ORIGINAL STUDY

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The incidence and management of slipped capital femoral epiphysis: a population-based study

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We aimed to investigate the national trends in the incidence and management of slipped capital femoral epiphysis (SCFE) and to report the need for reoperations.

We included all <19-year-old patients hospitalised for SCFE in 2004-2014 in mainland Finland (n=159). Data from the Finnish Care Register for Health Care, Statistics Finland, and Turku University Hospital patient charts were analyse for the incidence of SCFE in 2004-2012, the length of stay, and the type of surgery with respect to age, gender, study year, and season. The reoperations and rehospitalisations in 2004-2014 for SCFE were analysed for 2-10 years after surgery.

In 2004 to 2012, primary surgery for SCFE was performed for 126 children. The average annual incidence of SCFE was 1.06/100 000 (95% confidence interval [CI], 0.81-1.38) in girls and 1.35/100 000 (95% CI 1.07-1.70) in boys. The median age at surgery was lower in girls than in boys (11 and 13 years, respectively, p<0.0001). During the study period, there was no significant change in the incidence of SCFE (p=0.9330), the type of primary procedures performed (p=0.9988), or the length of stay after the primary procedure (p=0.2396). However, the length of stay after percutaneous screw fixation was shorter compared with open reduction and fixation (mean 3.4 and 7.9 days, respectively, p<0.0001). There was no significant difference in the rate of reoperations according to the type of primary surgery.

In conclusion, the incidence of SCFE and the proportion of different primary surgeries have recently remained stable in Finland.

Keywords: SCFE, SUFE, occurrence, complication, surgery, epiphyseolysis, hip, pinning, open reduction.

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is a disease of rapidly growing children and adolescents causing the proximal femoral epiphysis to slide posteriorly and inferiorly in relation to the metaphysis[1]. This causes progressive deterioration in the function of the hip joint and is a leading cause of hip replacement surgery in patients under 60 years old[2]. There are few recent reports on population based incidence of SCFE[3,5].

Reports on the trends in the incidence of SCFE vary between regions. Increase in the incidence of SCFE has been reported from Scotland[6] and Ontario[7], and a possible increased incidence in girls from Sweden[4]. The incidence seems to have remained stable in the UK[5], the Netherlands[8], and the USA[9]. More recently, decrease in the number of SCFE procedures has been reported from the USA[3], while there are differences in the trend between different states[10,11]. Increased risk of SCFE has been associated to obesity, increased serum leptin levels, vitamin D deficiency, hypothyroidism, hyperparathyroidism, and biomechanical factors such as smaller epiphyseal tubercle[12-18]. In Finland, fortification of commonly used foods with vitamin D has improved vitamin D intake[19]. However, obesity has simultaneously become more common in Finnish children and adolescents[20].

SCFE is treated surgically by fixation of the proximal femoral epiphysis. This can be achieved in mild and moderate cases using percutaneous screw osteosynthesis (in situ or after closed reduction), and in severe or unstable cases by using surgical dislocation in open reduction, various types of femoral osteotomies, and fixation. Possible complications related to SCFE

and its treatment are osteonecrosis of the femoral head, chondrolysis, growth arrest, impingement of the hip, development of bilateral disease, fixation failure and disease progression, later arthrosis of the hip joint[21], and instability of the hip joint[22]. Traditionally most SCFE patients have been treated with closed reduction and percutaneous pinning, while recently more invasive open reduction and fixation of SCFE seems to be accepted and used more often[23-26]. With open reduction, more anatomic reduction of the femoral head can be obtained than with closed reduction avoiding later impingement of the hip joint. However, whether open and more extensive surgery leads to increased complication rates including avascular necrosis or hip instability is a concern[26].

Recent trends in the occurrence and treatment of SCFE in Finland have not been reported. The aim of this study was to investigate the trends in the incidence and management of SCFE and to describe the length of hospitalisation and the need for reoperations. We hypothesized that the incidence of SCFE has increased, as childhood obesity has increased. In addition, we hypothesized that the proportion of open procedures with osteotomies as compared to in situ fixation have increased and that this increase would be associated with increased risk of reoperations.

MATERIALS AND METHODS

We included all patients less than 19-years of age admitted into pediatric, pediatric surgical, surgical, intensive care, or medical wards for SCFE in 2004-2014 in our country (n=159). We used the Finnish Care Register for Health Care (CRHC) data that is retrospectively collected from all hospitals in mainland Finland. It is based on the 10th Revision International Statistical Classification of Diseases and Related Health Problems (ICD-10) and is an obligatory hospital discharge database. The data from Turku University Hospital was double checked from the hospital data base due to a systematic error in reporting to the CRHC. We included patients with ICD-10 code M93.0 as primary or secondary discharge diagnosis. Surgical procedures were identified based on the Nordic Classification of Surgical Procedures codes including epiphyseodesis (NFK20), femoral osteotomy (NFK30), and screw fixation of the proximal femur (NFJ50). We obtained the corresponding population data from Statistics Finland.

Since virtually all SCFE patients that are diagnosed are treated operatively, the number of surgeries was used as a base for calculating the incidence of the condition. The crude incidence of SCFE, the type of surgical procedure, and the length of primary hospital stay in 2004-2012 were analysed with respect to age at surgery, gender, study year, and season (September to November, December to February, March to May, and June to August). The reoperations and rehospitalisations in 2004-2014 for SCFE (as primary or secondary diagnoses) were analysed for 2-10 years after the first operation for SCFE.

Continuous variables were described as means and standard deviations or medians and ranges were appropriate. Categorical variables were presented as frequencies and proportions (percentages). Crude incidence rates were calculated using publicly available population data from Statistics Finland[27]. The results were adjusted for gender and age. For differences in means, t-test or Analysis-of-Variance was performed. For differences in proportions, chi-squared test or Fisher's exact test was performed. The differences of proportions in multiple strata were evaluated with Cochran-Mantel-Haenszel test. Analysis of count data was carried out with Poisson regression or Negative Binomial regression. All analyses were conducted using R version 3.5.1. P-values less than 0.05 were considered statistically significant.

The study was approved by the National Institute for Health and Welfare of Finland (permissions no: THL/143/5.05.00/2015) and the Turku University Hospital Clinical Research Services (no: T08/047/17). The authors declared their potential conflicts of interests. This was a retrospective register study. The participants were not contacted. Thus, no informed consent or ethics committee approval was required. Legal basis for processing personal data is public interest and scientific research (EU General Data Protection Regulation 2016/679 (GDPR), Article 6(1)(e) and Article 9(2)(j); Data Protection Act, Sections 4 and 6).

This research did not receive any funding from public, commercial, or not-for-profit sectors. All authors have significantly contributed to this study and are willing to take public responsibility for all of its aspects: its design, data acquisition, and analysis and interpretation of data. All authors have been actively involved in the drafting and critical revision of the manuscript and provided final approval of this version.

RESULTS

During 2004 to 2012, primary surgery for SCFE was performed for 126 children, accounting for an average annual incidence rate of 1.21/100 000 (95% CI 1.02-

1.44). The incidence of SCFE did not change during the study years (p=0.9330). The average annual incidence rate was lower in girls 1.06/100 000 (95% CI 0.81-1.38) than in boys 1.35/100000 (95% CI 1.07-1.70). In 9-15-year old children, the average annual incidence rates were 2.8/100 000 (95% CI 2.12-3.62) and 3.4/100 000 (95% CI 2.65-4.27), respectively. The median age of all study patients at surgery was 12 years (range 8-17). Boys were significantly older at the time of surgery than girls [median age 13 (range 10-17) and 11 years (range 8-14), respectively (p<0.0001)]. The age and gender distribution is shown in Figure 1. There was no significant seasonal variation in the incidence of SCFE (p=0.388).

Percutaneous screw fixation was performed for 108 (86%) of the children as the primary surgery and open reduction and fixation for 20 (16%) children. Primary surgery was performed bilaterally in 10 of the patients: six patients had screw fixation on both sides, two patients had open reduction and fixation on both sides, and two had screw fixation on the other side and open reduction on the other as their primary procedures. There was no significant change in the frequency of SCFE operations (p=0.9330) or the proportion of the type of procedures performed during the study period (p=0.9988). See Figure 2 for the proportion of different procedures for SCFE during the study period.

The mean length of hospital stay after the primary operation for SCFE was 4.2 days (SD 3.7) in 2004-2012. The length of primary hospital stay did not significantly change during the study period (p=0.2396). However, the length of stay after screw fixation (NFJ50 or NFK20) was significantly lower compared to that after open reduction and fixation (NFK30) (mean 3.4 and 7.9 days, respectively, p < 0.0001).

Altogether 45 reoperations for SCFE were performed for 21 patients during the follow-up period in 2004-2014. The mean number of redo operations was 2 times (range 1 to 4). These figures also include the procedures on the contralateral side. There was no significant difference in the rate of reoperations for those primarily treated with percutaneous screw fixation compared with open reduction and fixation (17% [18/108] vs. 15% [3/20], p=1.000).

Out of the 18 patients reoperated after primary percutaneous screw fixation, 14 had the screw removed from one or two sides, 17 had redo screw fixation or screw fixation of the contralateral side, and only one patient underwent open reduction, osteotomy and fixation at the redo surgery. Out of the three patients primarily treated with open reduction and fixation, two needed a redo reduction and fixation, and two patients (1.6% of

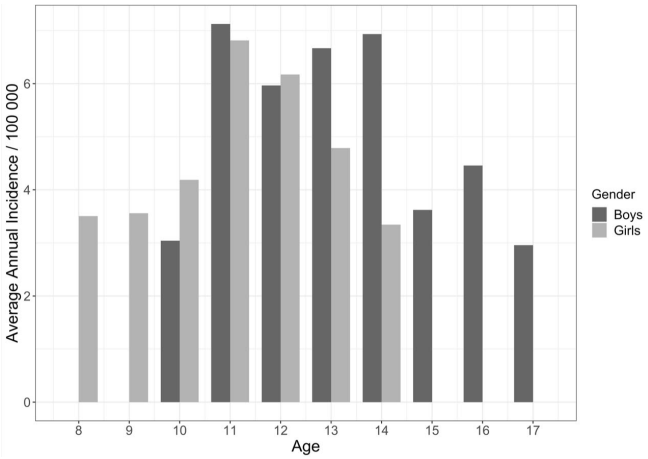

Figure 1. — The average annual incidence of slipped femoral capital epiphysis per 100 000 0-18-year-olds according to age and gender in Finland in 2004-2012.

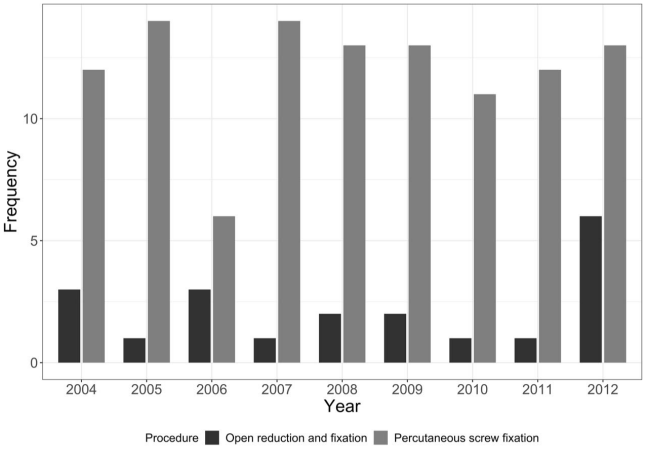

Figure 2. — The number of screw fixation (NFJ50 or NFK20) and open reduction, osteotomy and fixation (NFK30) procedures performed for slipped capital femoral epiphysis in Finland in 2004 through to 2012.

all study patients) needed hip arthroplasty during the follow up period.

The mean length of hospital stay after reoperation for SCFE was 2.7 days after percutaneous screw fixation and 7.5 days after open reduction and fixation as the primary procedure (p = 0.0785).

In the study patients, there were single patients who had previously been diagnosed with the following comorbidities: Still's disease, idiopathic scoliosis, Klinefelter's syndrome, congenital asymmetry of the lower limbs, femoral fracture, malignant brain tumor, and one patient had a kidney transplant. Additionally, two children had asthma, two anisomelia, and two juvenile polyarthritis.

DISCUSSION

This national study showed that the incidence of SCFE has remained stable during 2004-2012 in Finland.

Most patients were primarily treated with percutaneous screw fixation. There was no significant change in the proportion of different types of surgical procedures performed to treat SCFE or the length of hospital stay after the primary procedure during the study period. The length of stay after pinning was shorter compared to that after open reduction and fixation, but no significant difference was seen in the rate of reoperations or length of rehospitalisation according to the type of primary procedure.

Despite increasing of obesity rates in Finnish children[20], the incidence of SCFE was shown to be lower in Finland compared to previous publications from other countries[4,5]. Average annual incidence has previously been reported to be 4.4/10 000 in girls and 5.7/10 000 in boys for 9-15-year-old Swedish children during 2007-2013[4]. In the UK, the incidence was 4.8/100,000 in 0-16-year-olds[5]. Parallel to our study, a report from the UK reported the incidence remaining constant[5], while decrease in SCFE the procedures has been reported in the USA[3]. On the contrary, in Ontario, Canada the incidence has been reported to have increased in 2002-2011[7] and in Sweden the incidence of SCFE to has increased in 2007-2013 in girls[4]. In 2013, the prevalence of overweight and obese <20 year-olds was 26.0% in boys and 21.1% in girls in Finland compared to 20.4% and 21.1% in Sweden, 26.1% and 29.2% in the UK, 25.5% and 22.2% in Canada, and 28.8% and 29.7% in the USA, respectively[28]. The exact reason for the differences in the incidence of SCFE is not known. The reason is likely to be multifactorial including for example differences in obesity, nutritional state, and endocrine and biomechanical factors.

In accordance with a previous UK publication[5], we showed no seasonal variation in the incidence for SCFE in Finland. In contrast, the incidence of SCFE was greater in Sweden and USA during the summer months compared to the winter[4,29]. Unfortunately, we did not have data on the durations of symptoms and thus had to assess seasonality based on the time of surgery.

A previous study has shown an increase in open reductions, in the number of complications of treatment and in secondary procedures, but the rate of AVN remained unchanged in the USA[26]. The rate of in internal fixation in situ or after closed reduction was 91% compared to 86% demonstrated in our study. In our data, the proportion of different types of procedures has remained relatively stable in Finland during the study period. In addition, the number of patients requiring reoperations for SCFE did not differ according to the primary procedure. Thus, according to our results, both percutaneous screw fixation and open reduction and fixation seem to be reasonable alternatives to primary treatment of SCFE, keeping in mind that the length of stay is longer with open reduction and fixation than with percutaneous screw fixation.

The risk of reoperation in children undergoing percutaneous screw fixation was acceptable (17%) and did not significantly differ from that of open reduction and fixation (14%). This suggests that the majority of children with SCFE can be treated with good outcomes using simple percutaneous technique in contrast to more demanding open surgery, which is in accordance with the previous long-term outcome study on in situ fixation[30]. However, due to the lack of data on the severity of SCFE and the relatively short length of follow-up in our study, we cannot draw further conclusions on the outcomes of SCFE using different surgical techniques.

A major strength of this study is that the data were based on a nationwide register which has high accuracy and excellent coverage[31]. As this was a register study we could not classify SCFE into mild, moderate or severe subtypes as the condition has only one diagnosis code. We were also not able to assess the rate comorbidities such as obesity and hypothyreosis reliably, since these comorbidities are rarely reported to the register. The minimum follow-up time was two years, which is relatively short for detecting differences in the need for late hip surgery including osteoplasty for hip impingement and total hip arthroplasty.

CONCLUSION

While obesity rates are increasing among the youth, no major changes in the incidence of SCFE were seen in Finland. In contrast to our hypothesis, we could not find any increase in the proportion of hips requiring more extensive surgery than percutaneous screw fixation.

Author contributions: All authors have significantly contributed to this study and are willing to take public responsibility for all of its aspects: its design, data acquisition, and analysis and interpretation of data. All authors have been actively involved in the drafting and critical revision of the manuscript and provided final approval of this version.

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