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ORIGINAL ARTICLE

Male Health

Clinical and socioeconomic factors associated with delayed orchidopexy in cryptorchid boys in China: a retrospective study of 2423 cases

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We investigated the associations of clinical and socioeconomic factors with delayed orchidopexy for cryptorchidism in China. A retrospective study was conducted on cryptorchid boys who underwent orchidopexy at Children's Hospital at Chongqing Medical University in China from January 2012 to December 2017. Of 2423 patients, 410 (16.9%) received timely repair by 18 months of age, beyond which surgery was considered delayed. Univariate analysis suggested that the laterality of cryptorchidism ($P = 0.001$), comorbidities including inguinal hernia/scrotal hydrocele ($P < 0.001$) or urinary tract disease ($P = 0.016$), and whether patients lived in a poverty county ($P < 0.001$) could influence whether orchidopexy was timely or delayed. Logistic regression analysis suggested that the following factors were associated with delayed repair: unilateral rather than bilateral cryptorchidism (odds ratio [OR] = 1.752, $P < 0.001$), absence of inguinal hernia or hydrocele (OR = 2.027, $P = 0.019$), absence of urinary tract disease (OR = 3.712, $P < 0.001$), and living in a poverty county (OR = 2.005, $P < 0.001$). The duration of postoperative hospital stay and hospital costs increased with the patient's age at the time of surgery.

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INTRODUCTION

Cryptorchidism, or an undescended testis, is a common congenital anomaly in children, occurring in 1%–4% of full-term and 10%–30% of preterm male neonates.^{1–5} Although the undescended testis has the potential to descend to a normal position in the scrotum within the first 6–12 months of life, the condition remains static in most patients for years.^{6,7} Because the internal abdomen is warmer than the scrotum, the spermatogenic function of the undescended testis can be impaired, leading to reduced fertility.^{6,8–10} Furthermore, the number of germ cells in undescended testes may be reduced from the time of birth.¹¹ Cryptorchidism is also highly associated with inguinal hernia,^{8,12,13} and there is an increased risk of testicular malignancy¹⁴ and torsion.^{15,16}

Current opinion considers orchidopexy to be the standard therapy for cryptorchidism, and there is an emphasis on early treatment.^{1,17,18} The Nordic consensus suggests that orchidopexy should be performed when patients are between 6 and 12 months of age.¹⁹ The American Urologic Association (AUA) recommends that 6-month-old boys should undergo surgery before reaching the age of 18 months.²⁰ This latter guideline is more accepted by Chinese pediatric surgeons.

However, several studies have reported that, worldwide, the actual age at the time of orchidopexy is often older than recommended.^{5,21–23} Savoie *et al.*²² and Bayne *et al.*,²³ in the United States, and Schneuer

*et al.*²⁴ in Australia, have investigated socioeconomic and other factors associated with a delay in surgery, but there have been no relevant reports among Chinese populations. Identifying the factors that cause delayed surgical treatment of cryptorchidism in China would help to establish targeted medical health-care plans for high-risk groups, improve the rate of timely repair, and protect boys' reproductive health.

To investigate the clinical and socioeconomic factors associated with delayed orchidopexy in China, the present study is a retrospective examination of all orchidopexies performed at the largest child specialist medical center in West China (Children's Hospital of Chongqing Medical University, Chongqing) from January 2012 to December 2017.

PATIENTS AND METHODS

The study procedure was approved by the Institutional Review Board of Children's Hospital of Chongqing Medical University (No. 201896), and this study was performed on previously collected information that could not be linked to patients' identities.²¹ The need for informed consent was waived because of the retrospective design.

A retrospective review was conducted on boys who underwent orchidopexy from January 2012 to December 2017 at Children's Hospital of Chongqing Medical University after receiving a diagnosis of

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cryptorchidism. All hospitalized boys (with inpatient care or outpatient care) aged 0–18 years who underwent orchidopexy at Children's Hospital of Chongqing Medical University from 2012 to 2017 were included in this study (**Figure 1**). Patients with testicular torsion or retractile testes and those who had previously undergone orchidopexy were excluded from this analysis.

Demographic data included date of birth, county of residence, and medical insurance status at the time of surgery. Counties of residence were defined as poverty counties based on the average annual income of the local population, as listed at http://www.cpad.gov.cn/art/2012/3/19/art_50_23706.html (last accessed on February 18, 2018). The extracted clinical information included the following: laterality of cryptorchidism, comorbidities, date of surgery, postoperative hospitalization, hospitalization costs, and age at orchidopexy (calculated from the date of birth).

Following the AUA guideline,²⁰ which recommends that surgical repair of cryptorchidism should be performed when the patient is younger than 18 months, we defined delayed repair as primary orchidopexy performed after the age of 18 months.

Statistical analyses

Statistical analyses were conducted with SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). Dichotomous variables were compared using Chi-squared tests. Normally and non-normally distributed continuous variables were compared using Student's *t*-test and Mann–Whitney U test, respectively. Variables that were determined to be significant in the univariate analyses were included in the logistic regression analysis. The analysis of correlations was performed using Spearman's correlation method. Data were considered statistically significant at $P < 0.05$.

RESULTS

Among the potential candidates, 2423 patients with cryptorchidism satisfied the criteria for inclusion in this study (**Table 1**). The median age at orchidopexy was 27 months. Most cases were unilateral (84.8%). Almost 19.8% of the patients also had urinary system disease, and nearly 14.0% had inguinal hernia or scrotal hydrocele. A few had a genital anomaly (3.5%). The median postoperative hospital stay was

3 days, and the median hospital cost was 6294 Chinese yuan (CNY; approximately equal to 968 United States dollars). About 20.8% of the patients lived in a poverty county, and 30.0% did not have medical insurance.

Overall, about 16.9% of the study population received timely repair, with the highest percentage found in the year 2017 (20.6%; **Figure 2**). Among the patients with delayed repair, the percentages with urinary system disease ($P = 0.016$), inguinal hernia or scrotal hydrocele ($P < 0.001$), and bilateral cryptorchidism ($P = 0.001$) were significantly lower than those percentages among the patients who received timely repair. The proportion of children with genital anomalies did not differ between those receiving timely treatment and those with delayed treatment.

Patients who live in a poverty county were more likely to undergo delayed repair than to have a timely repair (**Table 1**). The rates of patients with medical insurance were comparable between the two groups; a minority was uninsured.

All of the variables that were determined by the univariate analysis to show a significant difference between patients who received timely and delayed treatment were included in the logistic regression analysis (**Table 2**). Boys with unilateral cryptorchidism ($P < 0.001$) and those with no urinary system disease ($P = 0.019$) were significantly more likely to receive a delayed repair than a timely repair. Patients without inguinal hernia or scrotal hydrocele were more than three times more likely to be given a delayed repair, compared with those with these conditions ($P < 0.001$). Living in a poverty county was highly associated with having a delayed repair ($P < 0.001$).

The median postoperative hospital stay in both the timely repair group and the delayed repair group was 3 days (**Table 1**). However, the average postoperative hospital stay of patients receiving a timely repair (2.9 [standard error of mean (s.e.m.): 0.9] days) was statistically lower than that of those receiving a delayed repair (3.0 [s.e.m.: 0.7] days; $P = 0.002$). The median hospital costs of the two groups were similar.

The study population was further distributed into four age categories, and it was found that the length of hospital stay after surgery ($r = 0.108$, $P < 0.001$) and hospital costs ($r = 0.097$, $P < 0.001$) significantly increased with age at the time of orchidopexy (**Figure 3**).

DISCUSSION

Although the specific timing of surgery remains controversial in the treatment of boys with cryptorchidism, it is well accepted that patients should undergo early surgical repair.^{8,19,20,25} In the present retrospective study, we determined that only 16.9% of the studied patients with cryptorchidism underwent orchidopexy by 18 months of age, although the AUA guidelines state that the procedure should be performed prior to this. Previous studies among American populations reported

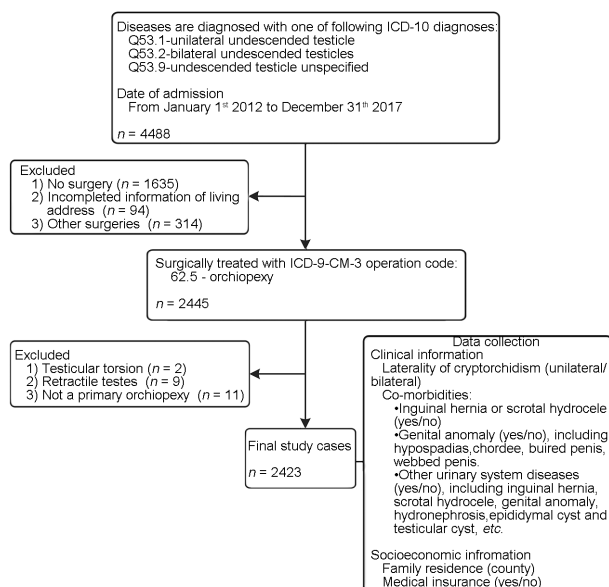


Figure 1: Flowchart of the retrospective protocol.

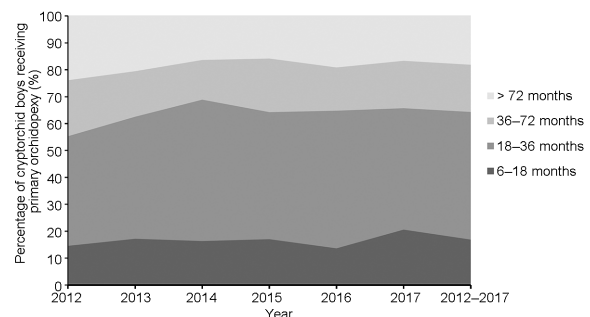


Figure 2: Percentages of cryptorchid boys receiving primary orchidopexy from 2012 to 2017 by age category.

Table 1: Demographic, clinical, and socioeconomic characteristics of 2423 cases

Characteristics	Total (n=2423)	Timely repair (n=410)	Delayed repair (n=2013)	P
Age at orchidopexy (month), median (IQR)	27 (20, 55)	16 (14, 17)	31 (23, 65)	<0.001
Average age (month), mean±s.e.m.	43.2±35.4	15.4±2.2	48.9±36.3	<0.001
Unilateral cryptorchidism, n (%)	2054 (84.8)	326 (79.5)	1728 (85.8)	0.001
Comorbidity, n (%)				
Genital anomaly	84 (3.5)	10 (2.4)	74 (3.7)	0.212
IH/SH	339 (14.0)	86 (21.0)	253 (12.6)	<0.001
Urinary disease	480 (19.8)	99 (24.1)	381 (18.9)	0.016
Poverty county residence, n (%)	505 (20.8)	53 (12.9)	452 (22.5)	<0.001
Medical insurance, n (%)	1696 (70.0)	290 (70.7)	1406 (69.8)	0.721
Postoperative hospital stay (day), mean ± s.e.m. ^a	3.0±0.7	2.9±0.9	3.0±0.7	0.002
Hospital costs (CNY/USD), median (IQR)	6294/968 (5229/804, 7282/1120)	6184/951 (5199/800, 7367/1133)	6340/975 (5237/806, 7256/1116)	0.330

^aDefined as time from surgery to discharge. IH: inguinal hernia; SH: scrotal hydrocele; IQR: interquartile range; s.e.m.: standard error of the mean; CNY: Chinese yuan; USD: United States dollar

Table 2: Logistic regression analysis of factors associated with delayed surgical repair

Factors	Parameter estimate	SE	Chi-squared test	P	OR (95% CI)
Unilateral cryptorchidism	0.561	0.141	15.719	<0.001	1.752 (1.328–2.311)
No urinary system disease	0.707	0.302	5.490	0.019	2.027 (1.122–3.662)
No inguinal hernia or scrotal hydrocele	1.312	0.322	16.639	<0.001	3.712 (1.977–6.971)
Living in poverty county	0.696	0.158	19.357	<0.001	2.005 (1.471–2.733)

SE: standard error; OR: odds ratio; CI: confidence interval

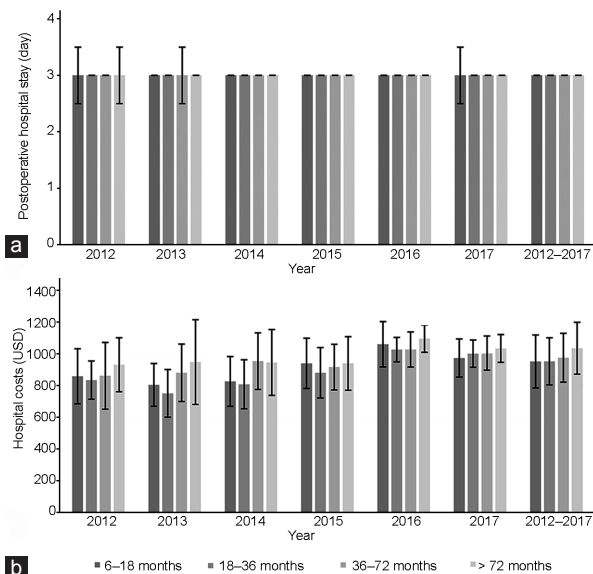


Figure 3: Spearman's correlation analysis of (a) postoperative hospital stay and (b) hospital costs by age category from 2012 to 2017. USD: United States dollar.

that the rate of timely surgical correction (orchidopexy by the age of 18 months) varied from 27% to 87%.^{22,26} A 2014 study of a Swedish population reported that <10% of patients received timely surgery (prior to the age of 1 year), and the median age at surgery was 3.4 years.⁵ The median age at the time of primary orchidopexy in this study was lower than this previous finding in Sweden. However, the Swedish study was based on the total population of boys in the country, whereas the present study was restricted to those treated at one tertiary pediatric surgery center, potentially excluding some orchidopexy surgeries performed on adolescents at general hospitals. This observed difference in the median ages for Chinese and Swedish boys is likely

to have been caused by the selection bias of the study populations. In addition, a population-based study in Taiwan (China) in 2013 reported that about 21% of cryptorchid boys received surgery before the age of 12 months.²⁷ The rate of early surgery for cryptorchidism found in our study population is relatively low internationally, compared with previous researches.

We found that certain clinical and socioeconomic factors were associated with the delay of surgical treatment for patients with cryptorchidism, including laterality of cryptorchidism, comorbidities, and the economic level of the patient's county of residence. The univariate analysis indicated that boys with unilateral cryptorchidism had a higher rate of delayed orchidopexy compared with boys with bilateral cryptorchidism. The logistic regression suggested that unilateral disease was associated with delayed surgery.

Savoie *et al.*²² reported that a nonpalpable testis may affect the age at orchidopexy because parents may discover the abnormality earlier, leading to an earlier evaluation by a primary care provider. We speculate that the small size of the scrotum and the obvious emptiness of the scrotal contents caused by bilateral cryptorchidism may raise the guardian's concern and lead to an earlier diagnosis, and primary health-care providers may be more likely to make timely referrals because no descended testicles were found in these boys.

We also found that children with inguinal hernia or hydrocele, or a urinary system disease, were more likely to receive a timely correction. Yiee *et al.*²⁶ suggested that parents could easily discern the abnormal signs of inguinal hernia and hydrocele. Similarly, having a urinary system disease in combination with cryptorchidism may increase the chances of visiting a physician. Thus, cryptorchidism in these boys could be diagnosed during the visit for inguinal hernia, hydrocele, or urinary system disease. According to another report,²³ a concomitant penile anomaly was not an associated factor affecting the timing of surgery. The reason may be that the number of patients with penile anomalies is relatively low, leading to a statistically insignificant difference. Because the above-associated factors may

motivate parents to bring their children to physicians for care, we recommend that primary health-care institutions emphasize the public awareness of cryptorchidism and routinely screen for this condition.

In terms of socioeconomics, we found that children living in poverty-stricken counties had a higher risk of delayed repair. Although primary-level medical care is undergoing a vigorous development in China,²⁸ medical and health resources in poor economic areas are relatively scarce, especially in terms of pediatricians and clinicians with pediatric expertise.²⁹ Early and accurate screening for cryptorchidism is not widespread. We previously conducted a questionnaire survey of primary health-care practitioners concerning the understanding of and referral patterns for childhood cryptorchidism, finding quite a low level of awareness.²¹ We recommend re-education training for primary health-care clinicians regarding the diagnosis and treatment of cryptorchidism, especially in poor economic areas.

The present study included an analysis of the influence of having medical insurance, and there was no significant difference in the timing of surgery between insured and uninsured boys. This finding is in contrast to a study based on a national database in the United States showing that insurance status was associated with age at orchidopexy.³⁰ The discrepancy may be because of differences in the insurance systems of the two countries. At present, the majority of Chinese people are insured with social medical insurance. The insurance industry in China is still being developed, with underdeveloped commercial insurance for children. Considering that the public's awareness of insurance is not strong, it may be the case that people generally do not delay treatment because of insurance issues.

Furthermore, we found that both postoperative hospital stay and hospitalization costs were significantly and positively associated with age at surgery. In the United States, surgeries that involve infants are more expensive than surgeries on older children (prior to puberty) because of the greater cost of surgeons with a pediatric subspecialty and subspecialty care.^{31,32} In the current study, all of the patients were treated at the same hospital; therefore, differences in subspecialty surgery or care did not contribute to differences in costs. Based on our clinical experience, the higher costs associated with age may be because of the larger surgical wound and wider separation of the spermatic cord in older boys. This may lead to more vascular injuries and postoperative complications, and thus postoperative hospital stay and hospitalization costs would increase. However, no analysis of postoperative complications was included in this study, and our speculation needs to be verified by further research.

The study had several limitations. First, our results were limited by the retrospective observational nature of the analysis. More detailed clinical and socioeconomic information that could be related to delayed surgery, such as referrals, postoperative complications, family economic conditions, and parental education level, was not available. Although our analysis of socioeconomic factors has not yet been completed, few studies have considered these factors in our study population. Second, because the data were drawn from a single pediatric institution, the study may be prone to some selection bias. The general public has a preference for tertiary medical centers, regardless of the severity of disease,³³ and patients who seek care in these facilities may have more comorbidities, which could influence the association between comorbidities and delayed surgery. Finally, only orchidopexy was included in this study, but children with cryptorchidism may undergo other operations, such as orchiectomy for testicular atrophy and exploration of scrotal contents for testicular absence. However, orchidopexy is the most frequently performed

surgery among cryptorchid children; regular orchiectomy for testicular atrophy remains controversial in China, and the testicular absence is relatively rare. Including orchidopexy only may reduce the bias caused by different indications of surgeries.

CONCLUSION

Approximately 16.9% of cryptorchid boys in our study received timely surgery (orchidopexy by the age of 18 months). Delayed orchidopexy was more likely for boys with unilateral cryptorchidism and the absence of associated anomalies and those living in a poverty county at the time of surgery. To maximize the possibility of timely orchidopexy, it is important to strengthen the public awareness of cryptorchidism and conduct re-education training for primary health-care clinicians, and routine screening for cryptorchidism should be implemented in China.

AUTHOR CONTRIBUTIONS

TXZ designed the study, carried out the data analysis, drafted and revised the manuscript. BL participated in the data analysis and helped to draft the manuscript. YXW helped to revise the manuscript. YW, XLT, LJS, CLL, and TL participated in the data analysis, collected all relevant data, and assisted in the study conception and design. SDW conceived of the study, participated in its design and coordination and helped to draft the manuscript. GHW helped to design the study and draft the manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declare no competing interests.

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