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

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Abstract

Purpose The incidence of slipped capital femoral epiphysis (SCFE) among children living in the Netherlands has never been published.

Methods The national hospitalization registration system of the Netherlands was searched for the incidence of surgical procedures for SCFE in the Netherlands among different pediatric age groups between 1998 and 2010. International Classification of Diseases, 9th Revision codes were used.

Results and conclusion The incidence of surgical procedures for SCFE during the last decade was 11.6 per 100,000 children aged 5 to 19 years. No statistical difference in the incidence of SCFE was found between boys and girls, although the incidence of SCFE did significantly increase in girls during the study period. Based on our analysis, the Netherlands appears to be the first country in which no difference in the incidence of SCFE among boys

and girls has been reported. However, during the study period there has been a concomitant increase in the number of girls with SCFE.

Keywords Incidence · Slipped capital femoral epiphysis · Gender differences · The Netherlands

Introduction

Slipped capital femoral epiphysis (SCFE) is a disorder of the proximal femur that occurs mainly in peripubertal children. It is defined as the displacement of the femoral neck and shaft relative to the femoral head in the growth plate in which the proximal femoral neck and shaft move anteriorly and rotate externally relative to the femoral head, while the femoral head remains in the acetabulum. SCFE has been described as the most common hip disorder of adolescent children in the USA [1]. Boys are more susceptible than girls in developing this disorder (Table 1). It is most often diagnosed in obese children around puberty and in children with endocrinopathies or chronic systemic diseases. In the Netherlands, the incidence of SCFE has never been published. To gain an understanding of SCFE and to compare its incidence in other countries we performed a literature search aimed at determining its incidence in different countries among children of different ages. We then performed a Dutch population-based search to determine the incidence of SCFE in the Netherlands and whether there was a difference between boys and girls. National data on body length and body weight of the children were used to interpret the findings. We compared our results with those of other studies that provide a local incidence of SCFE (Table 1).

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Materials and methods

Patients

We performed a search of the national hospital registration system of the Netherlands, i.e. the “Landelijke Medische Registratie (LMR), PRISMANT kubus Ziekenhuis statistiek”, which registers all patients admitted to Dutch hospitals. Only age groups and sex are listed in this registration system. Our study period covered the period 1998–2010, and the search items were the diagnosis of non-traumatic SCFE [NT SCFE; International Classification of Diseases, 9th Revision (ICD 9) code 732.2] and traumatic SCFE (T SCFE; ICD 9 code 820.01) as well as a combination of these two groups. The ICD codes only contain figures for the age categories 1–4 years, 5–9 years, 10–14 years and 15–19 years. We restricted ourselves to the age group 5–19 years. NT SCFE can be confused with T SCFE; therefore we counted the entities separately and as a combined group to these different codes. For the population figures we used Statline (Centraal Bureau voor Statistiek, the Netherlands).

To determine the size of the population at risk over the entire study period 1998–2010, we considered all children aged between 5 and 19 years in that period. First, we considered different age-cohorts (one cohort for each age 5, 6,...19 years) that were at risk for developing SCFE in

1998. The follow-up period for each age-cohort was defined from 1998 onwards either up to the year the patient turned 19 years old or until 2010, whichever came first. We also considered different entry-cohorts (one cohort for each year from 1999, 2000,...2010) that consisted of children who turned 5 years old in that year. For each entry-cohort, the follow-up period was defined from the year of entry until 2010. We estimated the number of boys and girls in each cohort as the average number of boys and girls in that cohort over its follow-up period. The total number of children at risk over the period 1998–2010 was estimated by summing each estimated cohort-size (Table 2).

Statistical analysis

Incidence was defined as the population-proportion of surgical procedures for SCFE in children. The difference in the incidence rates between boys and girls was assessed by relative risks, with corresponding 95 % confidence intervals (95 % CIs). The Cochran–Armitage test for trend was used to test for a linear trend of the yearly incidence rates over time. A 95 % CI not containing the value 1 or a p value of <0.05 was considered to be significant, while a p value of <0.1 was considered to be a trend. All statistical analyses were performed using SPSS ver. 15.0 (SPSS, Chicago, IL).

Table 1 Literature search on the incidence slipped capital femoral epiphysis

First author	Year of publication	Location of study	Incidence SCFE:100.000	Age of children enrolled in study (years)	Years of incidence noted	Male:female ratio
Henrikson [5]	1969	Gothenburg, Sweden	2.0–13.0	7–16	1947–1966	1.9
Kelsey [7]	1970	Connecticut	3.4	<25	1960–1967	2.7
			10.1	8–17		
		New Mexico	0.7	<25	1960–1967	1.7
			2.1	8–17		
Hagglund [4]	1984	Southern Sweden	61.0 (M), 30.0 (F)	5–23	1910–1982	2.3
Jerre [6]	1996	Gothenburg, Sweden	79.0	7–17	1946–1992	1.8
Loder [15]	1996	International multicenter study				1.4
Noguchi [10]	2002	Japan	2.2 (M), 0.8 (F)	10–14	1997–1999	3.1
Lehmann [1]	2006	USA	10.8	9–16	1997 and 2000	1.7
Benson [2]	2008	New Mexico	6.0	8–17	1995–2006	1.9
Lim [9]	2008	Singapore	1.2	5–14	1994–2006	4.1
Murray [14]	2008	Scotland	9.7	6–18	1981–2000	1.7
Song [11]	2009	Korea	0.3	10–14	1989–2003	3.1
Larson [8]	2010	Midwestern American (Olmsted) county	8.8	9–16	1965–2005	1.8
Nguyen [3]	2011	South Australia	2.8–8.2	10–19	1988–2007	1.7
Witbreuk (current study)	2012	Netherlands	11.6	5–19	1998–2010	1.1

SCFE slipped capital femoral epiphysis, M male, F female

Table 2 Population demographic statistics for the Dutch population aged 5–19 years between 1998 and 2010

per year	5 year		6 year		7 year		8 year		9 year		10 year		11 year		12 year		13 year		14 year		15 year		16 year		17 year		18 year		19 year		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
1998	101813	96787	102743	98434	103312	98208	98589	94821	97867	93536	98602	93653	97122	93674	94572	90779	93056	88625	90693	86677	91860	87542	94938	90954	97322	92256	94334	90287	95182	91565	
1999	100808	96695	102102	97076	103044	98739	98518	98908	95125	98227	93922	98279	94007	97483	94054	97483	94054	94910	91143	93446	89014	91174	87067	92871	88107	95891	91525	97837	93176	94712	91571
2000	101584	96998	101104	96876	102363	97438	103404	98065	104015	98823	99249	95500	98575	94254	98354	94333	97856	94410	95309	91542	94177	89467	92163	87603	93812	88633	96486	92394	98273	94457	
2001	99219	94823	101945	97325	101497	97188	102750	97841	103839	99401	104455	99250	99702	95887	99037	94678	99777	94716	98331	94792	96093	92029	95315	90157	93329	88241	94794	98650	97055	93852	
2002	99877	94360	99469	95155	102240	97608	101826	97478	103078	98147	104224	99726	104801	99585	100145	96275	99391	94996	100171	95074	98878	95238	97093	92664	96700	90942	94527	89361	95723	91162	
2003	99862	96106	99870	94451	99555	95208	102318	97765	101977	97606	103278	98292	104438	99924	105023	99821	100455	96491	98761	95274	100732	95463	99851	95822	98222	93285	97733	91851	95225	90727	
2004	103353	98652	99777	95995	99817	94296	99507	95122	102244	97726	101984	97631	103317	98349	104508	99977	105123	99933	100591	96586	99921	95389	100917	95600	100111	96025	98737	94021	98032	93100	
2005	104081	98997	103150	98398	99504	95779	99667	94096	99311	94933	102155	97641	101848	97489	103271	98326	104460	99889	105096	99857	100578	96586	99899	95346	100889	95719	100304	96529	98610	94923	
2006	105694	101506	103707	98623	102810	98095	99230	95526	99476	93910	99078	94706	102004	97438	101710	97397	103121	98211	104353	99834	104990	99784	100500	96582	99856	95461	100905	95930	100121	96913	
2007	103786	99284	105293	101149	103411	98317	102511	97821	99057	95368	99300	93753	98962	94595	101862	97300	101592	97251	103032	98090	104244	99775	104964	99766	100501	96587	99876	95598	100848	96329	
2008	102861	98035	103559	99042	105151	100946	103248	98210	102381	97712	98999	95270	99306	93720	98971	94537	101850	97282	101653	97264	103066	98101	104322	99828	105077	99894	100773	96620	100248	96397	
2009	102276	97540	102762	97950	103510	99013	105166	100944	103282	98191	102407	97743	99103	95345	99403	93813	99109	94637	101951	97357	101718	97350	103270	98224	104492	100129	105437	100471	101335	98101	
2010	98694	94651	102325	97569	102843	97974	103609	99080	105337	101167	103381	98392	102594	97917	98277	95549	99576	93992	99238	94805	102235	97580	102041	97587	103636	98488	105120	100731	106290	101715	
mean of all populations	102931	97952	104092	99658	104786	99663	100111	96288	99333	94986	100117	95082	98906	95273	96693	92548	95494	90451	92852	88279	93812	89019	96093	92181	97811	93296	94523	90929	95182	91565	
1998	101647	97309																													
1999	102035	97456																													
2000	99248	94852																													
2001	99248	94852																													
2002	99588	94043																													
2003	99351	95617																													
2004	102744	98048																													
2005	103518	98455																													
2006	105328	101142																													
2007	103616	99105																													
2008	102822	97986																													
2009	102031	97555																													
2010	98694	94651																													
1998-2010	2593626																														
	2573393																														

Results

Incidence

The total number of surgical procedures for SCFE was 609 in the period 1998–2010 for children between 5 and 19 years in the Netherlands. This translated into an incidence of 11.6 surgical procedures per 100,000 children over that period in the combined NT and T SCFE group. When the T SCFE group was not included in the analysis, the incidence of surgical procedures for NT SCFE was 8.8 per 100,000 children. The total incidence over the combined group for children aged 10–19 years was 13.7 surgical procedures per 100,000 children.

Gender ratio

In the combined group of NT and T SCFE the relative risk of exposure of boys compared to girls aged 5–19 years was 1.11 (95 % CI 0.95–1.30) over the period 1998 to 2010. The 95 % CIs over all years imply that there was no significant difference in the risk of being exposed to SCFE between boys and girls (Table 3).

The annual incidence of surgical procedures for SCFE (Fig. 1) increased significantly for girls aged between 5 and 19 years ($p = 0.034$). The incidence of the total group (boys and girls combined) did not increase significantly ($p = 0.384$) nor did the incidence for boys ($p = 0.438$).

The same results were seen in only the NT SCFE group, where the relative risk over the 13 years was 0.99 (95 % CI 0.82–1.18) (Table 4). The annual incidence of NT SCFE for girls also increased significantly ($p < 0.001$), but not

for boys or the combined group ($p = 0.309$ and $p = 0.293$, respectively) (Fig. 2).

Age

In the combined NT and T SCFE group, 499 of the 609 patients (82 %) with SCFE were between 10 and 14 years of age (Fig. 3). The T SCFE group contained more boys in the age group 10–14 years, whereas the NT SCFE group contained more girls (Fig. 4). In the age group 10–14 years, the incidence rates for boys and girls did not differ significantly (relative risk 0.92, 95 % CI 0.77–1.10). In the age group 15–19 years, the incidence rates did differ: 4.3:100,000 for boys and 0.6:100,000 for girls. One possible

Fig. 1 Annual incidence of traumatic slipped capital femoral epiphysis (T SCFE) and non-traumatic SCFE (NT SCFE) for boys and girls aged 5–19 years and for the two groups combined for the period 1998–2010

Table 3 Relative risk of being exposed to traumatic and non-traumatic SCFE for boys compared to girls aged 5–19 years, per year and over the entire study period 1998–2010

Study year	RR [95 % CI]: M vs. F
1998	1.49 [0.82–2.69]
1999	1.05 [0.58–1.89]
2000	1.47 [0.76–2.81]
2001	1.73 [0.94–3.19]
2002	1.22 [0.72–2.06]
2003	1.57 [0.86–2.87]
2004	0.70 [0.39–1.26]
2005	1.05 [0.57–1.93]
2006	1.20 [0.62–2.31]
2007	0.99 [0.58–1.70]
2008	0.88 [0.49–1.56]
2009	0.87 [0.54–1.41]
2010	0.91 [0.51–1.64]
1998–2010	1.11 [0.95–1.30]

RR relative risk, CI confidence interval

Table 4 Relative risk of being exposed to non-traumatic SCFE for boys compared to girls aged 5–19 years, per year and over the entire study period 1998–2010

Study year	RR [95 % CI]: M vs. F
1998	1.23 [0.61–2.47]
1999	0.96 [0.48–1.91]
2000	1.56 [0.74–3.31]
2001	1.67 [0.82–3.40]
2002	1.30 [0.72–2.36]
2003	1.31 [0.69–2.50]
2004	0.76 [0.40–1.47]
2005	1.09 [0.53–2.24]
2006	0.89 [0.43–1.85]
2007	0.68 [0.36–1.26]
2008	0.64 [0.32–1.25]
2009	0.92 [0.53–1.59]
2010	0.59 [0.30–1.18]
1998–2010	0.99 [0.82–1.18]

Fig. 2 Annual incidence of NT SCFE for boys and girls aged 5–19 years and for the two groups combined for the period 1998–2010

Fig. 3 Percentage of patients (boys and girls combined) with NT and T SCFE divided into different age groups for the entire study period 1998–2010

Fig. 4 Percentage of patients with NT SCFE and T SCFE per gender and for different age groups over the entire study period 1998–2010

explanation for this effect could be the earlier closure of the growth plate in girls (around 14 years of age) than in boys (around 16 years of age). In the age group 5–9 years, we observed the opposite effect: the incidence for boys was 0.6:100,000 and that for girls was 1.2:100,000.

Discussion

Our data show that the presumed gender dominance in the incidence of SCFE was not confirmed in the interval 1998–2010 in the Netherlands. The data also show an increase in the incidence of surgical procedures for SCFE in girls starting from 1998.

The strong points of this study are its nationwide coverage and the use of uniform diagnostic criteria.

One limitation to our study is our use of national Dutch hospital registration data, which did not allow us to take into account the etiology of SCFE (i.e. endocrinological, mechanical or other causes). NT SCFE is sometimes confused with T SCFE and often treated as such. Therefore, we combined the T/NT SCFE groups and also considered the NT SCFE group separately. The T SCFE group may have contained some high-energy epiphyseal fractures, leading to an overestimation of T SCFE. However, we expect this overestimation to be very small because of the low frequency of this type of fracture in general and the low number of high-energy lesions in the Netherlands. A second limitation to our study is that the statistics did not show whether patients had a unilateral slip or a bilateral slip nor could we find information on different cultures or seasonal variations.

Incidence

It is difficult to compare the incidence we found in the Netherlands with the incidences reported in the literature because data on different age groups are presented. In addition, different estimation methods have been used. A few studies use ICD codes, as we did [1–3], but most studies used the hospital information system because this provided a defined framework [4–11]. The incidence we found is comparable to data from Sweden and the USA.

In general, it would appear that Asian countries like Japan, Singapore and Korea [9–11] have a lower incidence of SCFE than Western countries. Speculations on the reasons for these differences have focused on ethnic or nutritional differences [9, 11] (see Table 1).

Gender ratio

All published studies report a male:female ratio with preponderance for boys, ranging from 1.4 to 4.1 (Singapore) [9].

Our study is unique in determining that the 95 % CIs over each of the past years in the Netherlands imply that there was no significant difference in the risk of being exposed to NT and T SCFE between boys and girls. Despite these figures, however, there has been an increase in the incidence of SCFE in girls over the past 13 years: the annual incidence increased significantly for girls aged 5 to 19 years. The incidence for boys did not increase significantly nor did that for the combined group.

Figure 1 shows that the difference is small between girls and boys on an annual basis but that over the years of the study period there was an increase in the incidence of SCFE in girls compared to boys. To date, our study is the first to report such a difference at the national level while concomitantly describing an increase in the incidence of SCFE in girls over the last decade.

A decrease of male predominance has also been found in Japan and Sweden. Despite the low incidence in Japan, a fivefold increase in boys and tenfold increase in girls was found between 1974 and 1999 [10]. In Sweden, the predominance of boys has decreased from 85–90 to 60–65 % during the first decade of this century [4, 12].

Age

We found the same distribution of children with SCFE in different age groups as reported in the other studies. All studies describe a peak in incidence around the age of onset of puberty. In our group, the 609 patients with SCFE were divided as follows: 5 % (29) in the 5- to 9-year-old group, 82 % (499) in the 10- to 14-year-old group and 13 % (81) in the 15- to 19-year-old group (see Fig. 3). A majority of studies describe a decrease in the mean age of onset during recent years. Hagglund et al. [4] suggest that the decreasing age at onset of SCFE is probably caused by the onset of puberty at an earlier age during the last century and by the increased awareness of parents, the social environment and physicians, leading to an earlier diagnosis of SCFE.

Body length

In the Netherlands nation-wide growth studies have been conducted since 1955. The fifth Dutch Growth study was carried out between 2008 and 2010. These results can be compared to earlier studies in the Netherlands. Schonbeck et al. [13] report that there has been no increase in the body length of boys and girls between 1997 and 2009 in the Netherlands.

Body weight

Figures obtained from the Factsheet Results Fifth National Growth Study TNO (June 10, 2010) show that there has

been a trend for an increase in overweight and obesity from 1997 to 2009. A comparison of data for the period 1997–2009 shows that 9.4 versus 13.3 % of Dutch boys and 11.9 versus 14.9 % of Dutch girls aged 2–21 years were overweight and 0.9 versus 1.8 % of the boys and 1.6 versus 2.2 % of the girls were classified as obese [13]. Although the boys have increased in body weight more than the girls, the incidence of SCFE for boys—but not for girls—seems to have stabilized. The increase of SCFE in girls in the past decade may also be due to these increases in body weight, but we have no data to support such a hypothesis for boys. Increasing obesity in adolescents has been found in many different countries, as has an increase in SCFE [2, 10, 11, 14]. In major cities in the Netherlands overweight prevalence has stabilized, with no increase in the body mass index, which leads to the hope that the rising trend in overweight is starting to turn [13].

Conclusion

Based on the results of our study, in the Netherlands there was no difference in the incidence of surgical procedures for SCFE between boys and girls during the period 1998–2010. In the past 13 years there has been an increase in the incidence of surgical procedures for SCFE among girls in the combined NT/T SCFE group and in the NT SCFE group alone. The incidence in boys and in the combined group has not increased. From other national registries we know that there has been an increase in the number of Dutch children who suffer from overweight and obesity, while the body length has not increased the past 10 years.

The incidence determined in our study seems to be comparable with that of other Western countries such as the USA and Sweden.

Conflict of interest None.

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