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Age at orchiopexy for undescended testis in the United States☆

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ABSTRACT

Purpose: Undescended testis (UDT) is the most common congenital anomaly of the male genitalia. The American Urological Association guidelines recommend orchiopexy by age 18 months to ameliorate the risk of subfertility. The study aim was to assess adherence to these guidelines on a national level.
Methods: We retrospectively reviewed both the State Ambulatory Surgery Database (SASD) in 2012 and the Pediatric Health Information System (PHIS) for 2015. All patients aged 18 years or less with a diagnosis of UDT who underwent orchiopexy were included. Demographic data including age at repair as well as surgical subspecialty and payer status were extracted.
Results: Analysis of the 2012 SASD for New Jersey, Florida, and Maryland yielded 1654 patients. The majority were white, 791 (48.3%), with a median age at repair of 4 years (IQR 1–8). Most patients, 1048 (64%), had orchiopexy later than age 2. A total of 844 males were identified from the PHIS database. Of these, 63% were white. The median age at repair was 5 years (IQR 1–9). There were 577 (68%) patients older than 2 years at orchiopexy.
Conclusion: Almost 70% of boys with undescended testes in the United States are undergoing orchiopexy at least 6 months later than the recommended age.
Type of study: Retrospective.
Level of evidence: III.

Undescended testis (UDT), or cryptorchidism, is the most common congenital anomaly of the male genitalia [1]. The incidence is higher in premature infants and spontaneous descent is common in the first 6 months of life. Failure of descent by 1 year of age occurs in 1% of male infants and is an indication for repair [1,2]. Professional pediatric and urological associations have progressively lowered the recommended age of repair, or orchiopexy, which is surgical repositioning of the testis within the scrotum [3–5]. Studies showing the negative effects of the undescended testis on fertility because of impaired spermatogenesis, and the potential malignancy risk in older children have formed the basis for these recommendations. A randomized controlled study comparing testicular volume, an indirect measure of spermatogenesis, in those who underwent repair at age 9 months compared to 3 years showed earlier surgical treatment resulted in partial catch-up testicular growth and that this was not the case in those delayed until age 3 [6]. The American Urological Association (AUA), in its most recent guideline statement, recommends "in the absence of spontaneous testicular descent by six months (corrected for gestational age), specialists should perform surgery within the next year" [3].

Adherence to these guidelines has been investigated worldwide with most studies showing that only a minority of boys undergo repair before 18 months [5,7–17]. A similar study in the United States using a large national database showed that only 43% of boys had surgery by 2 years of age [18]. This study examined only tertiary level children's hospitals during the period 1999 to 2008. Given that a significant proportion of pediatric surgical procedures are performed outside of freestanding children's hospitals [19], and with the most recent AUA guideline statement release in 2014, this study sought to: (1) re-examine national adherence using a more representative sample of the pediatric population and (2) to highlight trends in the age of repair over time. The study hypothesis was that the age of orchiopexy would be lower compared to older studies, in line with recent consensus guidelines.

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1. Methods

1.1. Data sources and study population

A retrospective review was conducted of all patients aged ≤18 years with a diagnosis of UDT who underwent orchiopexy. The diagnosis of UDT was identified using the International Classification of Diseases, Ninth Revision (ICD-9) code 752.51 and the International Classification of Diseases, Tenth Revision (ICD-10) code Q5310. Orchiopexy was identified using the Current Procedural Terminology (CPT) codes 54,560, 54,640, 54,650 and 54,692 and the following ICD-10 codes: 0VSC0ZZ, 0VSB0ZZ, 0VSB3ZZ, 0VSB4ZZ, 0VS90ZZ, 0VS93ZZ, and 0VS94ZZ. Patients were only included if the procedure was done electively. That is, for data extracted from the Pediatric Health Information System (PHIS), only those with a patient type of "ambulatory surgery" were included. Similarly for the State Ambulatory Surgery and Services Databases (SASD), those with an admission status of "admitted on weekend" were excluded.

In order to capture a representative sample of the population of children undergoing orchiopexy, two large databases were used. PHIS was used to investigate patients treated at specialty freestanding children's hospitals and SASD was used to investigate patients at other institutions where children are treated, such as adult hospitals with a pediatric wing. The years 2012 and 2015 were selected in order to identify any trend in the age of repair before and after the release of the AUA guidelines in 2014. For the purposes of this study orchiopexy was considered an outpatient or ambulatory surgery procedure, although it is also occasionally done as an inpatient.

The Institutional Review Board of Ann & Robert H. Lurie Children's Hospital of Chicago deemed the study exempt and, given the use of de-identified data, a waiver of informed consent was obtained. (IRB 2017–729).

1.1.1. State ambulatory surgery and services databases (SASD)

SASD is a part of the family of databases developed by the Agency for Healthcare Research and Quality (AHRQ) through a Federal-State-Industry partnership for the Healthcare Cost and Utilization Project (HCUP). The SASD contains encounter-level data for hospital-owned and nonhospital-owned ambulatory surgery facilities and outpatient services and spans thirty-five (35) states. Participating data organizations control the data elements that can be released so there is some variation in the types of data available by State and also by data year. The database contains more than 100 clinical and nonclinical variables typically included in a discharge abstract, irrespective of payer status including those covered by public and private insurance as well as the uninsured. Core data elements include demographic as well as diagnostic and procedure data. A separate charges file contains detailed charge information. SASD allows linkage of datasets by hospital identifiers, for example to the State Inpatient Databases (SID) also sponsored by AHRQ. SASD files are purchased through the HCUP Central Distributor [20].

For this study, we used SASD from three states, New Jersey (NJ), Maryland (MD) and Florida (FL), for the year 2012. NJ, MD, and FL were included as a convenience sample due to availability of data for only these states.

1.1.2. Pediatric health information system (PHIS)

Data were obtained from the Pediatric Health Information System (PHIS), an administrative database that contains inpatient, emergency department, ambulatory surgery and observation encounter-level data from over 45 not-for-profit, tertiary care pediatric hospitals in the United States, affiliated with the Children's Hospital Association (Overland Park, KS). The Children's Hospital Association and participating hospitals are responsibility for the overall quality and reliability of the data. Truven Health Analytics (Ann Arbor, MI) also manages portions of the data submission and quality processes. Participating hospitals provide discharge/encounter data including demographics, diagnoses, and procedures for the purposes of external benchmarking. Resource utilization data (e.g. pharmaceuticals, imaging, and laboratory) are also submitted into PHIS. Data are de-identified at the time of data submission, and subjected to a number of reliability and validity checks before being included in the database [21].

For this study we queried PHIS from January 1 to December 31, 2015. Administrative approval from the PHIS was obtained before data extraction and analysis.

1.2. Variables

Demographic data were extracted including age, ethnicity, race and payer type. From the PHIS database we also extracted data on surgical subspecialty, chronic conditions/comorbidities, and hospital location. The main outcome measure was age at orchiopexy.

1.3. Statistical analysis

Data from consecutive patient records were obtained for the specified time period from SASD and PHIS. Descriptive statistics were used to characterize the patient cohort. Data from each dataset was analyzed and reported separately. SASD data from each of the three states (NJ, MD and FL) were appended into one cohort for analysis. Using the current AUA guideline of repair of undescended testis (orchiopexy) by no later than 18 months, patients were dichotomized by age into two groups – less than 2 years old, and 2 years or older. Those in the latter group were considered to have undergone "late" repair. The association between timing of repair and ethnicity, surgical subspecialty and payer status was evaluated using Chi-square analysis. Analyses were performed using STATA version 10 (StataCorp, College Station, TX). A p-value less than 0.05 was considered statistically significant.

2. Results

2.1. SASD (NJ, MD, FL) 2012

A total of 1638 patients ≤18 years old who underwent orchiopexy for UDT were identified across the three states (NJ, MD and FL). The majority, 791 (48.3%), was White. Median age at orchiopexy was 4 years (Interquartile Range (IQR) 1–8) and 1048 (64%) underwent repair at ≥2 years old (Table 1).

2.2. PHIS 2015

A total of 844 patients were identified who met inclusion criteria. The majority, 531 (62.9%), were White and non-Hispanic, 558 (66.1%). Most procedures were performed by Urology, 741 (88%), and 74 (9%) by Pediatric Surgery. Chronic conditions were present in 44 (5.2%) patients. Median age at orchiopexy was 5 years (IQR 1–9) and 577 (68%) underwent repair at ≥2 years old (Table 1).

There were no significant associations noted between age at orchiopexy with ethnicity ($p = 0.56$), surgeon subspecialty ($p = 0.82$), payer status ($p = 0.33$), presence of chronic conditions (0.76), or hospital city ($p = 0.26$) (Table 2).

Fig. 1 demonstrates the median age of repair for the two datasets.

3. Discussion

This study demonstrates that the median age of orchiopexy in boys with UDT appears to be similar in both children's and non-children's hospitals, ranging from 4 to 5 years old. In this study, nearly 70% of boys in the United States underwent the procedure at age ≥2 years old, corresponding to at least 6 months outside of the time frame recommended by multiple society guidelines, including the AUA. There were no associations noted between late repair and patient ethnicity,

Table 1
Baseline characteristics and age at repair of patients with UDT who underwent orchiopexy using SASD and PHIS databases.

	SASD N = 1638	PHIS N = 844
Race, n (%)		
White	791 (48.3)	531 (62.9)
Black	309 (18.9)	91 (10.8)
Hispanic	384 (23.4)	--
Asian or Pacific Islander	34 (2.1)	29 (3.4)
Native American	5 (0.3)	6 (0.7)
Other	82 (5.0)	140 (16.6)
Unknown	33 (2.0)	47 (5.6)
Ethnicity, n (%)		
Hispanic	--	215 (25.5)
Non-Hispanic	--	558 (66.1)
Unknown	--	71 (8.4)
Payer, n (%)		
Private insurance	--	464 (55.0)
Public insurance	--	370 (43.8)
Self-pay or other	--	9 (1.1)
Missing	--	1 (0.1)
Surgical subspecialty, n (%)		
Urology	--	741 (87.8)
Pediatric Surgery	--	74 (8.8)
Other	--	29 (3.4)
Comorbidities	--	44 (5.2)
Age at repair, y, median (IQR)	4 (1–8)	5 (1–9)
Age at repair, n (%)		
≥2 yo	1048 (64.0)	577 (68.4)
<2 yo	590 (36.0)	267 (31.6)

surgical subspecialty, payer status, hospital, or presence of chronic conditions.

Within the international community, guidelines have been established around the timing of orchiopexy for UDT. The Nordic consensus, for example, recommends orchiopexy between 6 and 12 months [4]. In other nations, 18 months is considered the upper limit of the recommended age range for surgical intervention [2,5]. Several investigators have examined adherence to these guidelines worldwide and have found, similar to the present study, that the majority of patients are not undergoing surgery in the recommended time frame. The proportion of children who underwent late repair in these prior studies ranged from 60% to 95% with the average age at operation varying from 1.6 to 5.1 years [7–17]. However, some studies examining trends have shown that adherence is steadily increasing over time with more boys undergoing timely repair [5,10].

In the United States, the AUA, supported by the American Academy of Pediatrics, recommends orchiopexy by 12 months of age and no later than 18 months [3]. Kokorowski et al. investigated adherence to these guidelines using the Pediatric Health Information System and found that between 1999 and 2008 only 43% of patients had surgery

Table 2
Univariate analysis of associations between "late" repair and ethnicity, payer status and surgeon subspecialty using the PHIS database.

Characteristic	Age of repair < 2y	Age of repair ≥ 2y	p value
Ethnicity, n (%)			0.56
Hispanic	70 (32.6)	145 (67.4)	
Non-Hispanic	171 (30.7)	387 (69.3)	
Unknown	26 (36.6)	45 (63.4)	
Payer, n (%)			0.33
Private Insurance	144 (31.0)	320 (69.0)	
Public Insurance	120 (32.4)	250 (67.6)	
Self-pay/Other	3 (33.3)	6 (66.7)	
Missing	0 (0)	1 (100)	
Surgeon subspecialty, n (%)			0.82
Urology	236 (31.8)	505 (68.2)	
Pediatric Surgery	22 (29.7)	52 (70.3)	
Other	9 (31.0)	20 (69.0)	
Comorbidities, n(%)	13 (30)	31 (70)	0.76

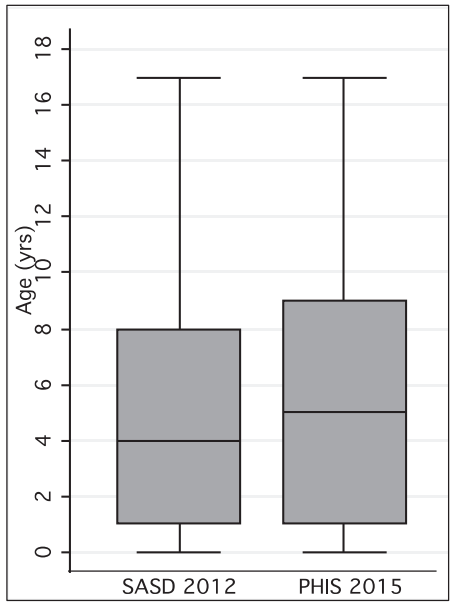

Fig. 1. Age at orchiopexy among patients with UDT in the United States.

by age 2 [18]. Using the same database from 2015 we found this proportion to be even lower, suggesting that among children's hospitals, the timing of repair has shown no improvement. In a single institution study out of West Virginia, 21% had orchiopexy by 12 months of age and 30% within the 13–24 month period [22]. Poor adherence to the guidelines on timing of orchiopexy has thus been shown to be a national dilemma with little change over time when our study is compared to older reports.

Both race and insurance type have been identified by some investigators as factors significantly associated with late repair. Those who are privately insured have been shown to have higher odds of undergoing timely orchiopexy and Black patients are more likely to undergo late repair than Whites [10,18,23]. Further, Kokorowski et al. suggested that the most important predictor of early surgery was the hospital where surgery was performed [18]. This study did not find significant associations on univariate analysis with ethnicity, payer status, hospital location, or presence of comorbidities.

Referral practices also have a significant influence on the timing of orchiopexy. The AUA guidelines recommend that primary care providers ought to "palpate testes for quality and position at each recommended well-child visit" and further that referral to a specialist be initiated expeditiously if there is no spontaneous descent by six months. The guidelines recommend against the use of ultrasound or other imaging modalities in the evaluation of UDT since these studies do not assist in decision-making [3]. Wei et al., in a survey among primary healthcare practitioners in China, found that only 14.3% would initiate a referral for UDT at age 6–9 months [8]. A similar survey conducted in Singapore found that 66% of healthcare professionals thought that orchiopexy should be performed after 1 year of age [13]. In a web-based survey among primary care providers in the United States, there was some degree of confusion and significant variation in counseling practices regarding the risks of infertility and malignancy and almost 20% of respondents waited until puberty to refer patients with UDT to a specialist [24]. In one single-institution review from New York, up to 25% of patients with UDT underwent an ultrasound prior to referral [25]. Thus, despite the availability of professional guidelines, there is still significant practice variation with respect to referrals for UDT. Provider and family education have been shown to have a positive effect on decreasing the age of corrective surgery and serve as critical tools for combatting this public health problem [9,26]. Due to the limitations of the administrative databases used for this study, it was not possible to

uncover reasons for delay such as late referral. However the authors believe that a prospective qualitative study examining referral practices and patient-related factors, such as change of insurance or change of provider, may identify the factors contributing to delay as well as potential targets for intervention.

Adherence to professional guidelines regarding age of orchiopexy for UDT has been viewed by many as a potential quality indicator for the primary care of children [23,26,27]. The associations with hospital type and the strong influence of referral practices suggest that these are the targets for any interventions that would increase adherence on a national level. Certainly, in other Western countries, adherence has improved when education of families and primary care providers was prioritized [5,26]. The stable rate of late repair in the United States over more than a decade is especially concerning, and despite disparities around race and insurance status that have been shown in other studies, our study suggests that delay affects most male children irrespective of these associations.

There are limitations to this retrospective review. The use of administrative databases means that the study is vulnerable to potential coding errors for both the procedure and the diagnosis. However, the results are still robust enough to answer the aim of highlighting the overall trend in age of repair. This study only examines outpatients although there are some instances in which orchiopexy may be performed as an inpatient, particularly if coupled with other diagnoses or procedures. This may have led to under capture, but the authors believe that this represents a very small percentage of patients and should not change the overall implications of the results.

An additional coding limitation was that UDT and ascending testes (those that are initially in the scrotum, but become displaced over time) do not have separate ICD-9 codes. Thus, it is impossible to know what proportion of older boys underwent orchiopexy for this entity compared with true UDT. In addition, the absence of chart records from administrative databases means that there are no data on prior testicular exams. The incidence of testicular ascent varies from 3.2% to as high as 50% in some reports, so it is unclear whether this may have significantly affected the median age [1,28]. However, age at repair for both database populations was normally distributed and not bimodal, with most children undergoing repair before age 8. This younger population is therefore unlikely to have a large proportion of those with testicular ascent.

4. Conclusion

Almost 70% of boys with UDT in two large datasets from the United States underwent orchiopexy at least 6 months later than the age recommended by multiple society guidelines. Older studies have yielded similar results, suggesting that poor adherence to the standard of care has shown no improvement for over a decade. The contributions of referral practices and unnecessary imaging workup to delay in surgery for UDT are important targets for future investigations. Interventions aimed at reducing the age of orchiopexy can be then be developed given the risks of malignancy and subfertility.

References

[1] Barthold JS, Gonzalez R. The epidemiology of congenital cryptorchidism, testicular ascent and orchiopexy. J Urol 2003;170(6 Pt 1):2396–401.
[2] Hutson JM, Thorup J. Evaluation and management of the infant with cryptorchidism. Curr Opin Pediatr 2015;27(4):520–4.
[3] Kolon TF, Herndon CD, Baker LA, et al. Evaluation and treatment of cryptorchidism: AUA guideline. J Urol 2014;192(2):337–45.
[4] Ritzen EM, Bergh A, Bjerknes R, et al. Nordic consensus on treatment of undescended testes. Acta Paediatr 2007;96(5):638–43.
[5] Bradshaw CJ, Corbet-Burcher G, Hitchcock R. Age at orchidopexy in the UK: has new evidence changed practice? J Pediatr Urol 2014;10(4):758–62.
[6] Kollin C, Stukenborg JB, Nurmio M, et al. Boys with undescended testes: endocrine, volumetric and morphometric studies on testicular function before and after orchidopexy at nine months or three years of age. J Clin Endocrinol Metab 2012;97(12):4588–95.
[7] Dobanovackic D, Vuckovic N, Slavkovic A, et al. Variations in timing of elective Orchidopexy. Med Pregl 2016;69(3–4):106–9.
[8] Wei Y, Wu SD, Wang YC, et al. A 22-year retrospective study: educational update and new referral pattern of age at orchidopexy. BJU Int 2016;118(6):987–93.
[9] Rod J, Marret JB, Dupont C, et al. The surgical management of undescended testis between 6 and 12 months: a difficult message to convey. Arch Pediatr 2016;23(5):477–80.
[10] Schneuer FJ, Holland AJ, Pereira G, et al. Age at surgery and outcomes of an undescended testis. Pediatrics 2016;137(2):e20152768.
[11] Chen YF, Huang WY, Huang KH, et al. Factors related to the time to cryptorchidism surgery–a nationwide, population-based study in Taiwan. J Formos Med Assoc 2014;113(12):915–20.
[12] Nilsson R, Omland H, Dahl AA, et al. Early outcome of orchiopexy and analysis of predictive factors: a retrospective study from 2001 to 2010 in a Norwegian regional hospital. Scand J Urol 2014;48(5):474–81.
[13] Nah SA, Yeo CS, How GY, et al. Undescended testis: 513 patients' characteristics, age at orchidopexy and patterns of referral. Arch Dis Child 2014;99(5):401–6.
[14] Ahn H, Lee HE, Park K, et al. Reasons for delayed orchiopexies in a korean tertiary care hospital. Korean J Urol 2014;55(1):69–73.
[15] Hrivatakis G, Astfalk W, Schmidt A, et al. The timing of surgery for undescended testis - a retrospective multicenter analysis. Dtsch Arztebl Int 2014;111(39):649–57.
[16] Hoefling K, Sperling P, Meyer T. Time of operative treatment of maldescensus testis in childhood - wishes and reality. Zentralbl Chir 2014;139(6):627–31.
[17] Springer A, Subramaniam R, Krall C, et al. Orchidopexy patterns in Austria from 1993 to 2009. J Pediatr Urol 2013;9(5):535–41.
[18] Kokorowski PJ, Routh JC, Graham DA, et al. Variations in timing of surgery among boys who underwent orchidopexy for cryptorchidism. Pediatrics 2010;126(3):e576-2.
[19] Somme S, Bronsert M, Morrato E, et al. Frequency and variety of inpatient pediatric surgical procedures in the United States. Pediatrics 2013;132(6):e1466-2.
[20] Quality, A.f.H.R.a. Available from: https://www.hcup-us.ahrq.gov/sasdoverview.jsp.
[21] Association, C.s.H. March 7, 2017]; Available from: https://www.childrenshospitals.org/programs-and-services/data-analytics-and-research/pediatric-analytic-solutions/pediatric-health-information-system.
[22] Dibianco JM, Point D, Morley C, et al. The undescended testicles of West Virginia: a single center experience. W V Med J 2016;112(4):24–7.
[23] Yiee JH, Saigal CS, Lai J, et al. Timing of orchiopexy in the United States: a quality-of-care indicator. Urology 2012;80(5):1121–6.
[24] Shnorhavorian M, Jacobs MA, Stearns G, et al. Practice variation and clinical confusion regarding undescended testes and retractile testes among primary care respondents: a multi-regional survey study in the United States. Pediatr Surg Int 2012;28(6):635–9.
[25] Aggarwal H, Rehfuss A, Hollowell JG. Management of undescended testis may be improved with educational updates for referring providers. J Pediatr Urol 2014;10(4):707–11.
[26] Brown JJ, Wacogne I, Fleckney S, et al. Achieving early surgery for undescended testes: quality improvement through a multifaceted approach to guideline implementation. Child Care Health Dev 2004;30(2):97–102.
[27] Bruijnen CJ, Vogels HD, Beasley SW. Age at orchidopexy as an indicator of the quality of regional child health services. J Paediatr Child Health 2012;48(7):556–9.
[28] Stec AA, Thomas JC, DeMarco RT, et al. Incidence of testicular ascent in boys with retractile testes. J Urol 2007;178(4 Pt 2):1722–4 [discussion 4-5].