

Slipped capital femoral epiphysis: Diagnostic pitfalls and therapeutic options

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Abstract

One of the most prevalent hip pathologies that develops during adolescence is Slipped Capital Femoral Epiphysis (SCFE), and over the past few decades, its incidence has been rising. To ensure an early diagnosis and prompt intervention, orthopedic surgeons should be aware of this entity. Review of recent developments in clinical examination and imaging diagnostic procedures.

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Key words: Epiphysis; femoral; fracture; orthopedic; surgery.

Contributions: EP: conceptualization (equal), methodology (equal), writing of the original draft (supportive), and writing including review and editing (equal). DP: writing of the original draft (supportive), and writing including review and editing (equal). VMC: writing of the original draft (supportive), and writing including review and editing (equal). AM: writing of the original draft (supportive), and writing including review and editing (equal).

Funding: None.

Conflict of interest: The Authors declare no conflict of interest.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate: Not applicable.

Informed consent: Not applicable.

Received for publication: 30 September 2022.

Revision received: 4 October 2022.

Accepted for publication: 4 October 2022.

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La Pediatria Medica e Chirurgica 2022; 44(s1):296

doi:10.4081/pmc.2022.296

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The presentation includes commonly used imaging methods, slippage measurement techniques, and classification schemes that are pertinent to treatment. An overview of SCFE surgery based on pertinent study findings and knowledge gained from ongoing clinical practice. The gold standard treatment for stable SCFE cases—those in which the continuity of the metaphysis and epiphysis is preserved—is pinning in situ using a single cannulated screw without reduction. However, there are disagreements over the best course of action for stable moderate/severe SCFE. On the best surgical strategy for unstable epiphysiolysis, no universal agreement has been reached. Finding the surgical procedure that will improve the long-term outcomes of a slipped capital femoral epiphysis is the question at hand.

Introduction

Slipped Capital Femoral Epiphysis (SCFE) is a fracture through the femoral growth plate resulting in slippage of the overlying metaphysis. Behind this phenomenon occurring in teens and early teens are increased forces applied across the epiphysis and a decreased resistance within the physis, owing to an inherent “weakness” of the cartilaginous growth plate.

Several classifications have been devised to stage this pathology: surgery-wise, the most prominently used are Southwick slip angle classification, which distinguishes mild, moderate, and severe cases based on the femoral epiphyseal-diaphyseal angle difference (respectively, $<30^\circ$, between 30° - 50° , or $>50^\circ$), and Loder classification, which distinguishes stable and unstable cases based on the patient's ability to bear weight on the affected lower limb.

For stable mild SCFE, pinning in situ is the globally preferred treatment.¹ However, pinning in situ is not equally efficient in treating unstable SCFE, or moderate/severe cases.²

Materials and Methods

This study aims to identify the most appropriate treatment for SCFE.

Discussion

Stable SCFE cases, where the metaphysis-epiphysis continuity is preserved, pinning in situ by means of a single cannulated screw without reduction is the gold standard treatment.² However, controversies arise in deciding treatment for stable moderate/severe SCFE. Initially, surgery used to consist in pin-

ning in situ, followed by a second reconstructive surgery to correct the outcomes if necessary: long-term follow-up revealed a sensibly increased risk of coxarthrosis following this kind of approach.³ Consequently, the preferred surgical approach for stable moderate/severe SCFE cases consists in performing two pinning in situ for deformity reduction with or without intertrochanteric osteotomy and open reduction via a modified Dunn procedure.^{1,2}

As unstable cases are the least frequent, few comparisons are available in the literature among the possible surgical strategies, with limited, inhomogeneous patient samples. Intentional closed reduction is usually contraindicated for unstable moderate/severe SCFE cases, as the risk of femoral head necrosis soars to 20-50%.¹

The preferred alternative approaches are: i) Pinning in situ with or without intertrochanteric osteotomy; ii) Open reduction via modified Dunn procedure; iii) Observing whether reduction spontaneously occurs following supine placement on the operating table: if it does, pinning in situ is preferred, otherwise open reduction is chosen.

A 2018 multicenter American study found that 35% of orthopedic surgeons directly proceeds with pinning in situ with articular decompression, 35% prefers open reduction via modified Dunn procedure, while the remaining 30% bases their choice on the eventual occurrence of spontaneous reduction.¹

An additional maneuver that may be performed and for which consensus is rapidly growing is performing capsulotomy before pinning in situ and reduction for unstable SCFE that require reduction, so as to allow hematoma evacuation. Indeed, epiphyseal slippage, might favor hematoma formation, with intra-articular and epiphyseal pressure exponentially growing: this is especially true for unstable cases, whose intra-articular baseline pressure is twice the normal value. The exact timing of pressure increment in relation to the onset of symptoms is yet to be identified, which might provide a possible explanation for the variable osteonecrosis rate even after decompression. Although a statistical correlation between capsulotomy and reduced osteonecrosis rate is yet to be solidly proven, satisfactory results and a low osteonecrosis rate have been described in SCFE cases treated with urgent capsulotomy and reduction.⁴ Recent advances in the intraoperative evaluation of physeal vascularization suggest the utility of dedicated intraoperative maneuvers to assess a regular blood flow return and reduce the risk of osteonecrosis.²

A debate that has been recently sparked in the current literature is whether reduction is required before fixation in moderate or severe epiphysiolysis. Indeed, the greater the severity of epiphysiolysis, the higher the risk of progression towards femuro-acetabular conflict and coxarthrosis, caused by a deformity within the physo-epiphyseal transition zone. Pinning in situ without reduction is the fastest technique that allows the lowest short-term complication rate, with acceptable short-term results; however, as the deformity is not addressed with this approach, the chances of a negative long-term evolution are more tangible, as demonstrated by recent studies with high rates of femuro-acetabular impingement and osteoarthritis, especially in severe cases.³

On the other hand, open reduction via modified Dunn procedure aims to correct deformity and instability: by restoring the anatomy, functional results are satisfactory and prevention of long-term coxarthrosis development is achieved, although the technical complexity of the approach and the potentially severe risks make it less palatable to surgeons. For instance, the historical risk of avascular osteonecrosis has been defined as 50%, though the development of newer surgical technique has lowered it to 5-25% in several series.⁵ Other disadvantages of the procedure include longer operating time, a slower learning curve and a wider and more demolitive cutaneous approach.

Closed reduction before fixation used to play a marginal role because of the historically attributed high risk of osteonecrosis: recent experiences have recently reconsidered its execution if performed gently and coupled with capsular decompression, as closed reduction reduces slippage severity and facilitates screw placement.⁶ Consequently, the risk of osteonecrosis following reduction must be carefully gauged against the risk of coxarthrosis if deformity is not reduced.⁷ Hence, a great variability has been observed among orthopedic surgeons in performing deformity reduction. The incidence of osteonecrosis following closed reduction in unstable SCFE is 5-50%, which is comparable to the 16-29% incidence following modified Dunn procedure observed in the most recent studies.

As far as inter- or subtrochanteric osteotomies are concerned, osteonecrosis rate are reportedly lower, though several authors underline that these procedures only produce a compensatory correction without achieving anatomic correction; additionally, the usage of fixation devices is associated with other risks.⁷ Comparing the most recent data in the literature, a growing consensus towards open reduction via modified Dunn procedure for severe cases of slippage is. Indeed, modified Dunn procedure entails a similar risk of osteonecrosis and surgical revisions in comparison to closed reduction and percutaneous fixation, with more satisfactory clinical and radiographic results: these promising results however must be confirmed by further large-population studies comparing different surgical approaches for moderate and severe cases of SCFE.⁵ It can't be ignored that the risk of osteonecrosis associated with each technique depends on the underlying steep learning curve, as lesser experienced surgeons may be prone to errors that facilitate the occurrence of osteonecrosis. Within the last few years, modified Dunn procedure has been revised to minimize the risk of vascular insult, with the key tenets being: retinacular blood vessels should be isolated and preserved; monitoring epiphyseal perfusion; evacuating eventual hematomas; shortening the femoral neck to reduce the underlying physeal pressure; using two screws or Kirschner wires during the fixation; prioritizing lower limb unloading in the post-operative period.⁵ As previously mentioned, because of the recently highlighted role of intracapsular pressure in favouring osteonecrosis, several authors recommend pre-fixation capsulotomy, especially in unstable SCFE cases.⁸

Conclusions

In conclusion, a universal consensus has not been reached on the most appropriate surgical approach for unstable epiphysiolysis, as the outcome depends on a multitude of factors, several of which yet unknown. While it's worth mentioning that modified Dunn procedure and capsulotomy are becoming growingly popular, multicentric studies are ultimately needed to identify the causes of post-operative osteonecrosis and to define the success rates of each surgical technique.

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