Res. 2015;473[6]:2108–17. DOI: 10.1007/s11999-014-4100-1.

13. Souder CD, Bomar JD, Wenger DR. The role of capital realignment versus in situ stabilization for the treatment of slipped capital femoral epiphysis. J Pediatr Orthop. 2014; 34 [8]: 791–8. DOI: 10.1097/BPO.0000000000000193.

14. Huber H, Dora C, Ramseier LE, Buck F, Dierauer S. Adolescent slipped capital femoral epiphysis treated by a modified Dunn osteotomy with surgical hip dislocation. J Bone Joint Surg Br [Internet]. 2011 Jun;93-B[6]:833–8. DOI: 10.1302/0301-620X.93B6.25849

15. Ziebarth K, Zilkens C, Spencer S, Leunig M, Ganz R, Kim Y-J. Capital realignment for moderate and severe SCFE using a modified Dunn procedure. Clin Orthop Relat Res [Internet]. 2009 Mar;467[3]:704–16. DOI: 10.1007/s11999-008-0687-4.

16. Örtegren J, Björklund-Sand L, Engbom M, Siversson C, Tiderius CJ. Unthreaded Fixation of Slipped Capital Femoral Epiphysis Leads to Continued Growth of the Femoral Neck. J Pediatr Orthop [Internet]. 2016 Jul;36[5]:494–8. DOI: 10.1097/BPO.0000000000000684.

17. Morash K, Orlik B, El-Hawary R, Gauthier L, Logan K. Femoral Neck Growth and Remodeling With Free-Gliding Screw Fixation of Slipped Capital Femoral Epiphysis. J Pediatr Orthop [Internet]. 2021 Apr;41[4]:e309–15. DOI: 10.1097/BPO.0000000000001770

18. Jones, Paterson D, Hillier T, Foster B. Remodelling after pinning for slipped capital femoral epiphysis. J Bone Joint Surg Br [Internet]. 1990 Jul;72-B[4]:568–73. DOI: 10.1302/0301-620X.72B4.2380205

IJMA

International Journal of Medical Arts

Volume 6, Issue 9, September 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780