Epidemiology and Demographics of Slipped Capital Femoral Epiphysis in Korea: A Multicenter Study by the Korean Pediatric Orthopedic Society

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Background: In 1979, slipped capital femoral epiphysis (SCFE) was rarely reported in Korea, although it is the most common hip disorder of adolescence in Western nations. However, because the number of reported cases of SCFE in Korea has increased a great deal since then, we performed a nationwide survey to ascertain its epidemiology and demographics in Korea.

Methods: We reviewed the discharge databases for the period between January 1989 and December 2003 from 19 university hospitals across Korea. Recorded data included age at onset, sex, past medical history, height, weight, and type of slippage. We compared those data with national census data. The incidence data are reported as cases per 100,000 children between the ages of 10 and 14 years.

Results: Data for 231 patients (175 boys and 56 girls) were included in our survey. The average age at onset was 12 years 10 months in boys and 12 years in girls. The average annual incidence was estimated to be at least 0.499 for boys and 0.142 for girls for every 100,000 children between the ages of 10 and 14 years, which was lower than that of Western nations and Japan. The incidence showed a pattern of increments across each period. The mean body mass index was significantly higher in Korean patients with SCFE than in the population of the same age group without it.

Conclusions: The incidence of SCFE in preadolescents in Korea has increased markedly since 1979, which may be related to increasing rates of obesity.

Level of Evidence: Therapeutic, level 4.

Key Words: slipped capital femoral epiphysis, epidemiology, demographics, obesity

(*J Pediatr Orthop* 2009;29:683–686)

As the first official report of slipped capital femoral epiphysis (SCFE) in Korea did not appear in the *Journal of the Korean Orthopaedic Association* until 1979, SCFE was thought to be rare in Korea. However, it is the most common hip disorder of adolescence in Western nations and is associated with many complications such as avascular necrosis, chondrolysis, and further slippage of the epiphysis, causing limitation of motion, pain, and early arthrosis.[1,2] In Korea, the number of reported cases has increased annually since that first report. In addition, medical access and diagnostic accuracy have changed a great deal since 1988, the year when national health insurance coverage became available to all citizens of Korea. For those reasons, the Multicenter Committee of the Korean Pediatric Orthopedic Society decided to undertake a nationwide retrospective review in 2003 of the data on SCFE. We report here the epidemiologic and demographic findings of that study. These data were used to produce incidence rates that were subsequently compared with previously published data from other countries.

METHODS

We sent inquiries to 19 university hospitals recognized as referral hospitals in the 9 provinces (Cheju-do, Chollanam-do, Chollabuk-do, Chungchongnam-do, Chungchongbuk-do, Kangwon-do, Kyonggi-do, Kyongsangnam-do, and Kyongsangbuk-do) of Korea. Patients treated between January 1989 and December 2003 were included in the study group. Data requested included patients' initials, sex, date of birth, address (local sector), family history of SCFE, past medical history including endocrine disorders, date of SCFE onset, type of slippage, height, weight, and treatment. Patients' initials and birth dates were used to exclude duplication of reported cases. Results of questionnaires, collected until September 2004, were thoroughly analyzed.

The incidence of SCFE was estimated by dividing the total number of reported SCFE cases by the population in the age group at high risk (10 to 14 y). The population of this age group was obtained from the data disclosed by the National Statistics Organization. Body mass index (BMI) was calculated from the height and weight measured at each patient's first visit to the hospital so that we could investigate the influence of obesity on the onset of SCFE. The obesity classification proposed by the World Health Organization was used to assess each

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patient. It defines any BMI $< 18.5\,kg/m^2$ as underweight, a BMI between 18.5 and $25.0\,kg/m^2$ as normal, 25 to $30\,kg/m^2$ as preobese, 30 to $35\,kg/m^2$ as obese class 1, 35 to $40\,kg/m^2$ as obese class 2, and $> 40\,kg/m^2$ as obese class 3.

Using regression analysis and the Wilcoxon signed-rank test, we conducted statistical analyses to compare the incidence rates for SCFE during five 3-year intervals from 1989 to 2003, and rates by age, sex, and endocrinologic disorder.

RESULTS

Excluding duplicated cases, data for 231 patients (175 boys and 56 girls) were included in this survey. The average number of new cases of SCFE in Korea each year is 15.4. The ratio of boys to girls with SCFE is 3.125:1.

Incidence

As SCFE is a childhood disorder, most reports comment on the number of cases per 100,000 children for the age range at risk to have SCFE. To directly compare incidence rates with neighboring countries, we adopted the Japanese parameters and calculated incidence rates for patients between the ages of 10 and 14 years. These criteria revealed 178 patients (boys: 141; girls: 37), which represented 77% of the total number cases of SCFE in the same time period. The estimated average annual incidence of SCFE per 100,000 in the at-risk population was 0.328. According to sex, the incidence was 0.499 for boys and 0.142 for girls (Fig. 1) (χ^2 test; $P < 0.001$). Comparison with the data from the Japanese series shows that the incidence of SCFE in Korea was significantly lower (boys: 22.5%; girls: 18.7%). Analyzing our data across 5 separate 3-year time intervals showed that the incidence has a pattern of increments across each period (χ^2 test; $R^2 = 0.662$; P for trend < 0.001).

Age of Onset

The distribution of age at onset in our study group was from 5 years and 5 months to 33 years and 7 months in male patients and 6 years and 7 months to 27 years and 4 months in female patients, which was similar to that for other countries.[3,4] Excluding patients with underlying diseases, the age of oldest onset was 17 years and 10 months in male patients and 14 years and 2 months in female patients.

The average age at onset was 12 years and 8 months (males: 12 y and 10 mo; females: 12 y). The peak age at onset was 12 years in boys and 11 years in girls. Six men and 3 women had an age at onset of more than 20 years, and each of them had various endocrine disorders, such as craniopharyngioma, hypopituitarism, and hypothyroidism.

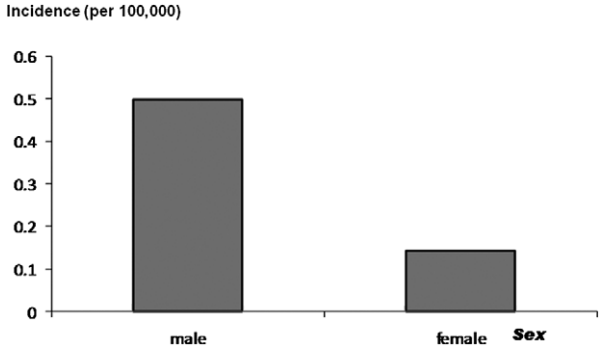

FIGURE 1. Incidence of slipped capital femoral epiphysis by sex.

Clinical Presentation

Of 231 hips, 75 (27.3%) were classified as acute disorder (symptoms lasting < 3 weeks), 79 (28.7%) as acute-on-chronic (symptoms lasting > 3 wk, with recent exacerbation), 122 (44.0%) as chronic (symptoms lasting > 3 wk), and 3 as unknown. There were 44 cases (19.0%) with bilateral slippage and 187 with unilateral slippage, 77 (33.3%) on the right side and 110 (47.7%) on the left side. The percentages for laterality of involvement were similar in boys and girls; that is, 59 cases (33.7%) had slippage on the right side, 83 (47.5%) had slippage on the left side, and 33 (18.9%) had slippage on both sides in boys, whereas the corresponding numbers for girls were 18 (32.1%) on the right, 27 (48.3%) on the left, and 11 (19.6%) on both sides. The median age of patients with bilateral SCFE was 13.2 years, whereas it was 12.6 years for those with unilateral SCFE. Fourteen of 44 patients with bilateral SCFE had an endocrinologic problem, but only 24 of 231 patients with unilateral SCFE did.

BMI

As already mentioned, 178 patients between the ages of 10 and 14 years were sorted to obtain data on patients at high risk for SCFE. Data on height and weight were then obtained in 170 cases (134 boys and 36 girls): The average height was 152.3 cm (males: 153.4 cm; females: 148 cm), and the average weight was 58.1 kg (males: 60.5 kg; females: 48.9 kg). The average BMI was $24.6\,kg/m^2$ (males: $25.1\,kg/m^2$; females: $22.2\,kg/m^2$; range: 12.5 to $42.4\,kg/m^2$), which was significantly higher than the average BMI of the general population of the same age range ($P = 0.0078$; Wilcoxon signed-rank test) (Fig. 2). According to the World Health Organization criteria for obesity using BMI, percentages of underweight, normal, preobese, obese class 1, obese class 2, and obese class 3 patients were 14.2%, 38.9%, 32.1%, 13.4%, 0.7%, and 0.7% in boys and 27.8%, 52.8%, 19.4%, 0%, 0%, and 0% in girls, respectively. The percentages of children in the general population in those categories have been reported to be 51.4%, 37.0%, 10.6%, 0.9%, $< 0.1\%$, and 0% in boys and 61.1%, 32.7%, 5.9%, 0.2%, $< 0.1\%$, and 0% in girls, respectively. These data suggest that significantly more patients with SCFE are obese than are children in the population without SCFE. The distribution of BMIs in both children with SCFE and those without it is shown in Figure 3. The average BMIs for unilateral ($24.56\,kg/m^2$) versus bilateral ($24.50\,kg/m^2$) involvement were not statistically significant.

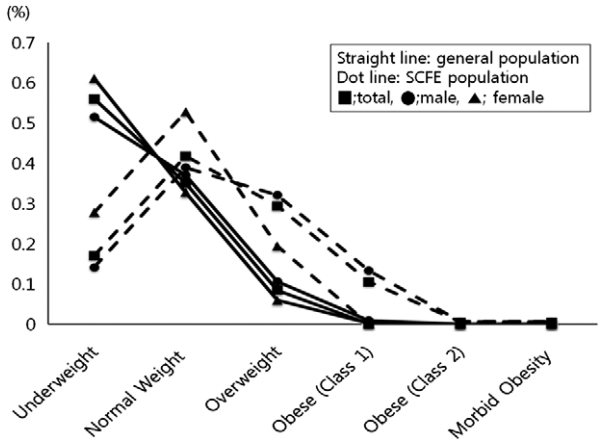

FIGURE 2. Distribution of population of preadolescents between the ages of 10 and 14 years according to obesity classification. SCFE, slipped capital femoral epiphysis.

DISCUSSION

Our survey is the first to be conducted nationwide and so will be the foundation of future studies in Korea. As the number of immigrants in Korea is quite limited, the trends of incidence of SCFE that we found may have implications beyond local concerns, possibly improving the general understanding of the disorder. Those trends may be interpreted by comparing our data with that for other Asian nations and for Western nations.

Demographics

Our local average incidence was approximately 0.328 per 100,000 children between the ages of 10 and 14 years. A much higher incidence of 10.8 per 100,000 children between the ages of 9 and 16 years has been reported[5] for the United States. Although direct comparison is not possible because the incidences refer to different age ranges, that is still a significant difference. The incidence of SCFE in Japan for the same age population that we studied is also surprisingly high: for the period from 1997 to 1999, the incidence was about 5 times higher in Japan[4] than in Korea. Ethnicity is known to be a factor that influences incidence.[6] However, because Japan is a neighboring East Asian country with a cultural background similar to that of Korea, the striking difference in incidence between the 2 nations should be investigated to determine whether it is caused by ethnic or nutritional differences. Interestingly, however, older Japanese data[7]—from 1976—showed an incidence of SCFE similar to the current incidence that we found for Korea. The increase in incidence is thought to be caused by the increasing numbers of obese children and their concomitant changes in habits in daily life. If we do a follow-up study in the next decade, Korea may be the place to determine the influence of obesity because it is a single-race country.

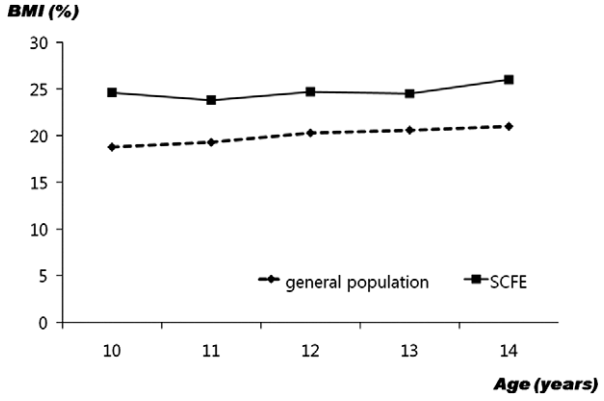

FIGURE 3. Comparison of average body mass index (BMI) for the general population versus that for patients with slipped capital femoral epiphysis (SCFE).

Age of Onset

The average age at onset of SCFE in Korea was found to be 12 years and 10 months for boys and 12 years for girls. The onset age for Korean girls was higher than that for girls in a recent Japanese report,[4] whereas that the onset ages for boys were similar in Korea and Japan. A continuing downward trend in age at onset has been reported,[8,9] suggesting that the primary cause of this phenomenon is the earlier age of maturation for children today. Therefore, future study is required to uncover any sex-linked difference in onset age and any trend in that difference.

Sex

We noted a preponderance of male patients in our study; our male-to-female ratio was 3.5.1, similar to the Japanese study[4] and the study in Southeast Asia,[10] where the male-to-female ratios were 3.1 to 4.1. We compared our findings with those of other studies,[3,11] and it seems that Asian boys may be more predisposed to SCFE than their Western counterparts are (Western male-to-female ratios: 1.28 to 1.52). However, we do not know whether this sex difference is caused by cultural factors or daily habits.

BMI

Obesity causes an increased mechanical load across the proximal femoral physis and physiologic disturbance and so may play a role in the development of SCFE.[12–15] Several studies, including those conducted in Asian[4] and Western countries,[3,8] have shown that the incidence of SCFE has increased 2-fold to 3-fold over 2 to 3 decades. It is difficult to understand the implications and causes of changes in SCFE incidence from our study alone, because it is the first incidence report from Korea. However, when we compared our study participants' BMIs with those of the general population, we found quite a different distribution, with patients with SCFE having the highest BMIs. The BMIs of Korean children and adolescents have continually increased since 1992, when the last national statistical report was issued in Korea (Fig. 4);

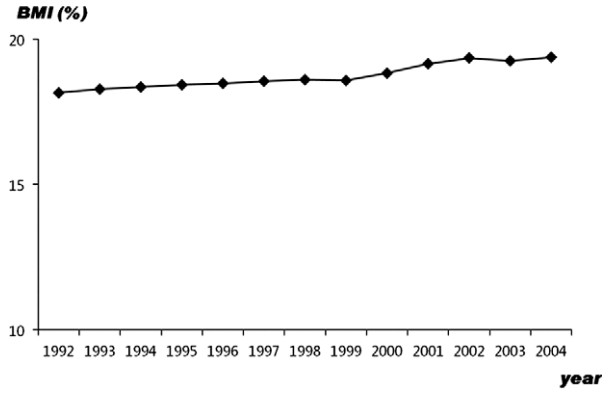

FIGURE 4. Annual increases in body mass index (BMI) since 1992 in the general Korean population of children between the ages of 10 and 14 years.

similarly, Japan[4] and Western nations[6,8] have seen an increase in the prevalence of obesity in their children since 1988. Therefore, we assume that the increase in SCFE incidence in Korea is related to obesity or increased BMI. Bhatia et al[16] asserted that increased BMI is related to bilateral SCFE, but we found no significant difference between BMIs of patients with unilateral involvement and those with bilateral involvement.

Clinical Presentation

Fifty-six percent of our patients presented with acute or acute-on-chronic SCFE, which is similar to the findings of the studies done in Japan and Southeast Asia. However, Loder[11] found that chronic SCFE comprised 85.5% of cases.

The preponderance of left hip involvement (47.5%) and the laterality of involvement were similar in boys and girls in our study, as was the case in the Japanese study. Our rate of bilaterality, 19%, was higher than that of the Japanese study,[4] at 14%. Although Loder[11] reported a lower incidence of bilaterality in Indonesian-Malay children, our rate of bilaterality was similar to that of multiethnic patients in the study of Loder.

CONCLUSIONS

From this multicenter study of the Korean Pediatric Orthopedic Society, we can be aware that the incidence of SCFE has markedly increased since 1979 in Korea. We found that preadolescents with SCFE had a higher incidence of obesity than the general population of the same age.

ACKNOWLEDGMENTS

The authors thank for the active participation of members of Korean Pediatric Orthopedic Society in this study, listed here in alphabetical order and not according to level of participation: the Catholic University, Chonbuk National University, Chonnam National University, Chungnam National University, Dong-A University, Hanyang University, Inje University, Korea University (Anam and Guro Hospitals), Kyungsang National University, Pusan National University, Seoul National University, Sungkyunkwan University, Ulsan University, Yonsei University (Sinchon and Young-Dong Hospitals). The authors also thank Katharine O'Moore-Klopf, ELS, for providing editorial services.

REFERENCES

1. Carney BT, Weinstein SL, Noble J. Long-term follow-up of slipped capital femoral epiphysis. *J Bone Joint Surg Am*. 1991;73:667–674.
2. Carney BT, Weinstein SL. Natural history of untreated chronic slipped capital femoral epiphysis. *Clin Orthop Relat Res*. 1996; 322:43–47.
3. Loder RT. Correlation of radiographic changes with disease severity and demographic variables in children with stable slipped capital femoral epiphysis. *J Pediatr Orthop*. 2008;28:284–290.
4. Noguchi Y, Sakamaki T; Multicenter Study Committee of the Japanese Paediatric Orthopaedic Association. Epidemiology and demographics of slipped capital femoral epiphysis in Japan: a multicenter study by the Japanese Paediatric Orthopaedic Association. *J Orthop Sci*. 2002;7:610–617.
5. Lehmann CL, Arons RR, Loder RT, et al. The epidemiology of slipped capital femoral epiphysis: an update. *J Pediatr Orthop*. 2006; 26:286–290.
6. Benson EC, Miller M, Bosch P, et al. A new look at the incidence of slipped capital femoral epiphysis in New Mexico. *J Pediatr Orthop*. 2008;28:529–533.
7. Ninomiya S, Nagasaka Y, Tagawa H. Slipped capital femoral epiphysis. A study of 68 cases in the eastern half area of Japan. *Clin Orthop Relat Res*. 1976;119:172–176.
8. Murray AW, Wilson NI. Changing incidence of slipped capital femoral epiphysis: a relationship with obesity? *J Bone Joint Surg Br*. 2008;90:92–94.
9. Hägglund G, Hansson LI, Ordeberg G. Epidemiology of slipped capital femoral epiphysis in southern Sweden. *Clin Orthop Relat Res*. 1984;191:82–94.
10. Lim YJ, Kagda F, Lam KS, et al. Demographics and clinical presentation of slipped capital femoral epiphysis in Singapore: comparing the East with the West. *J Pediatr Orthop B*. 2008;17: 289–292.
11. Loder RT. The demographics of slipped capital femoral epiphysis. An international multicenter study. *Clin Orthop Relat Res*. 1996; 322:8–27.
12. Brenkel IJ, Dias JJ, Davies TG, et al. Hormone status in patients with slipped capital femoral epiphysis. *J Bone Joint Surg Br*. 1989; 71:33–38.
13. Fishkin Z, Armstrong DG, Shah H, et al. Proximal femoral physis shear in slipped capital femoral epiphysis—a element finite study. *J Pediatr Orthop*. 2006;26:291–294.
14. Kelsey JL. Epidemiology of slipped capital femoral epiphysis: a review of the literature. *Pediatrics*. 1973;51:1042–1050.
15. Poussa M, Schlenzka D, Yrjönen T. Body mass index and slipped capital femoral epiphysis. *J Pediatr Orthop B*. 2003;12:369–371.
16. Bhatia NN, Pirpiris M, Otsuka NY. Body mass index in patients with slipped capital femoral epiphysis. *J Pediatr Orthop*. 2006; 26:197–199.