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ORIGINAL ARTICLE

Frequency of inguinal herniotomy in Australia (1998–2017)

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Abstract

Background/aim Closure of the processus vaginalis (PV) is considered as the last step of testicular descent. Therefore, patent processus vaginalis (PV), and inguinal hernias are linked to cryptorchidism. As the National Australian incidence of orchidopexy has decreased over the previous 20 years, we aimed to explore the incidence of inguinal herniotomy (including hydrocele) over time in Australia.

Methods The National Department of Human Services (DHS) database, and Bureau of Statistics database were obtained for the years 1998–2017. The numbers of inguinal herniotomies in patients aged 0–4, 5–14 and 15–24 yearswere examined with ethical approval.

Results Over the 20-year period, over 87,000 inguinal herniotomy procedures were performed in males. The incidence per year in males decreased across all ages over the 20-year period, but was most pronounced in infants and toddlers. Similar to males, the incidence in females decreased over time, with the ratio of procedures per head of population decreasing in children under 5 years of age. The ratio of male: females varied according to ages, and was between 2.8 and 6.2 males: 1 female.

Conclusion This study suggests that fewer 0–4-year olds are undergoing inguinal herniotomy, compared with 20 years ago. This is likely due to a change in practice for the management of unilateral symptomatic hernias, from routine bilateral herniotomies, to unilateral surgery. As well as less aggressive surgical intervention for hydroceles in boys.

Level of evidence III.

Keywords Inguinal hernia · Herniotomy · Patent processus vaginalis · National frequency

Introduction

The processus vaginalis (PV) forms a diverticulum of the peritoneal membrane inside the fetal gubernaculum as it migrates to the scrotum, which allows the intraabdominal fetal testis to reach the scrotum while still inside the peritoneal cavity [1]. After testicular descent is complete, the PV closes spontaneously, and this process is complete by birth or after minipuberty at 3–6 months of age. It has been proposed that the failure of PV obliteration may be secondary to the same causes that lead to undescended testis, because of the unique function of the PV to facilitate normal descent [2]. In a female fetus, a small PV forms inside the inguinal canal ('the canal of Nuck'), but in the absence of androgens, there is no normal elongation of the PV into the labia. The small PV in females may remain patent but hernias are less common than in males (< 10%) [3].

When the PV fails to obliterate by birth, the baby boy presents with an inguinal hernia, hydrocele or a hydrocele of the spermatic cord [4, 5]. In addition, it has been suggested that a fibrous remnant of the PV that has failed to disappear completely is the cause of acquired undescended testes (UDT), the so-called 'ascending testis' [6]. It has been standard practice to treat inguinal hernia and persisting hydrocele with inguinal herniotomy [4]. In recent years, there has been a change in practice with a unilateral symptomatic hernia undergoing unilateral rather than bilateral herniotomies. There has also been a move to defer inguinal herniotomy

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for hydrocele to a later age, while spontaneous closure of the patent PV is awaited [4].

As the frequency of orchidopexy operations was found to be decreasing in recent years in Australia [7], we wondered whether a similar trend may be occurring with inguinal herniotomy, especially given the trend to delay surgery in hydrocele after 2 years of age, which once was the recommended age for intervention [8].

We examined 20 years of Australian data for inguinal 'herniotomy' from 1998 to the present aiming to explore the trends in national operation rates over time. We used 'herniotomy' as a marker for both diagnosis and treatment of inguinal and femoral hernia, on the assumption that operative treatment is the accepted standard.

Methods

Data on 'herniotomy' were collected from the Australian Federal Department of Human Services for the calendar years 1998–2017 after ethical approval by the Royal Children's Hospital (Melbourne) Human Research Ethics Committee (reference number 38122A). Data were extracted using the age-specific operation codes for herniotomy for all patients aged 0–24 years (public and private). 'Herniotomy' was defined in the database as including; laparoscopic assisted or open femoral or inguinal hernias (including obstructed or strangulated hernias), infantile hydrocele repairs or inguinal hernia repair with orchidopexy, which included femoral and direct inguinal hernia, as well as closure of the PV with a hydrocele repair. Bilateral herniotomies were coded as two operations.

Coding is provided by all hospitals in the country and submitted to the federal government as part of the mechanism of Australian hospital funding. The database included all patients up to 24 years of age due to arbitrary data-extraction reasons, unrelated to the normal age limits for paediatrics. We included patients aged 15–24, as this was the only way to cover patients older than 14 years. As the national database only collated information in the three age groups (0–4, 5–14, 15–24), we were unable to subdivide the results into more meaningful age groups. We were also unable to separate the different types of hernia (femoral/inguinal/direct/indirect), as the database does not record all the diagnoses, just the operative procedure as part of the funding algorithm. However, we assumed that direct inguinal hernia and femoral hernia were included in such low numbers that they were unlikely to affect the overall analysis of trends, given that both direct inguinal and femoral hernias constitute less than 1% of the total diagnoses [9].

National population data were collected from the Australian Bureau of Statistics (ABS). Census data for each age group were available for years 1996, 2001, 2006, 2011 and 2016; demographic data for other years were ABS estimates. Patients were divided by the ABS into three age groups: 0–4, 5–14 and 15–24 years. Each 5-year quantum of data were averaged for each age group. A Poisson regression model was fitted to the data for each age group. An incident rate ratio (IRR) indicated the estimated annual (compound) rate of change over the 20-year period to reveal the trends in operation rates related to the whole population. Calculations were performed in Stata 14.

Results

Incidence of male herniotomy

The total number of male herniotomies in Australia over the 20-year period was 71,995. Overall, the incidence of operations per annum has decreased over the last 20 years, with 4032 operations performed in 1998 compared to 2481 in 2017. There was an average of 3323 operations per year between 1998 and 2002 compared to 3188 in the 2003–2007 period. This was followed by a further decrease between 2008 and 2012, with an average of 2986 operations, compared to 2669 procedures in 2012–2017 (Table 1 and Fig. 1a).

The number of male herniotomies in each age group was divided by the total population of boys in each age to give an estimate of the number of operations per head of the population. This shows a progressive decrease in the number of herniotomies per head over the 20-year period over all age groups. The decrease was largest in the 0–4-year age group (Fig. 1b). Meanwhile, the annual population of males aged 0–24 years increased from 1.7 million in the 1998–2002 period to 2.0 million in the 2013–2017 period. This means that in 1998, there were 0.66 million boys under the age of 5 years, compared with 0.8 million in 2017. In the 5–14-year age group, there were 1.3 million boys in 1998, compared with 1.6 million in 2017. In the 15–24-year age group, there were 1.3 million males in the 1998, compared with 1.6 million in 2017.

Table 1 Herniotomy rates in males, in three age groups, (mean number/ year) for each 5-year period

Incidence of herniotomy	0–4 years	5–14 years	15–24 years	Total
1998–2002	2944	688	590	3323
2002–2007	1860	665	664	3188
2008–2012	1650	637	700	2986
2013–2017	1399	692	579	2669
Total	6952	2681	2533	

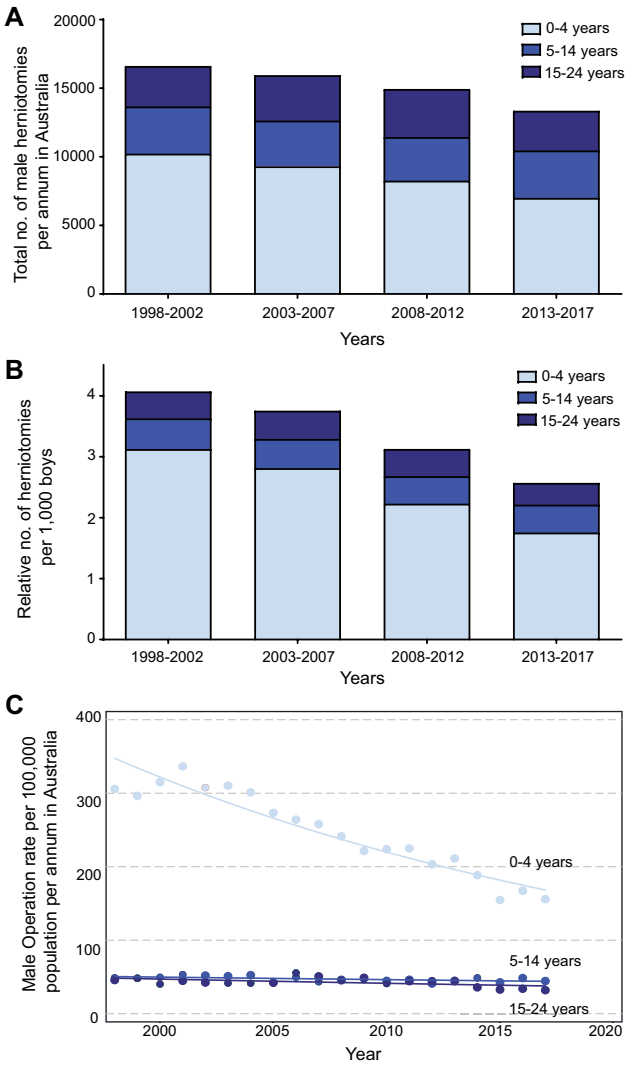

Fig. 1 **a** Total number of male herniotomies in Australia by age group. **b** Number of male herniotomies relative to the population of males in the population in each same age group. **c** Poisson regression model graphing relative incidence of male herniotomies in each age group divided by the total of boys in each age group. (Light blue: 0–4 years of age. Blue: 5–14 years of age. Dark blue: 15–24 years of age)

When the operation rates are divided into the three age groups: 0–4 years, 5–14 years and 15–24 years, it can be seen that operations in children under 5 years decreased about 38% from 2018 to 1258 per year. By contrast, in the 5–14 age group, the frequency of surgery remained constant 659–699 per year. In the 15–24-year-old group, the frequency of surgery decreased about 13%, from 605 operations to 524 per year, although small numbers precluded detailed comparison.

Using a Poisson regression model for each age group (Fig. 1c), the IRR indicates the estimated annual (compound) rate of change over time. For boys under the age of 5 years, there was a significant decrease in the rate of herniotomy operations ($P < 0.005$), with an average decline of 3.7% per year. This equates to halving of the numbers of herniotomies in boys under 5 years from about 300/100,000 in 1998 to about 150/100,000 in 2017. For the 5–14-year age group, there was a much smaller decrease in the rate of hernia repair operations ($P < 0.005$), with an average decline of 0.7% per year. For adolescents and young adults (15–24 years of age), there was also a small decrease ($P < 0.005$), with an average decline of 1.3% per year.

Table 2 Herniotomy rates in females, in three age groups, (mean number/year) for each 5-year period

Incidence of herniotomy	0–4 years	5–14 years	15–24 years	Total
1998–2002	507	246	75	828
2002–2007	469	233	101	803
2008–2012	402	229	107	738
2013–2017	299	249	122	670
Total	1677	957	405	

Incidence of female herniotomy

The total number of female herniotomies in Australia over the 20-years period was 15,195, which is about 1/5 the rate in boys. Overall, the incidence of operations per annum has decreased over the last 20 years, with 814 operations performed in 1998 compared to 623 in 2017. There was an average of 828 operations per year between 1998 and 2002 compared to 803 in the 2003–2007 period. This was followed by a further decrease between 2008 and 2012, with an average of 738 operations, compared to 670 procedures in 2012–2017 (Table 2 and Fig. 2a).

There was a progressive decrease in the number of female herniotomies per head over the 20-year period over all age groups, similar to the males. The decrease was largest in the 0–4-year age group (Fig. 2b). Meanwhile, the annual population of females increased steadily between 1998 and 2002 (3.2 million) and the 2013–2017 (3.7 million). This means that in 1998, there were 0.62 million girls under the age of 5 years, compared with 0.8 million in 2017. In the 5–14-year age group, there were 1.3 million girls in 1998, compared with 1.4 million in 2017. In the 15–24-year age group, there were 1.3 million females in the 1998, compared with 1.5 million in 2017.

When the operation rates are divided into the three age groups: 0–4 years, 5–14 years and 15–24 years, it can be seen that operations in children under 5 years decreased about 41% from 507 to 299 per year. By contrast, in the 5–14 age group, the frequency of surgery increased by 42% 246–349 per year. In the 15–24-year-old group, the

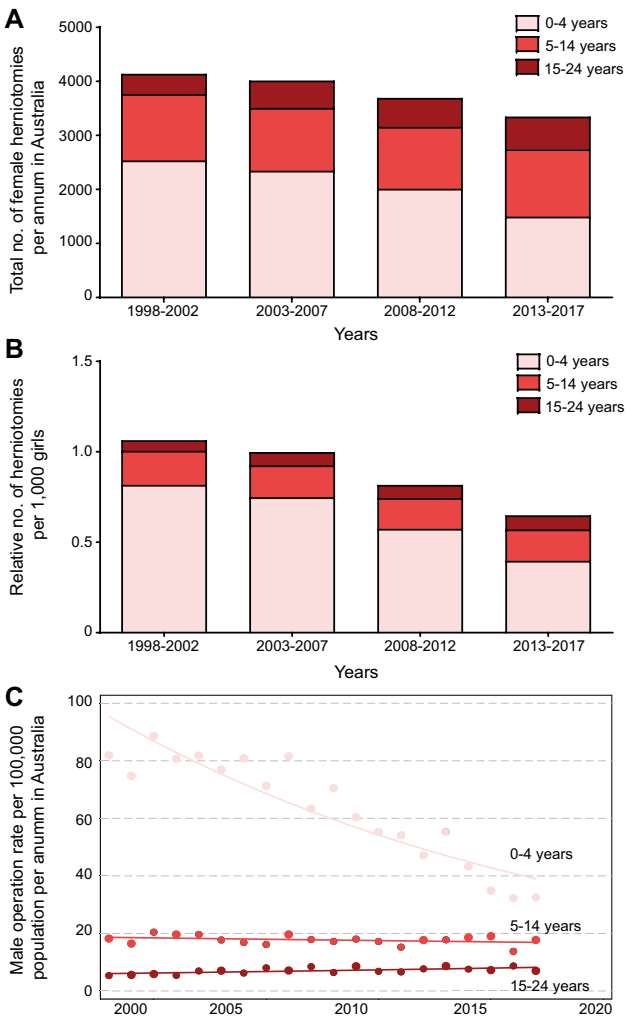

Fig. 2 **a** Total number of female herniotomies in Australia by age group. **b** Number of female herniotomies relative to the population of males in the population in each same age group. **c** Poisson regression model graphing relative incidence of female herniotomies in each age group divided by the total of girls in each age group. (Light red: 0–4 years of age. Red: 5–14 years of age. Dark red: 15–24 years of age)

frequency of surgery increased about 63%, from 75 operations to 122 per year.

Using a Poisson regression model for each age group (Fig. 2c), the IRR indicates the estimated annual (compound) rate of change over time. For girls under the age of 5 years, there was a significant decrease in the rate of herniotomy operations ($P < 0.005$), with an average decline of 4.6% per year. For the 5–14-year age group, there was a much smaller decrease in the rate of hernia repair operations ($P = 0.04$), with an average decline of 0.5% per year. For adolescents and young adults (15–24 years of age), there was an increase ($P < 0.005$), with an average increase of 1.6% per year.

The number of children under 4 years of age undergoing emergency herniotomy (which is coded separately from elective operations) was small but consistent, with girls undergoing 8–25 emergency herniotomies annually (10–16.9% of female surgical interventions), and males between 7 and 39 operations per year (2.3–5.9% of male surgical intervention). The comparative incidence of female: male (as a ratio) was 4:1 over all ages and years. When expressed according to age group, in the 0–4-year olds, there were 4.15 boys: 1 girl; and in the 5–14-year olds, there were 2.8 boys: 1 girl; lastly in the 15–24-year olds, there were 6.2 men: 1 woman.

Discussion

This study found that the overall incidence of herniotomy in Australia has decreased over the last 20 years, in both males and females. Compared to the population, the greatest decrease was in 0–4-year olds in both the male and female groups (3.7% and 4.6% per annum, respectively). By contrast, there was a much smaller decrease in the incidence of herniotomy in 5–14-year-old boys of 0.7%, and 0.5% per annum in girls over 20 years. In adolescent and young adults (15–24 years of age), there was a small decrease of men undergoing herniotomy of 1.3% per year, but the number of young women undergoing inguinal herniotomy increased by 1.6% (but with very small numbers in these last two groups).

The significant decrease in the number of infants/toddlers under 5 years of age is likely to reflect a decrease in operative intervention for hydroceles, as the constant rate of emergency herniotomy procedures over the two decades suggests no obvious change in the management of symptomatic inguinal hernia. It may also reflect the accepted standard for earlier surgical intervention 20 years ago compared with current management. We know that 30% of children have a patent processus vaginalis in the first few months of life and this closes shortly after [1].

A patent processus vaginalis contralateral to a symptomatic hernia is a well-known phenomenon, with only a small amount of PPV leading to hernia formations [10, 11]. There has been a trend to treat a unilateral symptomatic hernia with a unilateral herniotomy rather than bilateral herniotomies; and this may account for the decrease 41% decrease in herniotomies performed in 0–4-year-old girls over the time period.

Limitations on these data include the assumption that an appropriate number of herniotomies were performed over the 20-year period. The overall incidence of hernia (inguinal and femoral), and hydrocele is presumed to be the same as in other developed countries. We also assume that the correct operative procedure has been coded at the time of operation.

In conclusion, this study suggests that fewer 0–4-year olds are undergoing herniotomy procedures, compared with

20 years ago. This is likely due to a change in practice for the management of unilateral symptomatic hernias, from routine bilateral herniotomies, to unilateral surgery. As well as less aggressive surgical intervention for hydroceles in boys.

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Compliance with ethical standards

Conflict of interest None of the authors have any financial or personal interests to disclose.

Ethical approval Human ethical approval was obtained prior to undertaking the study via The Royal Children's Hospital (Melbourne), HREC No. 38122A.

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