

A Narrative Review of Body Mass Index in Pediatrics and its Relationship with Stability of Slipped Capital Femoral Epiphysis

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Abstract

Purpose: To present a narrative review of the literature related to body mass index of children and adolescents and whether it relates to stability in slipped capital femoral epiphysis.

Method: A review of literature was conducted. Using the MEDLINE database and Google Scholar search engine, publications in the English language were queried in regards to body mass index in children as well as any effects of body mass index on stability of slips in slipped capital femoral epiphysis.

Results: Being overweight or obese is a risk factor for having slipped capital femoral epiphysis in adolescence; however, underweight or normal weight adolescent children have higher risk of unstable slips when compared to their overweight or obese peers. Perhaps bony changes in obese children play a protective role in decreasing risk of unstable slips. Epiphyseal cupping is a process in which the superior aspect of the capital femoral physis extends laterally towards the metaphysis. However, there has been no correlation shown between obesity and increased epiphyseal cupping.

Conclusion: This calls for more research related to possible structural changes in the proximal femur of obese adolescents that may play a role in protecting against unstable slips in slipped capital femoral epiphysis.

Keywords: Slipped Capital Femoral Epiphysis (SCFE); Body Mass Index; Orthopedic Surgery; Stability; Stable; Unstable

Abbreviations

SCFE: Slipped Capital Femoral Epiphysis; BMI: Body Mass Index; AVN: Avascular Necrosis; FAI: Femoroacetabular Impingement; CT: Computed Tomography

Introduction

Slipped capital femoral epiphysis (SCFE) is a common cause of hip pain in children under the age of 18 [1,2]. In SCFE, the femoral head sustains an injury, causing separation of the proximal femur physis at the hypertrophic cell zone in which the metaphysis

translates in relation to the epiphysis [1,2]. This translation can be called a "slip", hence the name of the injury. The rate of SCFE differs from source to source, but it has been reported anywhere from 5.8 to 13.35 cases per 100,000 adolescents [3-5]. In some regions, the incidence is increasing; while in other regions it is decreasing. For example, there was a trend toward decreasing SCFE rates in Ontario between 2002 and 2011 [5]. On the contrary, there has been an increasing rate of SCFE in Korea since 1979, correlating with the increase in obesity in Korea during the same period [6]. The indig-

enous population of southern Australia also shows an increase in both childhood obesity and rates of SCFE; in fact, the indigenous population is three times more likely to have SCFE than their non-indigenous counterparts [7].

Being overweight and obese is a risk factor for having SCFE during adolescence, as the literature widely supports [8-11]. Prevalence of overweight and obese children and adolescents in developed countries has increased; 23.8% of boys and 22.6% of girls were overweight or obese in 2013 [12]. With the rate of overweight and obese children continuing to rise, the fear is that SCFE rates may follow suit. SCFE can be categorized as stable or unstable; the risk of complications such as avascular necrosis is increased greatly in unstable slips [3,13].

Purpose of the Study

The purpose of this article is to review the literature related to stable and unstable slips in SCFE, as well as find any correlation with overweight and obesity.

Method

A review of literature was conducted. Using the MEDLINE database and Google Scholar search engine, publications in the English language were queried in regards to BMI in children as well as any effects of BMI on stability of slips in SCFE. Example search queries included "body mass index SCFE" and "obesity SCFE unstable". Bibliographies of chosen studies were searched for additional sources. A total of 35 sources involving BMI in children, stability of SCFE, and BMI in SCFE stability were included in the narrative review.

Results

Body mass index in children

When discussing obesity and BMI in relation to SCFE, it is important to acknowledge the difference between BMI in adults and BMI in children. In adults, obesity is determined by a constant scale that is given by dividing a person's weight by their height squared. BMI of 18.5 to 24.99 is normal, 25.0 to 29.99 is overweight, and 30.0+ is obese [14]. This is not how childhood obesity is calculated. In children and teens, age and sex is taken into consideration and is referred to as BMI-for-age. This BMI-for-age uses a percentile rather than a range of numbers to account for the differences in body composition between males and females as they age. This means that BMI in children are expressed relative to others of the same age and sex. For example, a BMI between the 85th and 95th percentile is considered overweight, while a BMI above the 95th percentile

is considered obese [15]. One study finds that BMI-for-age is superior to weight-for-height at overweight detection in children 3 to 19 years of age [16]. Another study uses weight, height, triceps skinfold and subscapular skinfold to estimate obesity in adolescents; it concludes that the different criteria are similar and highly specific for both sexes, but sensitivity for females is low [17].

Stable versus unstable SCFE

Determination of stability in SCFE is crucial as it lends appraisal to the risk of avascular necrosis (AVN) of the femoral head [13]. A SCFE is considered to be stable if a patient is able to bear weight on the affected extremity with or without the assistance of crutches. An unstable SCFE is when weight bearing is too painful for the patient even with the aid of crutches [18-20]. AVN has a greater rate of occurrence in SCFE with an unstable slip. The literature reports the rate of AVN in unstable SCFE to be 15% to 50% [1,18,21,22]. The estimate of a recent meta-analysis goes as high as 9.4 times greater in unstable slips compared with stable slips [13].

The gold standard for treating SCFE is using in situ screw fixation, whether the slip is stable or unstable, as it has provided long-term function while minimizing complications [20,23,24]. Some providers treat stable SCFE with a single screw and unstable SCFE with two screws [25]. In unstable slips, one implicated cause of increased AVN is intracapsular hemorrhage causing increased intracapsular pressure and compressing critical blood vessels. Therefore, alternative treatment options are emerging to address that. Wright, *et al.* found that evacuating the hematoma followed by open reduction and fixation resulted in only a 5% rate of AVN in unstable slips [19].

Body mass index and stability of SCFE

It is widely accepted that being overweight or obese increases the risk of SCFE in adolescents, with many being above the 95th percentile of BMI-for-age [9-11,26-28]. This may be due to the increased shear stresses on the physis [29]. However, there is relatively little data on the relationship between BMI and slip stability. In the literature search, two studies mentioned such a relationship. One study reported that patients without obesity were significantly more likely to present with an unstable SCFE compared to those who were obese. When stable SCFE is compared with unstable SCFE, the unstable slips have lower BMI [30]. This is supported by another recent article that reports underweight or normal weight patients are more likely to have unstable SCFE than their overweight or obese peers [31].

Morris, *et al.* mentioned that adolescents with cam morphology may develop extension of the capital femoral epiphysis in which the superior aspect of the physis extends laterally towards the metaphysis [32]. It may be an adaptive response to the shear stress on the physis and may confer physeal stability in SCFE, reducing the risk of unstable slips [33]. This physeal extension is referred to as epiphyseal cupping [34]. However, Hosseinzadeh, *et al.* reviewed pelvic computed tomography (CT) scans of 68 children and adolescents and found no correlation between obesity and increased epiphyseal cupping [35].

Conclusion

The current literature suggests that underweight or normal weight adolescent children have higher risk of unstable slips in cases of SCFE compared to their overweight or obese peers [30,31]. It is possible that bony changes, such as epiphyseal cupping, in the capital femoral epiphysis may play a protective role in decreasing unstable slips. However, this is not supported by evidence as there is no correlation between obesity and increased epiphyseal cupping [36]. We recommend further research related to structural changes in the proximal femur in obese adolescents and whether those changes are protective against unstable slips in SCFE.

Conflicts of Interest

We declare that we have no conflicts of interest in the authorship or publication of this work.

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