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American Urological Association (AUA) Guideline

EVALUATION AND TREATMENT OF CRYPTORCHIDISM: AUA GUIDELINE

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Purpose: Cryptorchidism or undescended testis (UDT) is one of the most common pediatric disorders of the male endocrine glands and the most common genital disorder identified at birth. The main reasons for treatment of cryptorchidism include increased risks of impairment of fertility potential, testicular malignancy, torsion and/or associated inguinal hernia. Cryptorchidism has evolved significantly over the past half century, with respect to both diagnosis and treatment. The current standard of therapy in the United States is orchidopexy (also referred to as orchiopexy in the literature), or surgical repositioning of the testis within the scrotal sac, while hormonal therapy has fewer advocates. Successful scrotal relocation of the testis, however, may reduce but does not prevent these potential long-term sequelae in susceptible individuals. The purpose of this guideline is to provide physicians and non-physician providers (primary care and specialists) with a consensus of principles and treatment plans for the management of cryptorchidism. The panel members are representative of various medical specialties (pediatric urology, pediatric endocrinology, general pediatrics).

Methods: The primary source of evidence for this guideline was the systematic review and data extraction conducted as part of the Agency for Healthcare Research and Quality (AHRQ) Comparative Effectiveness Review titled *Evaluation and Treatment of Cryptorchidism* (2012). That report included rigorous searches of MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and EMBASE for English-language studies published from January 1980 through February 2012 relevant to cryptorchidism. To capture more recently published manuscripts and expand the body of evidence provided in the original AHRQ report, the American Urological Association (AUA) conducted additional supplementary searches of PubMed and EMBASE for relevant articles published between January 1980 and March 2013 that were systematically reviewed using a methodology developed *a priori*. In total, these sources yielded 704 studies, after exclusions, that were used to inform the statements presented in the guideline as Standards, Recommendations or Options. When sufficient evidence existed, the body of evidence for a particular clinical action was assigned a strength rating of A (high), B (moderate) or C (low). In the absence of sufficient evidence, additional information is provided as Clinical Principles and Expert Opinions.

GUIDELINE STATEMENTS

Diagnosis

1. Providers should obtain gestational history at initial evaluation of boys with suspected cryptorchidism. (Standard; Evidence Strength: Grade B)

2. Primary care providers should palpate testes for quality and position at each recommended well-child visit. (Standard; Evidence Strength: Grade B)

3. Providers should refer infants with a history of cryptorchidism (detected at birth) who do not have spontaneous testicular descent by six months (corrected for gestational age) to an appropriate surgical specialist for timely evaluation. (Standard; Evidence Strength: Grade B)

4. Providers should refer boys with the possibility of newly diagnosed (acquired) cryptorchidism after six months (corrected for gestational age) to an appropriate surgical specialist. (Standard; Evidence Strength: Grade B)

5. Providers must immediately consult an appropriate specialist for all phenotypic male newborns with bilateral, nonpalpable testes for evaluation of a possible disorder of sex development (DSD). (Standard; Evidence Strength: Grade A)

6. Providers should not perform ultrasound (US) or other imaging modalities in the evaluation of boys with cryptorchidism prior to referral as these studies rarely assist in decision making. (Standard; Evidence Strength: Grade B)

7. Providers should assess the possibility of a disorder of sex development (DSD) when there is increasing severity of hypospadias with cryptorchidism. (Recommendation; Evidence Strength: Grade C)

8. In boys with bilateral, nonpalpable testes who do not have congenital adrenal hyperplasia (CAH), providers should measure Müllerian Inhibiting Substance (MIS or Anti- Müllerian Hormone [AMH]) level), and consider additional hormone testing, to evaluate for anorchia. (Option; Evidence Strength: Grade C)

9. In boys with retractile testes, providers should monitor the position of the testes at least annually to monitor for secondary ascent. (Standard; Evidence Strength: Grade B)

Treatment

10. Providers should not use hormonal therapy to induce testicular descent as evidence shows low response rates and lack of evidence for long-term efficacy. (Standard; Evidence Strength: Grade B)

11. In the absence of spontaneous testicular descent by six months (corrected for gestational age), specialists should perform surgery within the next year. (Standard; Evidence Strength: Grade B)

12. In prepubertal boys with palpable, cryptorchid testes, surgical specialists should perform scrotal or inguinal orchidopexy. (Standard; Evidence Strength: Grade B)

13. In prepubertal boys with nonpalpable testes, surgical specialists should perform examination under anesthesia to reassess for palpability of testes. If nonpalpable, surgical exploration and, if indicated, abdominal orchidopexy should be performed. (Standard; Evidence Strength: Grade B)

14. At the time of exploration for a nonpalpable testis in boys, surgical specialists should identify the status of the testicular vessels to help determine the next course of action. (Clinical Principle)

15. In boys with a normal contralateral testis, surgical specialists may perform an orchiectomy (removal of the undescended testis) if a boy has a normal contralateral testis and either very short testicular vessels and vas deferens, dysmorphic or very hypoplastic testis, or postpubertal age. (Clinical Principle)

16. Providers should counsel boys with a history of cryptorchidism and/or monorchidism and their parents regarding potential long-term risks and provide education on infertility and cancer risk. (Clinical Principle)

INTRODUCTION

Purpose

Cryptorchidism or undescended testis (UDT) is one of the most common pediatric disorders of the male endocrine glands and the most common genital disorder identified at birth. The main reasons for treatment of cryptorchidism include reducing the risks of impairment of fertility potential, testicular malignancy, torsion and/or associated inguinal hernia. Cryptorchidism has evolved significantly over the past half century, with respect to both diagnosis and treatment. The current standard of therapy in the United States is orchidopexy (also referred to as orchiopexy in the literature), or surgical repositioning of the testis within the scrotal sac, while hormonal therapy has fewer advocates. Successful scrotal relocation of the testis, however, may reduce but does not prevent all of these potential long-term sequelae in susceptible individuals. The purpose of this guideline is to provide physicians and non-physician providers (primary care and specialists) with a consensus of principles and treatment plans for the management of cryptorchidism. The panel members are representative of various medical specialties (pediatric urology, pediatric endocrinology, general pediatrics).

Methodology

Quality of Studies and Determination of Evidence Strength. The primary source of evidence for this guideline was the systematic review and data extraction conducted as part of the Agency for Healthcare Research and Quality (AHRQ) Comparative Effectiveness Review titled Evaluation and Treatment of Cryptorchidism (2012). That report included rigorous searches of MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and EMBASE for English-language studies published from January 1980 through February 2012 relevant to cryptorchidism. To capture more recently published manuscripts and expand the body of evidence provided in the original AHRQ report, the American Urological Association (AUA) conducted additional supplementary searches of PubMed and EMBASE for relevant articles published between January 1980 and March 2013 that were systematically reviewed using a methodology developed a priori. In total, these sources yielded 704 studies, after exclusions, that were used to inform the statements presented in the guideline as Standards, Recommendations or Options. Quality of individual studies was rated as high, moderate, or low based on instruments tailored to specific study designs. Randomized controlled trials (RCTs) were assessed using the Cochrane Risk of Bias tool.[1] Conventional diagnostic cohort studies, diagnostic case-control studies, or diagnostic case series that presented data on diagnostic test characteristics were evaluated using the QUADAS-2 tool[2] that evaluates the quality of diagnostic accuracy studies. Cohort studies with a comparison of interest were evaluated with the Drug Effectiveness Review Project instrument.[3] The categorization of evidence strength is conceptually distinct from the quality of individual studies. Evidence strength refers to the body of evidence available for a particular question and includes consideration of study design, individual study quality, consistency of findings across studies, adequacy of sample sizes, and generalizability of samples, settings and treatments for the purposes of the guideline. The AUA categorizes body of evidence strength as Grade A (well-conducted RCTs or exceptionally strong observational studies), Grade B (RCTs with some weaknesses of procedure or generalizability or generally strong observational studies) or Grade C (observational studies that are inconsistent, have small sample sizes or have other problems that potentially confound interpretation of data). The quality of the evidence was variable depending on the issue examined. For many epidemiological issues there was a combination of moderate to large sized population-based studies, some of them prospective, being the key issue, as well as the consistency of findings. When evidence was consistent it was graded B, otherwise C. For issues related to management, studies tend to be non-randomized cohorts of moderate size or randomized trials of small to moderate size. Again the key issue was consistency of findings and the same criterion indicated above was applied. Seventy percent of the graded statements were considered level B (many under the AUA's premise of moderate quality, moderate certainty).

AUA Nomenclature: Linking Statement Type to Evidence Strength. The AUA nomenclature system explicitly links statement type to body of evidence strength and the Panel's judgment regarding the balance between benefits and risks/burdens.[4] ***Standards*** are directive statements that an action should (benefits outweigh risks/burdens) or should not (risks/burdens outweigh benefits) be undertaken based on Grade A or Grade B evidence. ***Recommendations***

are directive statements that an action should (benefits outweigh risks/burdens) or should not (risks/burdens outweigh benefits) be undertaken based on Grade C evidence. ***Options*** are non-directive statements that leave the decision to take an action up to the individual clinician and patient because the balance between benefits and risks/burdens appears relatively equal or appears unclear; the decision is based on full consideration of the patient's prior clinical history, current quality of life, preferences and values. ***Options*** may be supported by Grade A, B or C evidence.

In some instances, the review revealed insufficient publications to address certain questions from an evidence basis; therefore, some statements are provided as *Clinical Principles* or as *Expert Opinions* with consensus achieved using a modified Delphi technique if differences of opinion emerged.[5] A ***Clinical Principle*** is a statement about a component of clinical care that is widely agreed upon by urologists or other clinicians for which there may or may not be evidence in the medical literature. ***Expert Opinion*** refers to a statement, achieved by consensus of the Panel that is based on members' clinical training, experience, knowledge and judgment for which there is no evidence.

Limitations of the Literature. Limitations of the literature identified by both the AHRQ and the AUA reviews include, (1) lack of studies assessing the value of hormonal stimulation testing, long-term fertility outcomes, as well as inconsistent reporting of age at diagnosis and/or at treatment; (2) scant information about imaging effectiveness for modalities other than ultrasound (US) and magnetic resonance imaging (MRI); (3) low level evidence for the effectiveness of surgical treatment other than primary orchidopexy, accompanied by a lack of a standardized definition of success, follow-up length, reporting of complications, and control of confounding variables by indication; (4) inconsistent control of confounding variables among studies evaluating the epidemiology of cryptorchidism. This could be the result of the remaining uncertainty with respect to the etiological factors strongly and consistently associated with cryptorchidism.

Peer review. The AUA conducted an extensive peer review process. The initial draft of this Guideline was distributed to 84 peer reviewers of varying backgrounds, including those who applied through open comment; 43 responded with comments. The panel reviewed and discussed all submitted comments and revised the draft as needed. Once finalized, the Guideline was submitted for approval to the Practice Guidelines Committee (PGC). It was then submitted to the AUA Board of Directors for final approval.

Background

Definitions

Cryptorchidism, or undescended testis (UDT), is defined as failure of a testis to descend into a scrotal position. This situation most commonly refers to a testis that is present but in an extrascrotal position, but may also lead to identification of an absent testis. In the latter situation, the testis is most commonly referred to as *vanishing (or vanished);* consistent with evidence suggesting that it was present initially but disappeared during development most likely due to spermatic cord torsion or vascular accident.

Congenital cryptorchidism refers to testes that are extrascrotal from the time of birth. *Acquired* cryptorchid testes are intrascrotal at birth but subsequently identified in an extrascrotal position. Cryptorchid testes may be *prescrotal* (above or at the scrotal inlet), in the *superficial inguinal pouch* (distal and lateral to the external inguinal ring, anterior to the rectus muscle), at the *external ring* (or prepubic), *canalicular* (within the inguinal canal), *ectopic* (most commonly perineal) or *abdominal* ("peeping" through or proximal to the internal inguinal ring, or near the bladder, iliac vessels or kidney).

Acquired cryptorchid testes are considered *ascending,* when apparent change from an intrascrotal to an extrascrotal position occurs spontaneously at some point after birth, or *entrapped,* when such change occurs after prior inguinal surgery. A *retractile* testis is one that is initially extrascrotal on examination or moves easily out of scrotal position, (often associated with a vigorous cremasteric reflex), but that can be manually replaced in stable, dependent scrotal position and remain there without tension at least temporarily. An *atrophic* testis is one that suffers significant volume loss after prior inguinal or testicular surgery, or due to prolonged location in an extrascrotal position or primary developmental failure.

Epidemiology

Prevalence/incidence of congenital v. acquired

cryptorchidism. Although delayed diagnosis or treatment of cryptorchidism beyond the neonatal period is well-documented, the relative proportion of cases of true testicular ascent v. congenital cases that were not identified and/or referred early for care remains unclear.[6,7,8,9] However, the preponderance of data strongly supports the existence of acquired cryptorchidism as a real phenomenon whose prevalence may be similar to that of congenital cryptorchidism. In a population-based health registry study, cryptorchidism was frequently diagnosed beyond the newborn period, and there were no age-specific differences in time between diagnosis and surgical correction.[10] Similarly, in birth cohort studies,9,11 suprascrotal testes were newly diagnosed in about 2% of boys examined longitudinally at intervals up to 10 years of age. Spontaneous descent of congenitally cryptorchid testes occurred in 35-43% of newborn boys followed longitudinally, usually prior to 3 months of age,[9,11,12] but re-ascent (recurrent cryptorchidism) may occur, and was reported in 22% of boys in a recent prospective study.[13] In a referral population, Wenzler et al.[14] documented spontaneous descent in 24% of boys presenting prior to age 4 months and none presenting at or after 6 months, or a total of 6.9% of boys presenting in the first year of life. The overall rate of spontaneous descent in this latter study may be low because the referral population likely excluded cases of early postnatal spontaneous descent.

Sijstermans et al.[15] compiled a systematic review estimating the prevalence of cryptorchidism by different ages and birth weights (Table 1). They identified 97 articles, but only 49 remained eligible. These studies were conducted between 1934 and 2006. Thirty-eight studies (83%) were prospective, and the other eleven were retrospective, totaling over 704,000 males. Fifty percent of the studies used a formal definition to identify and diagnose cryptorchidism, although these definitions varied widely. Ten percent of articles used the definition by Scorer[16] that considers all testes at least 4 cm below the pubic crest in full term males (2.5 cm in preterm males) as descended; 41% included location in the definition, and 13% excluded high scrotal testes.

It can be seen that for boys up to one year of age and of normal weight, the estimates are rather stable, while for the same age range but low birth weight they vary widely. This age group constitutes 57% of the studies with over 591,000 infants. It is important to highlight,

Table 1: Prevalence of cryptorchidism

	Study characteristics	Estimates
Newborn	23 studies	
All		0.1-9.0%
<2.5 kg		1.1-45.3%
>2.5 kg		1.0-4.6%
One month		
All		1.0-1.2%
Three months	7 studies	
All		0.7-1.9%
<2.5 kg		1.7-5.2%
>2.5 kg		0.9-1.6%
One year	6 studies	
All		1.1%-2.1%
<2.5 kg		1.9-7.3%
>2.5 kg		1.0-1.5%
Three years		0.8-2.5%
Six years		0.0-2.6%
Eight years		0.0-6.3%
Ten years		0.0-3.6%
Eleven years		0.0-6.6%
Thirteen years		0.0-4.0%

*Adapted from Sijstermans K, Hack WW, Meijer RW et al: The frequency of undescended testis from birth to adulthood: a review. Int J Androl 2008; **31**: 1.

as indicated by the authors of the compendium, that low birth weight and prematurity were often used synonymously. The prevalence for boys three years and older is again rather stable between null and 6.6%. In addition to birth weight and prematurity, the authors indicate that the lack of distinction between congenital (never descended from birth) and acquired (previously scrotal) cryptorchidism may explain the differences in rates. The distinction between congenital and acquired cryptorchidism could not be made for the majority of these studies as only 5 (11%) of the studies reviewed included data documenting prior testicular position.

In a large population-based study of 819,111 non-syndromic boys in Denmark, Jensen and colleagues analyzed associations between birth weight, prematurity and cryptorchidism, which occurred in 14.1 cases out of 1000 boys.[17] When correcting birth weight for gestational age, only boys in the lowest quintile (<20th percentile) were at increased risk for cryptorchidism (OR 1.4, 95% CI 1.3-1.5).

Barthold and González (2003)[18] performed a review of epidemiological issues relevant to acquired

cryptorchidism. One of the issues they addressed was the incidence of testicular ascent among boys with completely descended testes at birth. Eleven studies have reported these cases (see evidence table in Appendix A). The studies reviewed by these authors performed a lengthy follow-up in which a normal position was recorded prior to discovery of testicular ascent. The mean age at surgery in most series was seven years. They found that the ascended testis is generally unilateral and most likely located distal to the inguinal ring (prescrotal, superficial inguinal pouch or high scrotal).

Genetic susceptibility. In a large population-based twin study, Jensen et al. observed increasing concordance rates of treated cryptorchidism based on family relationships: 1.8% in unrelated males, 2.4-4.3% in half-brothers, 7.5% in full brothers, and 16.7% in dizygotic and 26.7% in monozygotic twins.[19] These data suggest both unknown genetic and environmental factors contribute to cryptorchidism risk.

Animal models of cryptorchidism, mostly knockout mice, have identified insulin-like 3 (*INSL3*) and its receptor relaxin/insulin-like family peptide receptor 2 (*RXFP2*), also known as leucine-rich repeat-containing G protein-coupled receptor 8 (*LGR8*), as molecules involved in the genesis of cryptorchidism. However, despite a large number of studies comprising over 1,000 patients screened for mutations in the *INSL3* and *RXFP2* genes, few clear exonic variants have been identified that are likely functional mutations (see Table 2), and there is poor correlation between these variants and clinical phenotype.[20] While the T222P mutation of *RXFP2* significantly reduces *INSL3* signaling experimentally,[21] it is also found in normal controls.[22,23]

Two other potential candidate genes, androgen receptor (*AR*), and estrogen receptor alpha (*ESR1*) are involved in sex hormone function. Exon 1 of the *AR* gene encodes highly polymorphic polyglutamine (CAG) and polyglycine (GGN) repeat sequences. *In vitro* assays have demonstrated that CAG repeat expansion or GGN deletion is associated with diminished transcriptional activity of the receptor.[24] Five different cohorts[24-28] have examined the potential association between AR exonic repeats and cryptorchidism by testing the difference in the mean number of repeats between cases and controls (see evidence table in Appendix B). Three of these studies identified no differences in repeat length between cases and controls, one reported increased CAG repeat length in two small subgroups of Portuguese males (six bilateral cryptorchidism and seven unilateral with contralateral patent processus vaginalis),28 and the largest study reported reduced CAG repeats in Hispanic cryptorchid males from California.[25] GGN repeat length was higher in cryptorchid cases than controls in one study.[24]

For the *ESR1* gene, efforts have focused on the potential difference in the frequency distribution of alleles A and G between cases and controls for SNP12 (rs6932902). This SNP12 has been labeled as the tag SNP of the 5-SNP haplotype AGATA. Such allele frequency distributions have been assessed in three independent groups of cases and controls from three different ethnic backgrounds with disparate results (see evidence table in Appendix C). The A allele has been found to confer susceptibility to Japanese men,[29] (OR1.99, 95% CI 1.07, 3.67), seems protective among Caucasian men from Italy (OR 0.5, 95%CI 0.28, 0.90),30 and showed lack of association among a multi-ethnic US cohort.[31] For the latter, the allele frequency for G was significantly different between moderate and severe cases (OR 10.0, 95% CI 1.2, 78.2).

In summary, although there is some suggestion that the examined genomic loci may contribute to cryptorchidism susceptibility, the evidence is weak at this point and likely due to the multifactorial nature of the trait, the heterogeneous phenotypic manifestation of cryptorchidism as well as the lack of simultaneous assessment of potential gene-environment interactions.

Table 2: Summary of exonic variants in *INSL3* and *RXFP2* in cryptorchidism

Gene	Number of studies	Cases	Controls	Exonic variants
INSL3 [20]	15 (2000-08)	30/1650 (1.8%)	0/>1000	V18M, P49S, W69R, R73X, T86M, P93L, R102C, R102H,
LGR8 [1,7,20,23]	7 (2002-11)	43/1474 (2.9%)	16/2026 (0.8%)	T222P

Familial Aggregation

Two studies have explored the risk of UDT in an individual with a family history. Elert et al[32] assessed the familial risk in a group of 374 cases and 374 controls in Germany. Cases were identified in boys and men who underwent surgery for UDT between 1989 and 2001. The mean age of these males at surgery was 6 years (range 1-39 years). They found that 85 cases (23%) v. 28 controls (7.5%) had one or more family members with UDT for an overall risk of 3.6 (95% CI 2.3, 5.7). The highest risk was present if the family member was a brother (95% CI 6.9 [2.7, 17.9]), followed by an uncle (95% CI 5.2 [1.8, 15.4]) and then by the father (95% CI 4.6 [2.0, 10.6]).

The second study was a large population-based study conducted in Denmark between 1977 and 2005.[33] Danish boys were identified from the Civil Registration Systems and their relatives from the Danish Family Relations Database. The cryptorchidism status was gathered from the Danish Hospital Discharge Register. Using these data sources, of 42,105 cases, 20,398 (48.5%) were confirmed surgically. The measure of risk the authors used is the recurrence risk ratio (RRR), the ratio between cryptorchidism prevalence for individuals with a proband (older affected relative) and the prevalence of cryptorchidism for individuals with known relatives of the same kind where none of them is a proband. For twin pairs, a weighted average contribution from dizygotic and monozygotic twins was applied. Given their almost equal distribution in this cohort, a weight of 0.5 was assigned for each. The RRR was 10.1 (95% CI: 7.78, 13.1) in twins, 3.52 (95% CI: 3.26, 3.79) in brothers, 2.31 (95% CI: 2.09, 2.54) in sons, 2.12 (95% CI: 1.74, 2.60) in maternal half-brothers and 1.28 (95% CI: 1.01, 1.61) in paternal half -brothers. This led the authors to conclude that the maternal contribution is greater than the paternal one, suggesting either an X-linked mode of inheritance or a combination of genetic factors and maternal environment. Elert et al.[32] noted similar findings in a much smaller cohort study, but did not observe a difference in rates for maternal and paternal inheritance.

Environmental Exposure. The possibility that environmental chemicals alter normal reproductive tract development has been debated in the recent literature. There is significant potential concern that endocrine-disrupting chemicals may be linked to male reproductive tract anomalies that may have a common etiology, including cryptorchidism (sometimes termed 'testicular dysgenesis syndrome').[34,35] Concerns for a connection between endocrine-disrupting chemicals and cryptorchidism developed because of a reported higher risk related to early maternal exposure to diethylstilbestrol (DES)..

Environmental Chemicals

A quantitative summary of the potential effect of exposure to pesticides and the risk of cryptorchidism is not possible because of the large variability on study designs, exposure and outcome assessment and measurement. Virtanen and Adamsson (2012)[36] qualitatively summarized 18 studies in 2012. Two large ecological studies with adequate power found different results based on the pesticide use in the area; one a significant positive association and the other a non-significant positive association. Ten studies assessing exposure in terms of parental occupation, primarily in agriculture and gardening also had sufficient power. Outcomes differed with four studies indicating a positive significant association, three a non-significant association, and three studies reporting a decreased risk. Six studies assessed the exposure in terms of pesticide levels in biological specimens, assessing the exposure in a more direct fashion, but were inconclusive because of small sample size.

There have been a number of case control studies assessing other chemicals such as polychlorinated biphenyls (PCBs), dioxins, flame retardants and phthalates. These studies have been of small sample size and have not demonstrated statistical significance.[36-41]

Incidence seasonality

Mamoulakis et al.[42] examined the significance of seasonal trends in cryptorchidism incidence among over 209,000 live-born boys in Greece between 1995 and 1999. The incidence of cases at birth was cyclic with a peak in March (61.0) and a trough in September (36.1). After exclusions, 583 isolated true cryptorchid cases were identified. The authors reported that maternal hCG levels at 26 weeks gestation were lower in winter months and suggest that low environmental temperature may influence maternal hCG profiles and hence the inguinoscrotal phase of testicular descent. However, this finding is of questionable relevance as the authors did not compare hCG in pregnancies with

and without cryptorchid fetuses, and hCG levels are normally very low after the first trimester.

Three other studies were cited with a large number of cryptorchid cases conducted in European countries in which March is the month with peak incidence for cryptorchidism births. A fourth study in the United States of America found two peaks: one during September-November when a trough was observed in the other studies and a second smaller peak during March-May.

Maternal environment

Maternal Body Mass Index (BMI)

Adams et al.[43] conducted a population-based case-control study using birth record data from the state of Washington during the period 1992-2008. The authors discuss three potential mechanisms relating maternal obesity to the risk of cryptorchidism and hypospadias. These are, (1) levels of circulating hormones, (2) lower overall diet quality and blood concentrations of micronutrients, (3) impaired fasting glucose and glucose tolerance before and during pregnancy. Five randomly selected controls from the same birth year were assigned to each of the 3,946 cases of cryptorchidism. Maternal BMI was missing in 30% of cases and 28% of controls. Cryptorchidism and hypospadias may be more common in first pregnancies. Maternal weight was collected from the birth certificates, while height was collected from the driver's licenses prior to 2003, and from the birth certificates from 2003 onwards. BMI was categorized using the World Health Organization (WHO) thresholds. No association between BMI and the incidence of cryptorchidism was found based on odds ratios adjusted for year of birth, maternal age, education, parity, race, and cigarette smoking during pregnancy. Based on a reference group of mothers with normal weight, the adjusted odds ratio for underweight mothers was 1.14 (95% CI 0.93, 1.39); for overweight 1.03 (95% CI 0.93, 1.14) and for obese mothers 0.99 (95% CI 0.89, 1.11). Similarly, no effect was observed when weight was analyzed as a continuous variable with changes measured per each 5 kg/m2, OR=1.01 (95% CI 0.97, 1.05).

Maternal smoking

Hackshaw et al.[44] performed a systematic review of articles published in English between 1959 and February 2010 regarding the association between maternal smoking in pregnancy and birth defects, including cryptorchidism. Study designs included cohort, case-control, and surveys. Eighteen studies provided data for cryptorchidism (8,753 cases and 98,627 controls). Overall, mothers who reported smoking during pregnancy were 13% more likely to have a child with cryptorchidism (OR1.13, 95% CI 1.02, 1.25); although this estimate includes moderate heterogeneity I2=39%; individual study estimates ranged between OR=0.41 and OR=1.69. A second estimate was calculated based on 15 studies that adjusted for potential confounders. These 15 studies assessed 8,258 boys with cryptorchidism and 72,224 controls. The overall estimate was not different to the unadjusted estimate (OR 1.16, 95% CI 1.08, 1.25).

Maternal alcohol consumption

Three studies conducted in Denmark[10,45-47] and one in the United States[48] examined the potential association between maternal alcohol consumption during pregnancy and the risk of cryptorchidism in a prospective fashion (see Appendix D). The disparity in outcome measure used (two used odds ratio, one risk ratio and the other hazard ratio) precludes quantitative aggregation but allows qualitative summarization. Alcohol consumption was found to be associated with transient cryptorchidism if the mother consumed five or more drinks per week, adjusted OR 3.10, 95% CI 1.05, 9.10).[45] This finding was not present among boys with persistent cryptorchidism, adjusted risk ratio 0.70 (95% CI 0.40, 1.30).[46] The third Danish study[46] aimed at assessing in more detail the association of binge drinking with persistent cryptorchidism rather than regular alcohol consumption did not find a statistical effect. The American study also failed to find an association.[48]

Maternal analgesic consumption

Four cohort studies[49-52] reported the incidence/ prevalence of cryptorchidism in infants and young boys born from mothers who reported on the use of mild analgesics (COX inhibitors) during pregnancy. The underlying hypothesis is that COX inhibitors may impede prostaglandin production by a mechanism not completely elucidated yet. Prostaglandins are necessary for male sexual differentiation. Three of the studies[49,50,52] show that the use of mild analgesic, mainly paracetamol, during the second trimester (end

of the defined "programmatic window") increases the risk for cryptorchidism.

The way exposure information was collected does not allow us to determine whether consumption in both first and second trimester is necessary, and more precisely, when within these two periods the exposure increases the risk. This was the case in the study by Jensen et al.[49] where the risk of cryptorchidism did not increase if exposure to analgesic was in the first or second trimester alone, but when both combined the risk increased. The rate of exposure ranged between 47% and 81% and was by far most common for paracetamol.

The association between maternal analgesic consumption and cryptorchidism estimated from multivariable models ranged between a hazard ratio of 1.33 for paracetamol consumed in the first and second trimester,[49] to an odds ratio of 1.89 for paracetamol consumed in the second trimester (unknown whether also consumed during the first),[52] to an odds ratio of 2.30 for any mild analgesic consumed during the second trimester (again unknown whether consumed during the first).[50] Two of the studies (conducted in Denmark)[49,50] also showed that use of any mild analgesic for over two weeks increased the odds of cryptorchidism.[50] In another study,[49] the odds of cryptorchidism increased when the prolonged analgesic use was for more than four weeks during weeks 8-14 of gestation.

Maternal estrogen exposure

Vidaeff and Sever[53] performed a systematic review of articles published in English, French, Italian and Spanish between 1990 and 2003 dealing with prenatal exposure to endocrine disruptors, xenoestrogens and/or environmental estrogens. Articles were included if they reported the adverse effect of these exposures on cryptorchidism, hypospadias, or impaired sperm quality. Nine studies were identified, but heterogeneity of retrieved information precluded aggregation into meta-analysis. Three large studies report a positive association between pesticide exposure and cryptorchidism. The authors caution about the complex nature of both the components of the exposure and the pathogenic mechanisms involving multifactorial origin and potential trans-generation effects. Available data do not support with certainty the potential contribution of environmental estrogens to an increase in male reproductive disorders, but also do not provide sufficient information to totally reject such hypotheses.

Martin et al.[54] performed a meta-analysis aimed at assessing the role of estrogen in components of the testicular dysgenesis syndrome (TDS), namely hypospadias, cryptorchidism, and testicular cancer. It excluded exposure to suspected endocrine disruptors for which the mode of action was unspecified (e.g., pesticides), exposures to phytoestrogens, and maternal endogenous hormones. Only three studies examining DES exposure show an association with cryptorchidism based on a fixed effect model (OR 2.09, 95% CI 1.13, 3.86) but not if based on a random effects model (OR 1.80, 95% CI 0.83, 3.93).

GUIDELINE STATEMENTS

Diagnosis

Guideline Statement 1.

Providers should obtain gestational history at initial evaluation of boys with suspected cryptorchidism. (Standard; Evidence Strength: Grade B)

Testicular descent occurs in two phases: transabdominal descent and inguinoscrotal migration. Initial transabdominal descent occurs in the first trimester of gestation. At approximately 22-25 weeks of gestational age, the testes are located at the internal ring. The inguinoscrotal phase of testicular descent, which is androgen dependent, occurs between 25-30 weeks.[55,56] Given the relatively late migration of testes through the inguinal canal into the scrotum, the prevalence of cryptorchidism is higher in premature boys in the first months of life (1-3% in full-term and 15-30% in premature male infants).[15] Descent of the testes into the scrotum is probable in premature boys during the first months of life, but is unlikely after six months of corrected age.[16, 57] Obtaining the gestational age is thus critical to the proper and timely referral of a child with persistent undescended testes to a surgical specialist (see Appendix E for terminology defined).

In addition to gestational age, low birth weight for gestational age has also been closely associated with cryptorchidism: the prevalence of cryptorchidism in infants <900g is approximately 100%. The prevalence of cryptorchidism decreases as the birth weight of the infant increases, and is approximately 3% in infants

weighing 2,700-3,600g. [15,58-63]

Spontaneous postnatal testicular descent may be lower in boys with cryptorchidism and a history of small-for-gestational age compared to boys with cryptorchidism and normal birth weight.[59,64]

Guideline Statement 2.

Primary care providers should palpate testes for quality and position at each recommended well-child visit. (Standard; Evidence Strength: Grade B)

A UDT may be located in the abdomen, the inguinal canal, the superficial inguinal pouch, the upper scrotum, or, may rarely be in an ectopic location (perineum, contralateral scrotum, or femoral). Approximately 70% of UDTs are palpable.[65] For testes that are not palpable, approximately 30% will be found in the inguinal-scrotal area, 55% will be intra-abdominal, and 15% will be absent or vanishing.[66,67] Testicular position may change as infants and children grow. An internal review of 50 cohorts[68-115] of diagnostic laparoscopy performed in males with nonpalpable testes showed a highly variable distribution of testis location. (See Appendix F)

Spontaneous descent of testes may occur in the first six months of life.[16,57] Additionally, testes may "ascend" out of the scrotum (acquired cryptorchidism). Given the potential for change in testicular position throughout childhood, careful evaluation of the scrotum should be performed at every scheduled well-child check, which is in line with the recommendations of the American Academy of Pediatrics (AAP) (See Appendix G).

Physical Examination

The diagnosis of cryptorchidism is made by a careful genital physical examination. The method of testicular examination varies depending on the age and developmental status of the child. Infants should be examined in the supine position with legs gently frog-legged, or sitting on the lap of the parent. Gentle downward pressure along the inguinal canal from the anterior iliac spine to the scrotum and counter palpation with the opposite hand helps to identify the lowest position of a palpable testis. Older children may be examined in the upright cross-legged or supine position. Careful examination of the groin, femoral region, perineum, contralateral hemiscrotum (to detect the rare cases of transverse testicular ectopia), and pubic areas are needed in order to correctly classify a testis as palpable or nonpalpable. The palpability of the UDT will determine the surgical approach.

Once the testis is palpated, gently grasp it with the dominant hand and continue to sweep the testis toward the scrotum with the other hand. In palpable testes that can be manipulated into the scrotum, it is important to maintain the position of the testis in the scrotum for approximately 30 seconds in order to fatigue the cremaster muscle. This will allow differentiation of a retractile testis from a UDT. Release the testis, and if it remains in place, it is a retractile testis. If it immediately retracts to a prescrotal position, it is a UDT. Repeated examinations, patient distraction techniques, a warm environment, and use of a lubricant for the examiner's hands facilitate the physical examination. The size and location of the normally located contralateral gonad should also be noted as it may increase the ability to predict the status of the UDT. A hypoplastic hemiscrotum may imply that the testis is not present. The presence of compensatory hypertrophy (length greater than 2 cm in prepubertal young boys) is highly associated with monorchia.[67,116] However, hypertrophy of the contralateral testis, if present, is neither perfectly sensitive nor specific for the presence of vanishing testis. Therefore, because surgical exploration is indicated in all children with a nonpalpable testis, these children should be referred to a surgical specialist regardless of the size of the contralateral testis.

A genital examination should be performed at every well-child check as outlined by the Bright Futures of the AAP (see Appendix G). Documentation of testes in the dependent scrotum in the first few years of life should not preclude continued examination of the genitals at every scheduled clinic visit. Systematic genital examination will allow identification and referral of boys with acquired cryptorchidism (see Guideline Statement 4). Acquired cryptorchid testes are at risk for developing the same adverse histologic changes seen in primary cryptorchid testes and contribute significantly to the number of orchiopexies performed.[117-124] Systematic and continued genital examinations will also allow identification of boys with retractile testes. While retractile testes do not require surgical correction, the risk of testicular ascent may be higher in boys with retractile testes than in boys whose testes are always positioned in the dependent scrotum.[125,126] Therefore,

children with retractile testes should be monitored for "ascent" of the affected testis.

Guideline Statement 3.

Providers should refer infants with a history of cryptorchidism (detected at birth) who do not have spontaneous testicular descent by six months (corrected for gestational age) to an appropriate surgical specialist for timely evaluation. (Standard; Evidence Strength: Grade B)

Testes that remain undescended by six months (corrected for gestational age) are unlikely to descend spontaneously.[57] In order to facilitate timely orchidopexy, boys whose testicle(s) remain undescended by six months (corrected for gestational age) should be referred to an appropriate surgical specialist.[127] The rationale for referral by six months (corrected for gestational age) is the low probability of spontaneous descent and the probable continued damage to testes that remain in a non-scrotal location.

Cryptorchid testes of boys who underwent orchidopexy at three years demonstrated poorer growth compared to undescended testes of boys who underwent orchidopexy at nine months.[13,128] This impaired testicular growth is consistent with histologic studies of cryptorchid testes that remained undescended. Uncorrected undescended testes, in particular those that are nonpalpable, are at an increased risk for continued germ and Leydig cell loss.[120] Fertility index (defined as the number of spermatogonia per tubule) decreases in children with cryptorchid testes after one year of age. Longer duration of testis undescent correlates with higher rates of germ cell loss and adult infertility.[119,129,130] The specific etiology for this compromised fertility remains unclear, but is likely related to germ cell depletion and/or defective germ cell maturation, loss of Leydig cells, and/or an increase in testicular fibrosis.[130-132] These histological changes are associated with abnormal semen parameters in these patients during adulthood.[117,133] These findings suggest that untreated cryptorchidism is a progressive disease, not a static congenital malformation.[134]

Guideline Statement 4.

Providers should refer boys with the possibility of newly diagnosed (acquired) cryptorchidism after six months (corrected for gestational age) to an appropriate surgical specialist. (Standard; Evidence Strength: Grade B)

Acquired cryptorchidism is the ascent of a previously descended testis and subsequent inability to manipulate the testis back into the scrotum. Acquired cryptorchidism is a clinical condition distinct from primary UDT and is easily differentiated from congenital cryptorchidism if scrotal testicular position has been documented since birth. The prevalence of acquired cryptorchidism is 1–7% and peaks around 8 years of age.[9,135,136] The observation that acquired cryptorchidism is more common in boys with a history of proximal hypospadias suggests that a common mechanism, such as aberrant androgen signaling, may predispose to both anomalies in otherwise normal boys.[137] Additionally, boys with a history of retractile testes may be at increased risk for testicular ascent.[125,126,137] Although spontaneous descent of acquired cryptorchid testes was reported to be associated with onset of puberty, these observations have not been replicated.[138] Preliminary reports indicate that the same adverse histologic features (e.g. loss of germ cells) found in primary UDTs are also found in acquired cryptorchid testes.[118]

Given the potential for ascent of previously descended testes, a scrotal examination should be performed at every well-child check. Particular attention should be given to boys with a history of hypospadias, prior contralateral cryptorchidism or retractile testes. Children with a newly diagnosed non-scrotal testis found after six months of age should be referred to a surgical specialist.

Guideline Statement 5.

Providers must immediately consult an appropriate specialist for all phenotypic male newborns with bilateral, nonpalpable testes for evaluation of a possible disorder of sex development (DSD). (Standard; Evidence Strength: Grade A)

Approximately 20-30% of all patients with cryptorchidism have bilateral UDTs.[57] In this situation, it is critical to determine if the gonads are palpable or nonpalpable. A newborn with a male phallus and bilateral nonpalpable gonads is potentially a genetic female (46 XX) with congenital adrenal hyperplasia until proven otherwise. Failure to diagnose congenital adrenal hyperplasia can result in serious harm, as a

high proportion of patients with this condition are unable to regulate their electrolyte levels and may present with shock, hyponatremia and hyperkalemia.[139] Thus, serum electrolytes should be monitored. Additionally, karyotype and a hormonal profile (including 17-hydroxyprogesterone levels, LH, FSH, testosterone and androstenedione) must be obtained with simultaneous consultation with a pediatric endocrinologist and a pediatric urologist. Although the initial electrolyte evaluation can be obtained by the first -line provider, consultation with the aforementioned specialists should be obtained due to the complexity of the condition and the need for coordinated multi-specialty care.

Guideline Statement 6.

Providers should not perform ultrasound (US) or other imaging modalities in the evaluation of boys with cryptorchidism prior to referral, as these studies rarely assist in decision making. (Standard; Evidence Strength: Grade B)

In the hands of an experienced provider or specialist, more than 70% of cryptorchid testes are palpable by physical examination and need no imaging. In the remaining 30% of cases with nonpalpable testis, the challenge is to confirm absence or presence of the testis and to identify the location of the viable nonpalpable testis.

Factors that influence this recommendation against imaging (US, computed tomography [CT] scan or MRI) include imaging accuracy, cost, availability, rate of false positives and need for anesthesia in boys with retractile testes. Given the low cost and wide availability of US without need for anesthesia, it is the most commonly used test.[140] Nevertheless, US is non-contributory in routine use, with sensitivity and specificity to localize nonpalpable testis at 45% and 78%, respectively.[141] Typically, prepubertal intra-abdominal testes are not detected by US.[142,143] The cost and ionizing radiation exposure associated with CT scanning precludes its use. MRI with or without angiography has been more widely used with greater sensitivity and specificity but is deterred by cost, low availability and need for anesthesia.[144-148]

At this time, there is no radiological test that can conclude with 100% accuracy that a testis is absent. Therefore, a surgical exploration, such as diagnostic laparoscopy (or open exploration), must be performed on all nonpalpable unilateral and many bilateral cryptorchid patients. Diagnostic laparoscopy is the gold standard with high sensitivity and specificity. If testicular absence is confirmed, the surgery is finished. If a testis is found, the surgery continues and laparoscopic or open orchidopexy is completed, thereby providing diagnosis and therapy simultaneously. Thus, regardless of preoperative radiological findings, these studies rarely assist in the decision making and may at times yield misleading information (such as absence when actually present or *vice versa*).[140,149]

Guideline Statement 7.

Providers should assess the possibility of a disorder of sex development (DSD) when there is increasing severity of hypospadias with cryptorchidism. (Recommendation; Evidence Strength: Grade C)

A newborn boy with bilateral nonpalpable testes must be evaluated for disorder of sexual development (DSD) and should not be circumcised until after the workup is complete, even if a completely normal phenotypic penis is documented on examination. A 46 XX individual with severe congenital adrenal hyperplasia can be mistaken for a boy with bilateral cryptorchidism. The possibility of DSD, or other syndromes should also be entertained when unilateral or bilateral cryptorchidism is present with phallic anomalies, such as hypospadias or micropenis. (Further discussion of all possible scenarios is beyond the scope of this guideline.) In these cases, the presence of a nonpalpable gonad or proximal hypospadias significantly increases the risk of DSD. Radiological, genetic and endocrinological evaluations are indicated in cryptorchid males with disorder of sex development, in conjunction with hormone levels discussed in guideline statement 8 below.

Guideline Statement 8.

In boys with bilateral, nonpalpable testes who do not have congenital adrenal hyperplasia (CAH), providers should measure Müllerian Inhibiting Substance (MIS or Anti- Müllerian Hormone [AMH]) and consider additional hormone testing to evaluate for anorchia. (Option; Evidence Strength: Grade C)

Masculinized infants with bilateral nonpalpable testes require prompt careful consideration and testing. Partially or completely masculinized infants with

bilateral nonpalpable testes must be rapidly evaluated for 46 XX DSD due to life-threatening congenital adrenal hyperplasia (discussed above).

In contrast, if the infant with bilateral nonpalpable testes has normal penile development or micropenis and 46 XY karyotype, an evaluation to distinguish vanishing testis syndrome (bilateral congenital anorchia) versus bilateral abdominal testes is warranted. The latter is approximately 20 times more frequent than bilateral anorchia.[150] In order to avoid surgical exploration in the 46 XY male with anorchia, studies to assess for the presence of any viable testicular tissue should include serum MIS and consider additional hormone testing (inhibin B, FSH, LH, and testosterone).

Within the testis, Leydig cells respond to endogenous LH or exogenous hCG by producing testosterone while Sertoli cells respond to endogenous FSH by producing MIS and inhibin B. The failure of testosterone to increase after hCG stimulation alone is not diagnostic of anorchia; testicular dysgenesis with UDT may fail to respond to hCG stimulation. If the hCG stimulation test is used, it must be confirmed with a significant elevation in serum FSH and LH.[151] If the patient has anorchia and is less than 12 months of age, serum LH is high, FSH is high, MIS and inhibin B are undetectable, and testosterone is low.[152] In infants with anorchia, the postnatal testosterone surge will be absent. In the recent past, intramuscular injections of hCG with serum testosterone levels (hCG stimulation test) were recommended in the evaluation of bilateral nonpalpable testes to assess for Leydig cell function or absence. While the utility of hCG stimulation testing remains disputed, most recent studies suggest that a phenotypic 46 XY male with bilateral nonpalpable testes has isolated anorchia if undetectable levels of MIS and inhibin B with an elevated FSH level are present,[153] making neither hCG stimulation testing nor surgical exploration necessary for the diagnosis of isolated anorchia.[154] If the endocrine markers of Sertoli and Leydig cell function are normal, then testicular tissue is present despite being not palpable and warrants surgical therapy.

Guideline Statement 9.

In boys with retractile testes, providers should assess the position of the testes at least annually to monitor for secondary ascent. (Standard; Evidence Strength: Grade B)

Studies have reported an extremely broad range of incidence of testicular ascent out of the scrotum (between 2-45%) in boys with retractile testes.[18,126] It has been well documented that retractile testes are at increased risk for testicular ascent[18] which may be mechanistically related to the presence of a hyperactive cremasteric reflex, foreshortened patent processus vaginalis or entrapping adhesions. Seventy-seven percent of ascended cases are unilateral and located distal to the inguinal canal.[18] There are five series of the natural history of retractile testes (all referred) and three studies that address the prevalence of retractile testes among boys (this provides values of the prevalence in the general population). The outcomes of follow-up from the referred cohorts are summarized in Table 3. Given ascended and possibly retractile testes may also be at risk for germ cell maldevelopment and diminished fertility[118,155] and ascended testes are typically diagnosed in early or middle childhood,18 a physical examination including a testicular examination is recommended at least annually at every well-child visit in accordance with Bright Futures AAP recommendations.[156]

Treatment

Guideline Statement 10.

Providers should not use hormonal therapy to induce testicular descent as evidence shows low response rates and lack of evidence for long-term efficacy. (Standard; Evidence Strength: Grade B)

Overview of the Literature. Primary hormonal therapy with hCG or luteinizing hormone-releasing hormone (LHRH or gonadotropin-releasing hormone (GnRH)) has historically been used for many years, mostly in countries other than the United States. The action of hCG is virtually identical to that of pituitary LH although hCG appears to have a small degree of FSH activity as well. It stimulates production of androgens by the Leydig cells. The exact mechanism of action of increased androgens in stimulating testicular descent is not known but may involve an effect on the testicular cord or cremaster muscle. hCG is administered by intramuscular injection (IM) while GnRH can be administered intranasally. Multiple series have been published, but due to differences in patient age, treatment schedules, poor follow-up and possible inclusion of retractile testes, very divergent results

Table 3: Outcomes of follow-up from the referred cohorts with retractile testes

First Author	Location	Patients	Testes	Mean Age (yrs)	Mean Follow-up (yrs)	Resolution	Undescended
Agarwal[157]	USA	122	204	5	2.8	30%	32%
Bae[158]	Korea	43	64	3	4.4	45%	14%
La Scala[159]	Switzerland	150		5	3.8		<23%
Marchetti[160]	Italy	40	41	No Information	2.3	34%	25%
Stec[126]	USA	172	274	4	2.2	NI	7%

have been reported. Studies show a significant risk of recurrence.[161-167] Although an individual study may show a reasonable effect in inducing testicular descent, the overall review of all available studies fails to document long-term efficacy. Many hCG dosage schedules are reported, ranging from 3-15 doses.[168-170] hCG appears to be as effective in 3 or 4 doses versus 9 or 10 doses. Studies that compared doses and dosing schedules within hormone type were of poor quality (see Appendix H for Quality Assessment of Individual Studies used in AHRQ Evidence Report) and are too heterogeneous to allow useful conclusions. Success rates for descent into the scrotum are 25-55% in uncontrolled studies, but decrease to only 6-21% in randomized, blinded studies. Distal inguinal testes in older boys are more likely to descend in response to hormonal treatment than abdominal testes. Repeated courses have offered little advantage. Side effects of hCG treatment seen in up to 75% of boys include increased scrotal rugae, pigmentation, pubic hair, and penile growth, which may regress after treatment cessation. A total dose of more than 15,000 IU of hCG must be avoided since it may induce epiphyseal plate fusion and retard future somatic growth. hCG has also been reported to cause a temporary increase in intratesticular pressure and to render the testes hyperemic and enlarged. hCG treatment also increased the density per unit volume of the seminiferous tubules.[171] Others showed that treatment with hCG caused a temporary increase in germ cell apoptosis both in normal and cryptorchid testes. No long-term evaluation of hCG treatment was done.[172]

Agonistic analogs of LHRH, such as Nafarelin or Buserelin, stimulate the release of the pituitary gonadotropins, LH and FSH, resulting in a temporary increase of gonadal steroidogenesis. Repeated dosing abolishes the stimulatory effect on the pituitary gland and twice daily administration leads to decreased secretion of gonadal steroids by 4 weeks. This treatment is available as a nasal spray, but is only approved to induce testicular descent outside of the United States. Interpretation of results is again hindered by multiple treatment strategies. Success rates in uncontrolled studies range from 13-78% while better controlled investigations resulted in 6-38%.[173,174] The recognized side effects of GnRH (increased androgens, including increased penile or testicular size, scrotal erythema, or erections) seem to be less than seen with hCG. No long-term evaluation of LHRH treatment was done. For both hCG and GnRH it has been reported that hormonal treatment may harm the germ cells in one to three-year old cryptorchid boys who did not respond to the hormones used to induce testicular descent.[175]

Nineteen publications from 14 distinct studies addressed the effectiveness of initial hormonal therapy for the treatment of cryptorchidism, but only three were of good quality.[167,170,176-188] Only seven studies included a placebo arm.[167,176,177,181,182,185,187] One study examined long-term fertility outcomes associated with the use of perioperative hormonal therapy.188 Although there are numerous studies, most are only of fair or poor quality.[170,189] In the rare case in which a patient with cryptorchidism is deemed too high a risk for surgery, hormonal therapy may be considered as a primary treatment to induce testicular descent.

A few studies address the use of hCG to help distinguish a retractile testis from a true UDT. In a prospective uncontrolled study, 15 of 26 retractile testes (58%) descended with hCG ($p < 0.001$) compared to 13 of 64 (20%) UDTs. Based on pretreatment physical examination, 100% of retractile testes descended if the testis was in the high scrotal position but only 40% descended if the testis was in the superficial inguinal pouch or inguinal region.[189] Another study that examined the use of hCG or GnRH to induce descent of the UDT also used hCG to treat five boys with retractile testes. The testes were noted to be dependent in the scrotum in all five boys after treatment.[170]

Studies of LHRH and/or analogs to induce testis descent. Six double blind randomized controlled trials (all of fair or poor quality) examined the efficacy of LHRH in the treatment of cryptorchidism.[167,176,177,181,182,183,185,187] One study randomized 141 boys with cryptorchidism age 2 to 12 years to receive either LHRH 0.4mg or placebo intranasally three times a day for 4 weeks.[177] One hundred twenty-three (87%) participants included 62 (97 testes) in the LHRH group and 61 (90 testes) in the placebo group. Success rates immediately following treatment was not statistically significant (9.7% of LHRH compared to 1.6% of placebo).

One study (three papers from the original group) examined the effectiveness of LHRH in 1 to 12 year old boys.[181,182,183] Of 252 participants, 237 (281 UDTs) with complete follow-up were randomized to intranasal LHRH or placebo for 4 weeks. Treatment was unblinded 8 weeks after randomization (4 weeks of study drug followed by 4 weeks off treatment). Nine percent of boys randomized to LHRH achieved complete testicular descent compared to 8% in the placebo group. No testicle initially located above the external inguinal ring descended.

Other trials comparing LHRH to placebo had slightly higher rates of descent in the treatment arms relative to placebo, but were of poor quality. One assessed descent into the scrotum in 47 cryptorchid boys aged 1.5 to 10.5 years following intranasal LHRH for one month.185 Although 18 testes (62%) had an initial "therapeutic effect" (defined as "significant move from the pretreatment location towards the bottom of the scrotum") with LHRH compared to one (3%) in the placebo arm, only six of the successfully treated testes located at the scrotal neck remained descended at 6-12 months after treatment while two were located in the inguinal canal. Six to 12 months later, these last two testes had re-ascended out of the scrotum and required surgical repair.

Another poor-quality double-blinded RCT enrolled 50 boys aged 3 to 8 years with unilateral UDT to receive either intranasal LHRH 200ug or placebo six times a day for 28 days.[187] The primary outcome was complete descent into the scrotum assessed immediately following the completion of treatment and six months after randomization. Immediately following treatment, 20% (5 of 25) of the boys had responded to LHRH treatment. Of these, three were considered complete responses and two were "borderline." Twelve percent (3 of 25) of patients in the placebo group experienced testicular descent immediately following treatment. Response to treatment was not durable, with only 8% (2 of 25) in the LHRH arm and 4% (1 of 25) in the placebo arm still descended after 6 months. Neither this study nor the previous study identified factors that were associated with testicular re-ascent.

A similar RCT of poor quality randomized 49 boys (69 testes) aged 1.2 to 11.9 years to either intranasal LHRH 800ug or placebo three times a day for 28 days.[167] Thirty-seven percent in the LHRH arm had some degree of descent at 8 weeks compared to 18% of placebo-treated testes. However, complete testicular descent occurred in only 3 LHRH boys (9%) and in no placebo-treated boy.

Studies on hCG and/or its analogs to induce testis descent. Few studies[184,186,190] have examined the optimal dosing regimens of hormonal treatment to induce testicular descent (Table 5). Many have primarily focused on comparing higher vs. lower doses of hCG in order to ease administration and minimize side-effects. In one study, 183 cryptorchid boys were randomized to receive either hCG 1500 IU IM injection every other day for 14 days (88 patients) or four IM injections (100 IU/kg) every 4–5 days to a maximal dose of 3000 IU (95 patients).[184] No difference in successful descent to the scrotum was noted with different doses. Boys in whom the UDT was initially in the mid-inguinal canal or lower had higher success rates than those who had testes located above the mid-inguinal canal.

Another study randomized 332 boys aged 1 to 13 years

Table 4: Short-term testicular descent in two-arm, randomized, placebo-controlled studies

Study N Length of Follow-up Quality	LHRH Dose	LHRH Frequency	LHRH Duration	LHRH Descent (%)	Placebo Descent (%)
Olsen et al., 1992[177] N= 123 4 Weeks Fair	400 µg	3 times daily	4 weeks	9.7	1.6[a]
De Muinck Keizer-Schrama and Hazebroek et al. 1986-1987[181-183] N=237 8 Weeks Poor	200 µg	3 times daily	4 weeks	9.0	8.0
Hagberg and Westphal 1982[185] N=50 4 Weeks Poor	100 µg	3 times daily	28 days	62.0	3.0
Karpe et al, 1983[187] N= 50 6 Months Poor	100 µg	6 times daily	28 days	20.0	12.0
Wit el al., 1986[167] N=49 8 Weeks Poor	400µg	3 times daily	28 days	37	18

CI= Confidence interval; LHRH= luteinizing hormone releasing hormone; N= number
[a]Statistical significance was evaluated and reported only for this comparison—p=0.12 (95% CI, 0.1 to 16.6), and not evaluated for any other study.

to receive either 2 lower dose hCG injections per week for 5 weeks or 1 higher dose hCG injection every 7–10 days for 3 weeks (essentially the same total dose in both arms).[186] Success was assessed between 8 weeks and 6 months after full treatment. The dosing schedule with more injections had a significantly higher complete success rate than the schedule with fewer injections (39% vs. 30%, p<0.05).

A prospective observational study of good quality compared low-dose hCG (500 IU/week for 3 weeks) to a higher-dosing regimen (1,500 IU/m2 three times a week for 3 weeks) and failed to show a difference between the two doses.[190] Success was defined as complete descent into the scrotum and was assessed immediately following the treatment.

Studies comparing hormonal regimens to induce descent. Four studies have compared the effectiveness of hCG vs LHRH therapy to induce testicular descent (Table 6).[170,176,178,191] One study is a double-blind randomized control trial comparing the effectiveness of intranasal LHRH, IM hCG, and placebo and is of good quality.[170] Boys with unilateral (n=29) or bilateral (n=4) UDTs were assessed immediately following treatment and then monthly for up to three months after the conclusion of full treatment. One participant in the hCG arm (6%) had complete descent compared to three in the LHRH arm (19%) without a statistically significant difference. A parallel uncontrolled study of 13 boys examined retractile testes treated with the same hCG regimen and 38% had complete descent of the retractile testis into the scrotum supporting the possible effectiveness of hCG to help identify retractile testes.[170]

Other studies focused on combinations of hormonal therapy to determine if multidrug regimens worked better than single agents. One study[178] compared the effectiveness of four different hormonal regimens in 155 boys with unilateral palpable cryptorchidism age 10 to 48 months: hCG vs hCG/hMG vs LHRH vs LHRH/hCG.[178] Short term success was about 20% for all groups. The overall long-term success rate (as qualified by authors of these studies) in the study was 15%, with 13-19% success rates within the four groups. This study also recorded side effects- 74% of boys on hCG and 5% of those on LHRH initially reported signs of androgenization, such as penis growth that receded at

Table 5: Testicular descent in studies comparing dosages of hCG

Study N Length of Follow-up Quality	hCG Dose	hCG Frequency	hCG Duration	Descent, Side Unspecified (%)	Descent, Unilateral (%)	Descent Bilateral (%)**
Aycan et al., 2006[190] N=35 3 weeks Good	500 IU	Once a week	3 weeks	66.7	NR	NR
	1,500 IU/m^2	3 times a week	3 weeks	57.1	NR	NR
Forest et al., 1988[184] N=183 2-3 weeks Poor	1,500 IU	Every other day	14 days	NA	50.8	48.3
	100 IU/Kg to a max of 3,000 IU	4 injections every 4-5 day interval	NR	NA	50.9	50.0
Hesse and Fischer, 1988[186] N=332 8-12 weeks Poor	300-1,000 IU*	2 injections a week	5 weeks	NA	44.2	40.8
	1,000-5,000 IU±	1 injection every 7-10 days	3 weeks	NA	35.5	30.9

hCG=human chorionic gonadotropin; IU=international unites; NA=not applicable; NR=not reported
*1-2 yrs old: 300 IU; 2-6 yrs old: 500 IU; 6-13 yrs old: 1,000 IU
±1-3 yrs old: 1,000; 3-6 yrs old: 1,500; 6-10 yrs old: 3,000; 10-13 yrs old: 5,000
**No comparisons were statistically significant

long-term follow-up and erections.

Two papers from a single study compared intranasal buserelin to inhaled placebo with descent checked three months after the conclusion treatment followed by IM hCG.[179,180] Thirty-six percent of boys in the Buserelin/ hCG group were noted to have complete testicular descent at three months, as opposed to 11% (2 of 19) in the placebo/hCG group ($p<0.01$). However, one must note that all but one of the testes that responded to treatment were originally located in the prescrotal position.

Another study examined 324 boys with palpable unilateral or bilateral UDTs who were treated with one of five hormonal regimens: hCG, hMG, LHRH, hMG and hCG vs LHRH/hCG.[191] Every six months a new treatment was randomly assigned prospectively for newly enrolling boys aged 6 months to 13 years. hCG alone was the most effective treatment (35%), followed by LHRH/hCG (30%), LHRH alone (29%), and hCG/hMG (26%), and hMG alone (0%). There was no significant

Table 6: Testicular descent in studies comparing LHRH with hCG*

Study N Length of Follow-up Quality	hCG (%)	hCG+HMG (%)	LHRH (%)	LHRH+hCG (%)
Rajfer et al., 1986[170] N=33 12 weeks Good	5.9	NA	18.8	NA
Bertelloni et al., 2001[178] N=155 6 months Poor	18.9	12.8	12.8	15.0
Esposito et al., 2003[191] N=324 4-6 weeks Poor	34.5	25.9	29.4	29.6

hCG=human chorionic gonadotropin; HMG=human menopausal gonadotropin; LHRH=luteinizing hormone releasing hormone; NA=not applicable
*No comparisons were significant

difference in effectiveness between the four effective therapies. However there was no placebo control group and follow-up was only 6 months.

A fair-quality study assessed the effectiveness of a four week treatment hCG, LHRH or placebo in boys aged 1.8 -13 years.[176] Complete follow-up was available in 220 boys. For bilateral cryptorchidism, 23% treated with hCG had complete descent of both testes into the scrotum, as opposed to 9% in the LHRH group and 0% in the placebo group in short term follow-up (p=0.001). With unilateral UDTs, hCG was effective in inducing complete descent in 15% as opposed to 0 percent in either the LHRH or placebo groups (p=0.02).

Use of hormones to improve fertility (rather than to induce testicular descent). No reports on long-term fertility outcomes following isolated hormonal therapy (no surgery at any time) were found in our literature search. Hormonal therapy may have prophylactic value to optimize germ cell maturation and/or sperm production (in distinction from the use of hormones to induce testicular descent). LHRH or hCG administration prior to orchidopexy has been shown to improve the fertility index on biopsies obtained at the time of orchidopexy.[179,193] One small study showed that use of LHRH analogue in boys with very poor testis histology (total germ cell count less than 0.2 germ cells/tubule in UDT and less than 0.6 germ cells/tubule in CDT) has an advantageous effect on the developing germ cells. Patients who had no germ cell count on the biopsy did not show improvement after hormonal therapy but those who had some germ cells demonstrated improvement.[192]

In another good-quality prospective study, 42 boys with 63 UDTs were prospectively randomized to receive either orchidopexy alone (21 patients) or with neoadjuvant GnRH therapy (21 patients). In both groups testicular biopsies for histology fertility index were performed during orchidopexy. Preoperative GnRH significantly improved the fertility index in primary cryptorchid testes. The average fertility index increased above the prognostically important threshold of 0.6, improving the individual fertility potential. The most advantageous fertility prognosis was achieved with neoadjuvant GnRH administration for bilateral orchidopexy within the first year of life.[193]

One good-quality study explored long-term fertility outcomes of hormonal therapy as an adjunct to orchidopexy. They compared 15 cryptorchid boys who underwent orchidopexy followed by Buserelin every other day for 6 months to 15 age-matched controls who were treated by orchidopexy alone. The primary outcomes were semen analysis parameters measured in early adulthood (mean age=19 years). Those with surgery and Buserelin had significantly higher sperm counts (90 million sperm per ejaculate compared to 1 million in the surgery only group, p<0.001). In addition, 11% percent of those who received surgery and hormone therapy had normal morphology as opposed to none in the surgery alone group.[188]

This improvement in germ cell count and maturation may eventually reflect a better prognosis for fertility. It is still unclear if this effect on testis histology persists into adulthood improving fertility and paternity potential or disappears once the hormonal stimulus is removed.

Guideline Statement 11.

In the absence of spontaneous testicular descent by six months (corrected for gestational age), specialists should perform surgery within the next year. (Standard; Evidence Strength: Grade B)

In a 10 year, retrospective study of 1,235 consecutive boys with cryptorchidism referred to pediatric urology practice, all patients with eventual spontaneous descent initially presented by six months (corrected for gestational age). Of those boys initially presenting beyond age six months no patient had spontaneous testicular descent.57

Orchidopexy in the first 18 months of life is recommended to preserve available fertility potential. In the majority of cases the total number of germ cells is within the normal range in cryptorchid testes during the first six months of life, but about 25% of the cryptorchid boys are born with a reduced number of germ cells.[194] After 15 to 18 months of age some cryptorchid boys lack germ cells in the testes and the number of boys without germ cells in a testicular biopsy increases to about 40% in bilateral cryptorchid boys at 8-11 years of age.[130] In total the number of germ cells in undescended testes remains low and does not increase with age. Histologic examination of cryptorchid testes has shown that testes that remain undescended are associated with progressive loss of germ and Leydig cells.[119,120,130] The UDT fails to show normal maturation

at both three months and five years of age. At three months of age, the fetal gonocytes are transformed into adult dark (Ad) spermatogonia. At five years of age, the Ad spermatogonia become primary spermatocytes. Both of these steps are abnormal in the UDT, and to a lesser extent, the contralateral descended testis. Previous beliefs that the UDT was normal between birth and 1 year of age are incorrect, since they were derived from counts of all germ cells without taking into account whether maturation was occurring. After two years of age, thermal effects on the testis being left out of position are seen possibly independent of the endocrinologic effects.

A retrospective study examined the testis biopsy total germ cell counts in 226 cryptorchid boys aged 6 months-16 years.[195] Of 184 patients with unilateral UDT, 87 also underwent biopsy on the contralateral descended testis. A total of 42 patients had bilateral UDTs. Age matched comparisons were made between fertility index measurements of the UDT and those previously reported of normal testes. Additional case matched comparisons of fertility indexes were made in those children who underwent biopsy of the UDT and its contralateral descended mate. When comparing undescended to descended testes, there was no significant difference in the fertility index of patients 1 year old or younger but fertility index differences were statistically significant in all of the other age groups. Fertility index measurements were significantly decreased from normal expected values in all age groups with unilateral cryptorchidism and in all but the 13 to 18-month-old group with bilateral cryptorchidism.

Guideline Statement 12.

In prepubertal boys with palpable, cryptorchid testes, surgical specialists should perform scrotal or inguinal orchidopexy. (Standard; Evidence Strength: Grade B)

While it is optimal to perform surgery for the cryptorchid testis by 18 months of age (see previous discussion in statement 11), there are clear benefits to performing orchidopexy in all prepubertal boys at the time of diagnosis of a cryptorchid testis.[196] With regard to fertility, there has not been any direct assessment or long-term follow-up of patients with early vs. late orchidopexy. Nevertheless, even though progressive and adverse histologic changes will occur in the cryptorchid testis prior to puberty, there is evidence to suggest that there are likely fertility benefits that can still be realized with surgical correction of the cryptorchid testis prior to puberty, even if not performed in the first 18 months of life[197-200] With respect to cancer risk, it is widely recognized that the cryptorchid testis is associated with an inherent risk of malignant degeneration. Early reports of this increased risk were likely overestimated and recent review of the literature suggests that the overall relative risk is 2.75-8.196 There is now ample evidence to suggest that this risk is decreased when orchidopexy is performed prior to puberty[196,201-203] Prepubertal orchidopexy results in a two to six fold reduction in the relative risk compared with postpubertal orchidopexy. In the post pubertal child with cryptorchidism, consideration should be given to performing an orchiectomy or biopsy, although there needs to be careful consideration of other factors including associated medical conditions, anesthetic risk, and status of the contralateral testis. Further discussion of the adult with cryptorchidism is beyond the scope of this guideline.

Orchidopexy remains one of the most common urologic procedures performed in pediatric patients. The technique for the standard two- incision approach (inguinal and scrotal) has not changed in decades. The inguinal portion of the procedure is performed to mobilize the cord structures and gain adequate length for repositioning the testis in the scrotum, along with closure of a patent processus vaginalis, when present. The secondary scrotal incision is performed to create a subdartos pouch for placement and fixation of the testis. This can be done as an outpatient procedure with minimal morbidity. Given the long standing well recognized historical success of this common procedure, there is a paucity of recent literature to document its effectiveness. However, recent studies that have evaluated open surgical intervention for the cryptorchid testis, even with inclusion of testes that are intra-abdominal, the overall success has been documented to be greater than 96% (range from 89-100%) (See Table 7). Subsequent atrophy of the testis is very uncommon and reported to be less than 2%. (See Table 8)

For the palpable testis that is low lying, single incision orchidopexy is also a viable option. This primary scrotal approach was introduced by Bianchi and Squire[204] and has since gained widespread use and has been documented in retrospective studies to be equally effective to two incision orchidopexy in selected

patients with testes located distal to the external inguinal ring that can be mobilized adequately via a scrotal incision.[205,206] The primary single incision scrotal approach has potential advantages with respect to enhanced recovery and cosmesis, as well as reduced operative time. This technique can be effective even when there is a patent processus/hernia sac present. Adequate high ligation of the sac may be achieved in the many cases even though the external oblique fascia is not opened.[207] In cases where adequate ligation cannot be achieved, the procedure can still be converted to a conventional two incision technique.

Guideline Statement 13.

In prepubertal boys with nonpalpable testes, surgical specialists should perform examination under anesthesia to reassess for palpability of testes. If nonpalpable, surgical exploration and, if indicated, abdominal orchidopexy should be performed. (Standard; Evidence Strength: Grade B)

In boys that are brought to the operating room with a nonpalpable testis, a thorough examination should be performed following induction of general anesthesia to further determine if the testis is palpable. If the testis is palpable, open orchidopexy should be undertaken. However, if the testis remains nonpalpable, then a decision needs to be made to either pursue laparoscopic or open exploration. Laparoscopy in the

Table 7: Success rates after orchidopexy for nonpalpable testes (open or laparoscopic, mixed techniques -primary, 1 or 2 stage Fowler-Stephens)

Author Country	Quality	Total Participants/ techniques	Total Testicles	% Success (N Testicles Treated)
Stec et al., 2009[208] United States	Good	136 Open or laparoscopic	156	89.1 (92)
Baker et al., 2001[209] United States	Poor	226 Laparoscopic	263	97.2 (178)
Chang et al., 2001[210] United States	Poor	80 Laparoscopic	92	100 (66)
Denes et al., 2008[67] Brazil	Poor	46 Laparoscopic	54	96 (26)
Dhanani et al., 2004[211] United States	Poor	74 Open or laparoscopic	83	100 (28)
Kim et al., 2010[212]* South Korea	Poor	67 Laparoscopic	86	98 (49)
Moursy et al., 2011[89] Egypt	Poor	66 Laparoscopic	76	100 (28)
Pooled %		**Total: 695**	**Total: 810**	**96.4**

N=number
*Controlled for location. All studies were retrospective cohorts.

Table 8: Atrophy rates after orchidopexy for nonpalpable testes

Author Country	Quality	Total Participants	Total Testicles	% Atrophy (N Testicles Treated)
Baker et al., 2001[209] United States	Poor	226	263	2.2 (178)
Denes et al., 2008[67] Brazil	Poor	46	54	4 (26
Humphrey et al., 1998[83] United Kingdom	Poor	48	20	0 (8)
Moursy et al., 2011[89] Egypt	Poor	66	76	0 (33)
Radmayr et al., 2003[92] Austria	Poor	84	57	0 (28)
Pooled %		**Total: 470**	**Total: 470**	**1.83**

treatment of cryptorchidism has two roles: (1) as an exploratory tool to locate a nonpalpable undescended testicle in the abdomen; and (2) as a minimally invasive method of orchidopexy. Previous studies evaluating laparoscopy for determining the location of the testicle have reported similar findings to open exploration.[213,214] Success of the ensuing surgeries was also similar, regardless of exploratory approach. However, given technical advancements and increased familiarity of younger urologic surgeons with minimally invasive techniques, laparoscopy has become the preferred method of exploration for the nonpalpable testis for most pediatric urologists. Nevertheless, depending on the training and comfort level of the individual surgeon with laparoscopic techniques, open surgical management of the intra-abdominal testis is also appropriate given the lack of evidence to demonstrate that laparoscopic techniques have distinct advantages over open techniques with respect to success of the orchidopexy itself.[69,215,216,217]

If an intrabdominal testis is found with anatomy that is felt to be appropriate for salvage, one of three surgical options can be chosen regardless of whether one approaches the testis laparoscopically or with an open approach. The three types of surgical repair that one may consider are primary orchidopexy, one-stage Fowler Stephens (FS) orchidopexy, and two-stage FS orchidopexy. Extensive review of previous studies evaluating the effectiveness of these procedures reveals that the weighted success rate for all three approaches exceeds 75%, with an overall reported rate of 96.4% for primary orchidopexy, 78.7% for one-stage FS, and 86% for two-stage FS. (See Tables 10 and 11) While initial review of these success rates may suggest that primary orchidopexy is superior to the two other FS approaches, one must take into account that all of these studies are observational cohort designs and are limited in their conclusions due to numerous factors including surgeon bias as to what procedure was performed and lack of randomization of the surgical techniques in many of the studies. This limits one's ability to make any definitive conclusions regarding the superiority of primary orchidopexy to either the one- or two-stage FS approach. Nonetheless, these studies do provide some insight into regarding the surgical success of these different procedures. There is clear consensus that if the testicular vessels are long enough to reach into the scrotum, then the vascular supply should be spared and a primary orchidopexy is performed in preference to FS orchidopexy. One should make every effort to preserve the primary blood supply to the testis. The FS methods are reserved for cases in which the vessels are too short to allow adequate repositioning of the testis into the scrotum. In the FS approach, the testicular vessels are divided and the blood supply to the testis is maintained through collaterals, including the artery of the vas deferens. When the FS orchidopexy is done in one stage, the testicular vessels are ligated and the testicle is immediately moved down into the scrotum; in the two-stage approach, only ligation is done at the time of the first stage, without mobilization of the testis. The patient is then followed for three to six months, to presumably allow for improved collateral circulation to develop. A second stage repair is then undertaken with repositioning of the testis in to the scrotum.[67,83,89,92,208-212] While results from previous studies may suggest that the two-stage approach is superior to the one-stage approach, it is difficult to make this determination since the groups of patients and their associated testicular vessel anatomy in these studies were not necessarily the same. Thus, specific treatment choices were most likely made on the basis of where the affected testicle was located and in part, surgeon preference. Because these studies did not control for these variables, the results can only be interpreted as providing noncomparative data on outcomes in groups with differing clinical presentations. Therefore, when a primary orchidopexy cannot be performed in cases where the testicular vessels are too short, the decision to perform a one-stage or two-stage FS orchidopexy is left to the discretion for the surgeon based on the location of the testis, associated vascular supply to the testis, and the anatomy of the peritesticular structures.

Guideline Statement 14.

At the time of exploration for a nonpalpable testis in boys, surgical specialists should identify the status of the testicular vessels to help determine the next course of action. (Clinical Principle)

The identification of the testicular vessels should be the end point of any exploration for a nonpalpable testis. As previously mentioned in the guideline, radiologic imaging is typically not helpful in this situation because of its lack of both sensitivity and specificity for the identification of an abdominal testis. Several surgical approaches exist for the surgeon caring for the patient with nonpalpable testis, which include laparoscopic exploration, inguinal exploration or scrotal exploration.

Table 9: Success rates after one-stage Fowler-Stephens for nonpalpable testes

Author Country	Quality	Total Participants	Total Testicles	% Success (N Testicles Treated)
Stec et al., 2009[208] United States	Good	136	156	63 (27)
Baker et al., 2001[209] United States	Poor	226	263	74.1 (27)
Chang et al., 2001[210] United States	Poor	80	92	84 (19)
Chang et al., 2008[218] United States	Poor	48	48	94.3 (35)
Comploj et al., 2011[219] Austria	Poor	41	50	79 (33)
Denes et al., 2008[67] Brazil	Poor	46	54	33 (3)
Kim et al., 2010[212]* South Korea	Poor	67	86	82 (11)
Pooled %		**Total: 644**	**Total: 749**	**78.7**

N=number

*Controlled for location. All studies were retrospective cohorts.

Each approach offers benefits as well as limitations. Regardless of approach, the objective of the procedure is the same, which is to either identify the previously nonpalpable testis or identify the termination of the testicular vessels. The testicular vessels may end blindly anywhere along the course of descent of the testis. The exact location may range from the retroperitoneum along the psoas, the inguinal canal or commonly the scrotum itself.

On physical examination, a vanishing testis may manifest as a testicular "nubbin," which can be palpated in the scrotum, and is representative of a completely atrophic testis. The identification of a vanishing testis at the time of exploration is the end point of surgical exploration.[220] Typically a hemosiderin deposit will be visible on the pathologic specimen. A potential complication resulting from this approach can be inadvertent injury to a long-looping vas that could occur during surgical exploration or there may be an erroneous diagnosis, although the risk of these

Table 10: Success rates after two-stage Fowler-Stephens for nonpalpable testes

Author Country	Quality	Total Participants	Total Testicles	% Success (N Testicles Treated)
Stec et al., 2009[208] United States	Good	136	156	67.6 (37)
Baker et al., 2001[209] United States	Poor	226	263	87.9 (58)
Chang et al., 2001[210] United States	Poor	80	92	86 (7)
Chang et al., 2008[218] United States	Poor	48	48	80 (10)
Comploj et al., 2011[219] Austria	Poor	41	50	82 (17)
Denes et al., 2008[67] Brazil	Poor	46	54	88 (25)
Dhanani et al., 2004[211] United States	Poor	74	83	98 (49)
Kim et al., 2010[212]* South Korea	Poor	67	86	67 (3)
Moursy et al., 2011[89] Egypt	Poor	66	76	88.8 (36)
Pooled %		**Total: 784**	**Total: 908**	**86.0**

N=number

*Controlled for location. All studies were retrospective cohorts.

unfavorable outcomes is unknown.

The advent and miniaturization of laparoscopic instrumentation has afforded the surgeon the ability to inspect the retroperitoneum within the abdominal cavity with minimal morbidity. This allows the surgeon to perform an exhaustive search from the level of the kidney to the internal ring. In situations where the testis is identified, a decision is made to proceed with either orchidopexy or orchiectomy. When the testis is not identified, the surgeon must identify the vessels. The vessels may end blindly within the abdomen or exit the internal ring. The identification of the vas deferens should not guide management as it is of distinct embryologic origin and may not be fused to the testis. Of note, in cases of vanishing testes that have descended distal to the internal ring, the testicular vessels typically are less robust as they enter the internal ring as compared to the normal descended side. When the vessels end blindly in the retroperitoneum, the surgeon may terminate the procedure or explore distal to the internal ring to confirm the absence of testicular tissue or remove a vanishing testis. In situations where the vessels clearly enter the internal ring, the surgeon must explore either the inguinal canal or the scrotum, depending on the surgeon's preference. If a palpable nubbin is present, in the scrotum, potentially representing a vanishing testis, then scrotal exploration can safely be performed.[220] Advocates of the inguinal approach feel that this gives the surgeon the best approach to confirm the vessels are indeed traversing the internal ring. Regardless of the approach, the specimen should be sent for pathologic confirmation, to confirm a vanishing testis and no presence of malignancy. Special mention should be made regarding a "peeping testis." This phenomenon may occur when a patent processus vaginalis prevents palpation of the testis. When the abdomen is insufflated with laparoscopy, the testis travels through the internal ring and can be palpated. This patient can be managed safely with either laparoscopic orchidopexy or inguinal orchidopexy.

Guideline Statement 15.

In boys with a normal contralateral testis, surgical specialists may perform an orchiectomy (removal of the undescended testis) if a boy has a normal contralateral testis and either very short testicular vessels and vas deferens, dysmorphic or very hypoplastic testis, or postpubertal age. (Clinical Principle)

When operating on an abdominal testis, the surgeon may encounter situations that preclude an orchidopexy. These situations may arise when the patient has an atretic and/or short vas deferens, very short testicular vessels that place the testis high within the retroperitoneum, a dysmorphic testis or a testis in a postpubertal male. In these situations, an orchiectomy may be prudent in the presence of a normal contra-lateral descended testis. To help determine whether orchiectomy is advisable, it may be appropriate to perform an intra-operative biopsy of the affected testis, but the utility of this is not proven. If an orchiectomy is performed, then the patient and family should be counseled about the importance of wearing protective gear during sporting activity. Another option for treatment is autotransplant of the undescended testis, however this has been done sparingly.[221-224]

Guideline Statement 16.

Providers should counsel boys with a history of cryptorchidism and/or monorchidism and their parents regarding potential long-term risks and provide education on infertility and cancer risk. (Clinical Principle)

There are two major long-term concerns for patients with a history of cryptorchidism: an increased incidence of developing testicular cancer and a heightened risk of subfertility.[225-227]

Testicular malignancy. Men with a history of cryptorchidism have an increased risk of testicular cancer. The increased incidence of malignancy in cryptorchid testes varies from 49/100,000 (0.05%) to 12/1,075 (1%).[227,228] Early reports stated a significantly higher risk of carcinoma in an abdominal testis; however, inclusion of boys with abnormal karyotype and/or genitalia may have confounded the results.[229,230] One hypothesis for the etiology of the testicular cancer is that it is related to the abnormal position of the testis. However, the mild increase in cancer in the contralateral descended testis argues for an intrinsic testicular abnormality as the cause.[231] Although earlier findings have suggested that orchidopexy does not decrease the risk of testicular cancer, more recent studies have demonstrated that orchidopexy performed before puberty decreases the risk of testis cancer compared to those boys with cryptorchidism who undergo orchidopexy after puberty.[231] However, the

risk of testis cancer does not decrease to that of normal controls even when orchidopexy is performed at an early age.[231,232] The increase in the incidence of malignancy in the cryptorchid testis warrants close follow-up, especially after puberty. Every previously cryptorchid boy should be taught how to perform a monthly testicular self-examination after puberty to potentially facilitate early cancer detection.

Fertility. Formerly bilateral cryptorchid men have greatly reduced fertility compared with men with a history of unilateral cryptorchidism and the general male population.[233-237] One retrospective study showed a paternity rate of 62% (38% infertile) in formerly bilaterally cryptorchid men compared with a matched control group of 94% (6% infertile), indicating a six fold increased risk.[238] In contrast, unilaterally cryptorchid men had a paternity rate of 89.5%, which is similar to the level of fertility found in other studies of the general population (94%). Examination of subfertility, or time to pregnancy, shows that bilaterally cryptorchid men have greatly increased waiting times to pregnancy (33.9 months compared with 11.1 months for unilateral UDTs and controls). An assessment of paternity among men with monorchidism, whether as a result of an absent testis or orchiectomy, found no difference compared with those with unilateral cryptorchidism or control men.[239] Another study examined the association of pretreatment UDT location with fertility rates and various hormone levels (inhibin B, LH, FSH, testosterone) in adulthood.[240] The authors concluded that pre-operative location in men with previous unilateral UDT is not a major determinant of fertility as measured by paternity reporting, sperm count, or hormone levels. A long-term study followed 91 young adults with previous surgical correction of unilateral UDT and 19 with bilateral UDT.[241] Evaluation compared initial testis bilateral testis biopsy histopathology with adult hormonal studies (LH, FSH, testosterone, inhibin B) and semen analysis. No significant differences in semen analysis parameters were seen among the normal v. abnormal germ cell groups. In unilateral UDT, sperm density and sperm count in the abnormal adult dark (Ad) spermatogonia per tubule group remained within normal range but were significantly decreased ($p = 0.005$ and $p = 0.028$). FSH levels were significantly higher in patients with unilateral UDT with abnormal Ad spermatogonia counts but remained within normal range ($p = 0.009$). In bilateral UDTs, sperm density was below normal range and significantly decreased in the abnormal Ad spermatogonia group ($p = 0.05$). Further, FSH level, sperm count, and sperm motility for the abnormal Ad spermatogonia per tubule group were outside normal clinical range, but these results were not statistically significant. Total germ cell count via biopsy at orchidopexy was not associated with significant changes in hormone levels or semen analysis results in adulthood, but Ad spermatogonia counts were more significant. Testis biopsy at orchidopexy may have limited use in predicting future fertility in unilateral UDT but may be more clinically useful in predicting fertility potential for those with bilateral UDTs.

Recently, a long-term study followed 91 young adults with previous surgical correction of 963 bilateral UDT and 87 with unilateral UDT. Evaluation compared initial testis biopsy histopathology with adult hormonal studies (FSH) and semen analysis. In bilateral cryptorchidism the mean age corrected number of germ cells per transverse tubule positively correlated to sperm density and to volume of pair of testes and negatively correlated to serum FSH. In cases of no germ cells there was approximately a 75 to 100% risk of infertility, based on a lack of germ cells in one or both testes.[242] In unilateral cryptorchidism, a lack of germ cells in testicular biopsies taken at surgery was associated with approximately 33% risk of later infertility. Between ages 2 and 12 years the timing of unilateral orchidopexy may vary without an effect on subsequent fertility potential. When biopsy at surgery lacks germ cells in unilateral cryptorchidism, there is an approximate 33% age independent risk of subsequent infertility. Otherwise patients may be fertile after unilateral orchidopexy between ages 2 and 12 years.[243,244]

FUTURE RESEARCH

More research is needed to address long-term follow-up of surgically treated ascending UDTs. These studies should compare fertility and testis cancer rates with UDTs identified and treated in infancy.

Additionally, a randomized control trial is needed to compare long-term testicular function after one-stage versus two-stage laparoscopic Fowler-Stephens abdominal orchidopexy. While a one-stage approach has a slightly lower success rate, the two-stage approach has added risks. A similar comparison of open versus laparoscopic abdominal orchidopexy could be employed.

Continued research should also investigate the effects

of genetic susceptibility and environmental toxins on the risk of cryptorchidism and/or testicular maldevelopment.

Studies of paternity in patients surgically treated for cryptorchidism, and its correlation with semen analysis, androgen function, and testis histology data as available, are needed.

Long-term outcome data are needed in boys with monorchidism due to a vanishing testis and monorchidism; additional research should whether excision of the vanishing testis is indicated and the necessity for scrotal fixation of the contralateral testis.

Finally, further studies are needed to determine whether orchiopexy between six and eighteen months of age is superior to later surgical treatment in improving fertility potential in adulthood.

LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
Ad	Adult dark spermatogonia
AHRQ	Agency for Healthcare Research and Quality
AR	Androgen receptor
AUA	American Urological Association
BMI	Body mass index
CAH	Congenital adrenal hyperplasia
CT	Computed tomography
DES	Diethylstilbestrol
DSD	Disorder of sex development
ESR1	Estrogen receptor alpha
FS	Fowler Stephens
INSL3	Insulin-like 3
LGR8	Leucine-rich repeat-containing G protein-coupled receptor 8
MRA	Magnetic resonance angiogram
MRI	Magnetic resonance imaging
MRV	Magnetic resonance venography
PCB	Polychlorinated biphenyl
RCT	Randomized controlled trial
RRR	Recurrence risk ratio
RXFP2	Relaxin/insulin-like family peptide receptor 2
TDS	Testicular dysgenesis syndrome
UDT	Undescended testis
US	Ultrasound

REFERENCES

1. Higgins JDA: Assessing quality of included studies in Cochrane Reviews. The Cochrane Collaboration Methods Groups Newsletter 2007; **11**.

2. Whiting PF, Rutjes AWS, Westwood ME, et al. QUADAS-2: A Revised Tool for the Quality Assessment of Diagnostic Accuracy Studies. Ann Intern Med 2011; **155**:529.

3. Norris SL, Lee NJ, Severance S et al: Appendix B. Quality assessment methods for drug class reviews for the drug effectiveness review project. Oregon Health & Science University 2008.

4. Faraday M, Hubbard H, Kosiak B et al: Staying at the cutting edge: a review and analysis of evidence reporting and grading; the recommendations of the American Urological Association. BJU Int 2009; **104:** 294.

5. Hsu C and Sandford BA: The Delphi Technique: Making Sense of Consensus. Practical Assessment, Research & Evaluation 2007; **12:** 1.

6. Bayne AP, Alonzo DG, Hsieh MH et al: Impact of anatomical and socioeconomic factors on timing of urological consultation for boys with cryptorchidism. J Urol 2011; **186**: 1601.

7. Kokorowski PJ, Routh JC, Graham DA et al: Variations in timing of surgery among boys who underwent orchidopexy for cryptorchidism. Pediatrics 2010; **126**: e576.

8. Snodgrass W, Bush N, Holzer M et al: Current referral patterns and means to improve accuracy in diagnosis of undescended testis. Pediatrics 2011; **127**: e382.

9. Acerini CL, Miles HL, Dunger DB, et al: The descriptive epidemiology of congenital and acquired cryptorchidism in a UK infant cohort. Arch Dis Child 2009.

10. Jensen MS, Olsen LH, Thulstrup AM et al: Age at cryptorchidism diagnosis and orchiopexy in Denmark: a population based study of 508,964 boys born from 1995 to 2009. J Urol 2011; **186**: 1595.

11. Wohlfahrt-Veje C, Boisen KA, Boas M et al: Acquired cryptorchidism is frequent in infancy and childhood. Int J Androl 2009; **32**:423.

12. Wagner-Mahler K, Kurzenne JY, Delattre I et al: Prospective study on the prevalence and associated risk factors of cryptorchidism in 6246 newborn boys from Nice area, France. Int J Androl 2011; **34**: e499.

13. Kollin C, Grahnholm T, Nordenskjold A et al: Growth of spontaneously descended and surgically treated testes during early childhood. Pediatrics 2013; **131:** e1174.

14. Wenzler DL, Bloom DA and Park JM: What is the rate of spontaneous testicular descent in infants with cryptorchidism? J Urol 2004;**171**:849.

15. Sijstermans K, Hack WW, Meijer RW et al: The frequency of undescended testis from birth to adulthood: a review. Int J Androl 2008; **31**: 1.

16. Scorer CG: The Descent of the Testis. Arch Dis Child 1964; **39**: 605.

17. Jensen MS, Wilcox AJ, Olsen J et al: Cryptorchidism and hypospadias in a cohort of 934,538 Danish boys: the role of birth weight, gestational age, body dimensions, and fetal growth. Am J Epidemiol 2012; **175**: 917.

18. Barthold JS and Gonzalez R: The epidemiology of congenital cryptorchidism, testicular ascent and orchiopexy. J Urol 2003; **170**: 2396.

19. Jensen MS, Toft G, Thulstrup AM et al: Cryptorchidism concordance in monozygotic and dizygotic twin brothers, full brothers, and half-brothers. Fertil Steril 2010; **93**: 124.

20. Foresta C, Zuccarello D, Garolla A et al: Role of hormones, genes, and environment in human cryptorchidism. Endocr Rev 2008; **29**: 560.

21. Bogatcheva NV, Ferlin A, Feng S et al: T222P mutation of the insulin-like 3 hormone receptor LGR8 is associated with testicular maldescent and hinders receptor expression on the cell surface membrane. Am J Physiol Endocrinol Metab 2007; **292**: E138.

22. Ars E, Lo Giacco D, Bassas L et al: Further insights into the role of T222P variant of RXFP2 in non-syndromic cryptorchidism in two Mediterranean populations. Int J Androl 2011; **34**: 333.

23. El Houate B, Rouba H, Imken L et al: No association between T222P/LGR8 mutation and cryptorchidism in the Moroccan population. Horm Res 2008; **70**: 236.

24. Radpour R, Rezaee M, Tavasoly A et al: Association of long polyglycine tracts (GGN repeats) in exon 1 of the androgen receptor gene

with cryptorchidism and penile hypospadias in Iranian patients. J Androl 2007; **28**: 164.

25. Davis-Dao C, Koh CJ, Hardy BE et al: Shorter androgen receptor CAG repeat lengths associated with cryptorchidism risk among Hispanic white boys. J Clin Endocrinol Metab 2012; **97**: E393.

26. Ferlin A, Garolla A, Bettella A et al: Androgen receptor gene CAG and GGC repeat lengths in cryptorchidism. Eur J Endocrinol 2005; **152**: 419.

27. Sasagawa I, Suzuki Y, Tateno T et al: CAG repeat length of the androgen receptor gene in Japanese males with cryptorchidism. Mol Hum Reprod 2000; **6**: 973.

28. Silva-Ramos M, Oliveira JM, Cabeda JM et al: The CAG repeat within the androgen receptor gene and its relationship to cryptorchidism. Int Braz J Urol 2006; **32**: 330.

29. Yoshida R, Fukami M, Sasagawa I et al: Association of cryptorchidism with a specific haplotype of the estrogen receptor alpha gene: implication for the susceptibility to estrogenic environmental endocrine disruptors. J Clin Endocrinol Metab 2005; **90**: 4716.

30. Galan JJ, Guarducci E, Nuti F et al: Molecular analysis of estrogen receptor alpha gene AGATA haplotype and SNP12 in European populations: potential protective effect for cryptorchidism and lack of association with male infertility. Hum Reprod 2007; **22**: 444.

31. Wang Y, Barthold J, Figueroa E et al: Analysis of five single nucleotide polymorphisms in the ESR1 gene in cryptorchidism. Birth Defects Res A Clin Mol Teratol 2008; **82**: 482.

32. Elert A, Jahn K, Heidenreich A et al: Population-based investigation of familial undescended testis and its association with other urogenital anomalies. J Ped Urol 2005; **1**: 403.

33. Schnack TH, Zdravkovic S, Myrup C et al: Familial aggregation of cryptorchidism - A nationwide cohort study. Am J Epidemiol 2008; **167**: 1453.

34. Main KM, Skakkebaek NE and Toppari J: Cryptorchidism as part of the testicular dysgenesis syndrome: the environmental connection. Endocr Dev 2009; **14**:167.

35. Sharpe RM and Skakkebaek NE: Testicular dysgenesis syndrome: mechanistic insights and potential new downstream effects. Fertil Steril 2008; **89**: e33.

36. Virtanen HE and Adamsson A: Cryptorchidism and endocrine disrupting chemicals. Mol Cell Endocrinol 2012; **355**: 208.

37. Damgaard IN, Skakkebaek NE, Toppari J et al: Persistent pesticides in human breast milk and cryptorchidism. Environ Health Perspect 2006; **114**: 1133.

38. Fernandez MF, Olmos B, Granada A et al: Human exposure to endocrine-disrupting chemicals and prenatal risk factors for cryptorchidism and hypospadias: a nested case-control study. Environ Health Perspect 2007; **115**: 8.

39. Main KM, Mortensen GK, Kaleva MM et al: Human breast milk contamination with phthalates and alterations of endogenous reproductive hormones in infants three months of age. Environ Health Perspect 2006; **114**: 270.

40. Pierik FH, Burdorf A, Deddens JA et al: Maternal and paternal risk factors for cryptorchidism and hypospadias: a case-control study in newborn boys. Environ Health Perspect 2004; **112**:1570.

41. Weidner IS, Moller H, Jensen TK et al: Cryptorchidism and hypospadias in sons of gardeners and farmers. Environ Health Perspect 1998; **106**: 793.

42. Mamoulakis CH, Antypas S, Stamatiadou A et al: Cryptorchidism: seasonal variations in Greece do not support the theory of light. Andrologia 2002; **34**: 194.

43. Adams SV, Hastert TA, Huang Y et al: No association between maternal pre-pregnancy obesity and risk of hypospadias or cryptorchidism in male newborns. Birth Defects Res A Clin Mol Teratol 2011; **91**:241.

44. Hackshaw A, Rodeck C and Boniface S: Maternal smoking in pregnancy and birth defects: A systematic review based on 173 687 malformed cases and 11.7 million controls. Hum Reprod Update 2011; **17**: 589.

45. Dammgaard IN, Jensen TK, the Nordic Cryptorchidism Study Group et al: Cryptorchidism and maternal alcohol consumption during pregnancy. Environ Health Perspect 2007; **115**: 272.

46. Jensen MS, Bonde JP and Olsen J: Prenatal alcohol exposure and cryptorchidsim. Acta Paedriatrica 2007; **96**: 1681.

References

47. Standberg-Larsen K, Jensen MS, Ramlau-Hansen CH et al: Alcohol binge drinking during pregnancy and cryptorchidism. Hum Reprod 2009; **24**: 3211.

48. Mongraw-Chaffin ML, Cohn BA, Cohen RD et al: Maternal smoking, alcohol consumption, and caffeine consumption during pregnancy in relation to a son's risk of persistent cryptorchidism: a prospective study in the Child Health and Development Studies Cohort, 1959-1967. Am J Epidemiol 2008; **167**: 257.

49. Jensen MS, Rebordosa C, Thulstrup AM, et al. Maternal use of acetaminophen, ibuprofen, and acetylsalicylic acid during pregnancy and risk of cryptorchidism. Epidemology 2010; **21**: 779.

50. Kristensen DM, Hass U, Lesné L et al: Intrauterine exposure to mild analgesic is a risk factor for development of male reproductive disorders in human and rat. Hum Reprod 2011; **26**: 235.

51. Philippat C, Giorgis-Allemand L, Chevrier C et al: Analgesics during pregnancy and undescended testis. Epidemiology 2011; **22**: 747.

52. Snijder CA, Kortenkamp A, Steegers EAP et al: Intrauterine exposure to mild analgesics during pregnancy and the occurrence of cryptorchidism and hypospadia in the offspring: the Generation R Study. Hum Reprod 2012; **27**: 1191-1201.

53. Vidaeff AC and Sever LE: In utero exposure to environmental estrogens and male reproductive health: a systematic review of biological and epidemiologic evidence. Reprod Toxicol 2005; **20**: 5-20.

54. Martin O, Shialis T and Lester J: Testicular dysgenesis syndrome and the estrogen hypothesis: a quantitative meta-analysis. Cien Saude Colet 2008; **13**: 1601.

55. Barteczko KJ and Jacob MI: The testicular descent in human. Origin, development and fate of the gubernaculum Hunteri, processus vaginalis peritonei, and gonadal ligaments. Adv Anat Embryol Cell Biol 2000; **156**: III.

56. Sampaio FJ and Favorito LA: Analysis of testicular migration during the fetal period in humans. J Urol 1998; **159**: 540.

57. Berkowitz GS, Lapinski RH, Dolgin SE et al: Prevalence and natural history of cryptorchidism. Pediatrics 1993; **92**: 44.

58. Depue RH: Maternal and gestational factors affecting the risk of cryptorchidism and inguinal hernia. Int J Epidemiol 1984; **13**: 311.

59. Berkowitz GS, Lapinski RH, Godbold JH et al: Maternal and neonatal risk factors for cryptorchidism. Epidemiology 1995; **6**: 127.

60. Moller H and Skakkebaek NE: Testicular cancer and cryptorchidism in relation to prenatal factors: case-control studies in Denmark. Cancer Cause Control 1997; **8**: 904.

61. Thonneau PF, Gandia P and Mieusset R: Cryptorchidism: incidence, risk factors, and potential role of environment; an update. J Androl 2003; **24**: 155.

62. Jensen, MS, Toft G, Thulstrup AM et al: Cryptorchidism according to maternal gestational smoking. Epidemiology 2007; **18**: 220.

63. John Radcliffe Hospital Cryptorchidism Study Group: Cryptorchidism: a prospective study of 7500 consecutive male births, 1984-8. Arch Dis Child 1992; **67**: 892.

64. Berkowitz, GS, Lapinski RH, Dolgin SE et al: Prevalence and natural history of cryptorchidism. Pediatrics 1993; **92**: 44.

65. Smolko MJ, Kaplan GW and Brock WA: Location and fate of the nonpalpable testis in children. J Urol 1983; **129**: 1204.

66. Merguerian PA, Mevorach RA, Shortliffe LD et al: Laparoscopy for the evaluation and management of the nonpalpable testicle. Urology 1998; **51**: 3.

67. Denes FT, Saito FJ, Silva FA et al: Laparoscopic diagnosis and treatment of nonpalpable testis. Int Braz J Urol 2008; **34**: 329.

68. Abbas TO, Hayati A, Ismail A et al: Laparoscopic management of intra-abdominal testis: 5-year single-centre experience -A retrospective descriptive study. Minimally Invasive Surgery 2012.

69. Abolyosr A: Laparoscopic versus open orchiopexy in the management of abdominal testis: a descriptive study. Int J Urol 2006; **13**: 1421.

70. Alzahem A: Laparoscopy-assisted orchiopexy versus laparoscopic two-stage Fowler Stephens orchiopexy for nonpalpable testes: comparative study. Urol Ann 2013; **5**: 110.

71. Argos Rodríguez MD, Unda Freire A, Ruíz Orpez A

et al: Diagnostic and therapeutic laparoscopy for nonpalpable testis. Surg Endosc 2003; **17**: 1756.

72. Atawurah H: Role of laparoscopy in diagnosis and management of nonpalpable testes. World J Lap Surg 2011; **4**:73.

73. Baillie CT, Fearns G, Kitteringham L et al: Management of the impalpable testis: the role of laparoscopy. Arch Dis Child 1998; **79**: 419.

74. Bittencourt DG, Miranda ML, Moreira AP et al: The role of videolaparoscopy in the diagnostic and therapeutic approach of nonpalpable testis. Int Braz J Urol 2003; **29**: 345.

75. Brown RA, Millar AJW, Jee LD et al: The value of laparoscopy for impalpable testes. S Afr J Surg 1997; **35**: 70.

76. El Gohari MA: Non-descent of the testis: an overlooked laparoscopic finding. J Ped Urol 2008; **4**: 364.

77. Esposito C, Damiano R, Gonzalez Sabin MA et al: Laparoscopy-assisted orchidopexy: an ideal treatment for children with intra-abdominal testes. J Endourol 2002; **16**: 659.

78. Ferro F, Lais A and Gonzalez-Serva L: Benefits and afterthoughts of laparoscopy for the nonpalpable testis. J Urol 1996; **156**: 795.

79. Flett ME, Jones PF and Youngson GG: Emerging trends in the management of the impalpable testis. Br J Surg 1999; **86**: 1280.

80. Guiney EJ, Corbally M and Malone: Laparoscopy and the management of the impalpable testis. Br J Urol 1989; **63**: 313.

81. Hassan ME and Mustafawi A: Laparoscopy management of impalpable testis in children, new classification, lessons learned, and rare anomalies. J Lap & Advanced Surg Tech 2010; **20**: 265.

82. Holcomb GW, Brock JW, Neblett WW et al: Laparoscopy for the nonpalpable testis. Am Surg 1994; **60**: 143.

83. Humphrey GM, Najmaldin AS and Thomas DF: Laparoscopy in the management of the impalpable undescended testis. Br J Surg 1998; **85:** 983.

84. Hvistendahl GM and Poulsen EU: Laparoscopy for the impalpable testes: experience with 80 intra-abdominal testes. J Pediatr Urol 2009; **5**: 389.

85. Ismail K, Ashour M, El-Afifi M et al: Laparoscopy in the management of impalpable testis: series of 64 cases. World J Surg 2009; **33**: 1514.

86. Lima M, Bertozzi M and Ruggeri G: The nonpalpable testis: an experience of 132 consecutive videolaparoscopic explorations in 6 years. Pediatr Med Chir 2002; **24**: 37.

87. Mark SD and Davidson PJ: The role of laparoscopy in evaluation of the impalpable undescended testis. Aust N Z J Surg 1997; **67**: 332.

88. Moore RG, Perters CA, Bauer SB et al: Laparoscopic evaluation of the nonpalpable testis: a prospective assessment of accuracy. J Urol 1994; **151**: 728.

89. Moursy EE, Gamal W and Hussein MM: Laparoscopic orchiopexy for non-palpable testes: Outcome of two echniques. J Pediatr Urol 2011; **7:** 178.

90. Onal B and Kogan BA: Additional benefit of laparoscopy for nonpalpable testes: finding a contralateral patent processus. Urology 2008; **71**: 1059.

91. Papparella J, Romano M, Noviello C et al: The value of laparoscopy in the management of non-palpable testis. Ped Urol 2010; **6**: 550.

92. Radmayr C, Oswalk J, Schwentner C et al: Long-term outcome of laparoscopically managed nonpalpable testes. J Urol 2003; **170:** 1463.

93. Sheikh A, Mirza B, Ahmad S et al: Laparoscopic management of 128 undescended testes: our experience. Afr J Paediatr Surg 2012; **9**: 106.

94. Singh RR, Rajimwale A and Nour S: Laparoscopic management of impalpable testes: comparison of different techniques. Pediatr Surg Int 2011; **27**: 1327.

95. Tang PMY, Leung MWY, Chao NSY et al: Use of laparoscopy in the management of impalpable testis in children. Hong Kong Journal of Paediatrics 2009; **14**: 172.

96. Topuzlu Tekant G, Emir H, Eroglu E et al: Experience with laparoscopy in nonpalpable testis. Eur J Pediatr Surg 2001; **11**: 177.

97. Ueda N, Shiroyanagi Y, Suzuki H et al: The value of finding a closed internal ring on laparoscopy in unilateral nonpalpable testis. J Pediatr Surg 2013; **48**: 542.

98. Van Savage JG: Avoidance of inguinal incision in

laparoscopically confirmed vanishing testis syndrome. J Urol 2001; **166**: 1421.

99. Weiss RM and Seashore JH: Laparoscopy in the management of the nonpalpable testis. J Urol 1987; **138**: 382.

100. Yamazaki Y, Suzuki M, Shiroyanagi Y et al: Scrotal nubbins associated with blind-ending spermatic vessels and a normal vas deferens on laparoscopy. Int J Urol 2009; **16**: 902.

101. Ang CW and Forrest J: Diagnostic laparoscopy and management of the impalpable testis--a review of 10 years' practice at a non-paediatric specialist centre. J Pediatr Urol 2008; **4**: 214.

102. Cisek LJ, Peters CA, Atala A et al: Current findings in diagnostic laparoscopic evaluation of the nonpalpable testis. J Urol 1998; **160**: 1145.

103. Denes FT, Silva FAQ, Giron AM et al: Laparoscopic evaluation and treatment of the impalpable testis. Brazilian J Urol 2001; **27**: 380.

104. Diamond DA and Caldamone AA: The value of laparoscopy for 106 impalpable testes relative to clinical presentation. J Urol 1992; **148**: 632.

105. El-Anany F, Gad El-Moula M, Abded Moneim A et al: Laparoscopy for impalpable testis: classification -based management. Surg Endosc 2007; **21**: 449.

106. Elder JS: Laparoscopy for impalpable testes: significance of the patent processus vaginalis. J Urol 1994; **152**: 776.

107. Fukuzaki A, Tanahashi Y, Orikasa S et al: Laparoscopic examination for nonpalpable testes. Japanese Journal of Endourology and ESWL 1990; **3**: 66.

108. Galvin DJ and Bredin H: The role of laparoscopy in the management of the impalpable testicle. Ir J Med Sci 2002; **171**: 73.

109. Gheiler EL, Barthold JS and González R: Benefits of laparoscopy and the Jones technique for the nonpalpable testis. J Urol 1997; **158**: 1948.

110. Hay SA, Soliman HA, Abdel Rahman AH et al: Laparoscopic classification and treatment of the impalpable testis. Pediatr Surg Int 1999; **15**: 570.

111. Lowe DW, Brock W and Kaplan GW: Laparoscopy for localization of nonpalpable testes. J Urol 1984; **131**: 728.

112. Perovic S and Janic N: Laparoscopy in the diagnosis of non-palpable testes. Br J Urol 1994; **73**: 310.

113. Plotzker ED, Rushton HG, Belman AB et al: Laparoscopy for nonpalpable testes in childhood: is inguinal exploration also necessary when vas and vessels exit the inguinal ring? J Urol 1992; **148**: 635.

114. Tenenbaum SY, Lerner SE, McAleer IM et al: Preoperative laparoscopic localization of the nonpalpable testis: a critical analysis of a 10-year experience. J Urol 1994; **151**: 732.

115. Vaysse P: Laparoscopy and impalpable testis--a prospective multicentric study (232 cases). Eur J Pediatr Surg 1994; **4**: 329.

116. Hurwitz RS and Kaptein JS: How well does contralateral testis hypertrophy predict the absence of the nonpalpable testis? J Urol 2001; **165**: 588.

117. Rusnack SL, Wu HY, Huff DS et al: Testis histopathology in boys with cryptorchidism correlates with future fertility potential. J Urol 2003; **169**: 659.

118. Rusnack SL, Wu HY, Huff DS et al: The ascending testis and the testis undescended since birth share the same histopathology. J Urol 2002; **168**: 2590.

119. Park KH, Lee JH, Han JJ et al: Histological evidences suggest recommending orchiopexy within the first year of life for children with unilateral inguinal cryptorchid testis. Int J Urol 2007; **14**: 616.

120. Tasian GE, Hittelman AB, Kim GE et al: Age at orchiopexy and testis palpability predict germ and Leydig cell loss: clinical predictors of adverse histological features of cryptorchidism. J Urol 2009; **182**: 704.

121. Rabinowitz R and Hulbert WC Jr: Late presentation of cryptorchidism: the etiology of testicular re-ascent. J Urol 1997; **157**: 1892.

122. Donaldson KM, Tong SY and Hutson JM: Prevalence of late orchidopexy is consistent with some undescended testes being acquired. Indian J Pediatr 1996; **63**: 725.

123. Rao M, Wilkinson J and Benton DC: Screening for undescended testes. Arch Dis Child 1991; **66**: 934.

124. Mayr JM, Lawrenz K and Berghold A: Undescended testicles: an epidemiological review. Acta Paediatr 1999; **88**: 1089.

125. Guven A and Kogan BA: Undescended testis in older boys: further evidence that ascending testes are common. J Pediatr Surg 2008; **43**: 1700.

126. Stec AA, Thomas JC, DeMarco RT et al: Incidence of testicular ascent in boys with retractile testes. J Urol 2007; **178**: 1722.

127. Surgical Advisory Panel: Referral to pediatric surgical specialists. Pediatrics 2014; **133:** 350.

128. 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:** 4588.

129. McAleer IM, Packer MG, Kaplan GW et al: Fertility index analysis in cryptorchidism. J Urol 1995; **153**: 1255.

130. Cortes D, Thorup JM and Visfeldt J: Cryptorchidism: aspects of fertility and neoplasms. A study including data of 1,335 consecutive boys who underwent testicular biopsy simultaneously with surgery for cryptorchidism. Horm Res 2001; **55**: 21.

131. Hadziselimovic F, Thommen L, Girard J et al: The significance of postnatal gonadotropin surge for testicular development in normal and cryptorchid testes. J Urol 1986; **136**: 274.

132. Hadziselimovic F and Herzog B: Importance of early postnatal germ cell maturation for fertility of cryptorchid males. Horm Res 2001; **55**: 6.

133. Nistal M, Riestra ML and Paniagua R: Correlation between testicular biopsies (prepubertal and postpubertal) and spermiogram in cryptorchid men. Hum Pathol 2000, **31**: 1022.

134. Hadziselimovic F, Herzog B and Buser M: Development of cryptorchid testes. Eur J Pediatr 1987; **146** Suppl 2: S8.

135. Hack WW, Meijer RW, Van Der Voort-Doedens LM et al: Previous testicular position in boys referred for an undescended testis: further explanation of the late orchidopexy enigma? BJU Int 2003; **92**: 293.

136. Hack WW, Sijstermans K, van Dijk J et al: Prevalence of acquired undescended testis in 6-year, 9-year and 13-year-old Dutch schoolboys. Arch Dis Child 2007; **92**: 17.

137. Tasian GE, Zaid H, Cabana MD et al: Proximal hypospadias and risk of acquired cryptorchidism. J Urol 2010; **184**: 715.

138. Sijstermans K, Hack WW, van der Voort-Doedens LM et al: Puberty stage and spontaneous descent of acquired undescended testis: implications for therapy? Int J Androl 2006; **29**: 597.

139. White PC: Neonatal screening for congenital adrenal hyperplasia. Nat Rev Endocrinol 2009; **5**: 490.

140. Tasian GE, Yiee JH and Copp HL: Imaging use and cryptorchidism: determinants of practice patterns. J Urol 2011; **185**: 1882.

141. Tasian GE and Copp HL: Diagnostic performance of ultrasound in nonpalpable cryptorchidism: a systematic review and meta-analysis. Pediatrics 2011; **127**: 119.

142. Kullendorff CM, Hederstrom E and Forsberg L: Preoperative ultrasonography of the undescended testis. Scand J Urol Nephrol 1985;**19**: 13.

143. Kullendorff CM, Hederstrom E and Forsberg L: Preoperative ultrasonography of the undescended testis. Scand J Urol Nephrol 1985; **19**:13.

144. Kanemoto K, Hayashi Y, Kojima Y et al: Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of non-palpable testis. Int J Urol 2005; **12**: 668.

145. Kantarci M, Doganay S, Yalcin A et al: Diagnostic performance of diffusion-weighted MRI in the detection of nonpalpable undescended testes: comparison with conventional MRI and surgical findings. AJR Am J Roentgenol 2010; **195**: W268.

146. Maghnie M, Vanzulli A, Paesano P et al: The accuracy of magnetic resonance imaging and ultrasonography compared with surgical findings in the localization of the undescended testis. Arch Pediatr Adolesc Med 1994; **148**: 699.

147. Miyano T, Kobayashi H, Shimomura H et al: Magnetic resonance imaging for localizing the nonpalpable undescended testis. J Pediatr Surg 1991; **26**: 607.

148. Yeung CK, Tam YH, Chan YL et al: A new management algorithm for impalpable undescended testis with gadolinium enhanced

magnetic resonance angiography. J Urol 1999; **162**: 998.

149. Tasian GE, Copp HL and Baskin LS: Diagnostic imaging in cryptorchidism: utility, indications, and effectiveness. J Pediatr Surg 2011; **46**: 2406.

150. Boisen KA, Kaleva M, Main KM et al: Difference in prevalence of congenital cryptorchidism in infants between two Nordic countries. Lancet 2004; **363**: 1264.

151. Bartone FF, Huseman CA, Maizels M et al: Pitfalls in using human chorionic gonadotropin stimulation test to diagnose anorchia. J Urol 1984; **132:** 563.

152. Grinspon RP, Ropelato MG, Bedecarras P et al: Gonadotrophin secretion pattern in anorchid boys from birth to pubertal age: pathophysiological aspects and diagnostic usefulness. Clin Endocrinol (Oxf) 2012; **76**: 698.

153. Brauner R, Neve M, Allali S et al: Clinical, biological and genetic analysis of anorchia in 26 boys. PloS one 2011; **6**: e23292.

154. Teo AQ, Khan AR, Williams MP et al: Is surgical exploration necessary in bilateral anorchia? J Pediatr Urol 2013; **9**: e78.

155. Mayr J, Rune GM, Holas A et al: Ascent of the testis in children. Eur J Pediatr 1995; **154**: 893.

156. Bright Futures/American Academy of Pediatrics: Recommendations for preventative pediatric health care. 2014.

157. Agarwal PK, Diaz M and Elder JS: Retractile testis--is it really a normal variant? J Urol 2006; **175**: 1496.

158. Bae JJ, Kim BS and Chung SK: Long-term outcomes of retractile testis. Korea J Urol 2012; **53**: 649.

159. La Scala GC and Ein SH: Retractile testes: an outcome analysis on 150 patients. J Pediatr Surg 2004; **39**: 1014.

160. Marchetti F, Bua J, Tornese G et al: Management of cryptorchidism: a survey of clinical practice in Italy. BMC Pediatr 2012; **12**: 4.

161. Borkenstein M: Intranasal LH-RH for cryptorchidism: response to initial treatment and to treatment after relapse. Eur J Pediatr 1987; **146:** S42.

162. Hocht B: LH-RH treatment for cryptorchidism: Randomized study and 10-year follow-up results. Eur J Pediatr 1987; **146:** S44.

163. Illig R, Bucher H and Prader A: Success, relapse and failure after intranasal LHRH treatment of cryptorchidism in 55 prepubertal boys. Eur J Pediatr 1980; **133:** 147.

164. Saggese G, Ghirri P, Gabrielli S et al: Hormonal therapy for cryptorchidism with a combination of human chorionic gonadotropin and follicle-stimulating hormone. Success and relapse rate. Am J Dis Child 1989; **143:** 980.

165. Schwarz HP, Aebi S and Perisic M: Success and relapse rate after treatment of cryptorchidism with intranasal LHRH. Acta Paediatr Scand 1985; **74:** 274.

166. Waldschmidt J, el-Dessouky M and Priefer A: Therapeutic results in cryptorchidism after combination therapy with LH-RH nasal spray and hCG. Eur J Pediatr 1987; **146;** S31.

167. Wit JM, Delemarre-Van de Waal HA, Bax NM et al: Effect of LHRH treatment on testicular descent and hormonal response in cryptorchidism. Clin Endocrinol (Oxf) 1986; **24**: 539.

168. Bigler JA, Hardy LM and Scott HV: Cryptorchidism treated with gonadotropic principle. Am J Dis Child 1938; **55**: 273.

169. Job JC, Canlorbe P, Garagorri JM et al: Hormonal therapy of cryptorchidism with human chorionic gonadotropin. Urol Clin North Am 1982; **9**: 405.

170. Rajfer J, Handelman DJ, Swerdloff RS et al: Hormonal therapy of cryptorchidism. N Engl J Med 1986; **314**: 466.

171. Hjertkvist M, Läckgren G, Plöen L et al: Does hCG treatment induce inflammation-like changes in undescended testes in boys. J Pediatr Surg 1993; **28**: 254.

172. Heiskanen P , Billig H, Toppari J et al: Apoptotic cell death in the normal and cryptorchid human testis: the effect of human chorionic gonadotropin on testicular cell survival. Pediatr Res 1996; **40**: 351.

173. Waldschmidt J, Doede T and Vygen I: The results of 9 years of experience with a combined treatment with LH-RH and HCG for cryptorchidism. Eur J Pediatr 1993; **152**(suppl 2): S34.

References

174. Lala R, Matarazzo P, Chiabotto P et al: Combined therapy with LHRH and HCG in cryptorchid infants. Eur J Pediatr 1993; **152** (suppl 2): S31.

175. Cortes D, Thorup J and Visfeldt J: Hormonal treatment may harm the germ cells in 1 to 3-year old cryptorchid boys. J Urol 2000; **163**: 1290.

176. Christiansen P, Muller J, Buhl S et al: Treatment of cryptorchidism with human chorionic gonadotropin or gonadotropin releasing hormone. A double-blind controlled study of 243 boys. Horm Res 1988; **30**: 187.

177. Olsen LH, Genster HG, Mosegaard A et al: Management of the non-descended testis: doubtful value of luteinizing-hormone-releasing-hormone (LHRH). A double-blind, placebo-controlled multicentre study. Int J Androl 1992 Apr; **15**: 135.

178. Bertelloni S, Baroncelli GI, Ghirri P et al: Hormonal treatment for unilateral inguinal testis: comparison of four different treatments. Horm Res 2001; **55**: 236.

179. Bica DT and Hadziselimovic F: Buserelin treatment of cryptorchidism: a randomized, double-blind, placebo-controlled study. J Urol 1992; **148**: 617.

180. Bica DT and Hadziselimovic F: The behavior of epididymis, processus vaginalis and testicular descent in cryptorchid boys treated with buserelin. Eur J Pediatr 1993; **152**: S38.

181. De Muinck Keizer-Schrama SM, Hazebroek FW, Drop SL et al: LH-RH nasal spray treatment for cryptorchidism. A double-blind, placebo-controlled study. Eur J Pediatr 1987; **146**: S35.

182. De Muinck Keizer-Schrama SM, Hazebroek FW, Matroos AW et al: Double-blind, placebo-controlled study of luteinising-hormone-releasing-hormone nasal spray in treatment of undescended testes. Lancet 1986; **1**: 876.

183. Hazebroek FW, de Muinck Keizer-Schrama SM, van Maarschalkerweerd M et al: Why luteinizing-hormone-releasing-hormone nasal spray will not replace orchiopexy in the treatment of boys with undescended testes. J Pediatr Surg 1987; **22**: 1177.

184. Forest MG, David M, David L et al: Undescended testis: comparison of two protocols of treatment with human chorionic gonadotropin. Effect on testicular descent and hormonal response. Horm Res 1988; **30**: 198.

185. Hagberg S and Westphal O: Treatment of undescended testes with intranasal application of synthetic LH-RH. Eur J Pediatr 1982; **139**: 285.

186. Hesse V and Fischer G: Three injections of human chorionic gonadotropin are as effective as ten injections in the treatment of cryptorchidism. Horm Res 1988; **30**: 193.

187. Karpe B, Eneroth P and Ritzen EM: LHRH treatment in unilateral cryptorchidism: effect on testicular descent and hormonal response. J Pediatr 1983; **103**: 892.

188. Hadziselimovic F and Herzof B: Treatment with a luteinizing hormone-releasing hormone analogue after successful orchiopexy markedly improves the chance of fertility later in life. J Urol 1997; **158**: 1193.

189. Miller OF, Stock JA, Cilento BG et al: Prospective evaluation of human chorionic gonadotropin in the differentiation of undescended testes from retractile testes. J Urol 2003; **169**: 2328.

190. Aycan Z, Ustunsalih-Inan Y, Cetinkaya E et al: Evaluation of low-dose hCG treatment for cryptorchidism. Turk J Pediatr 2006; **48:** 228.

191. Esposito C, De Lucia A, Palmieri A et al: Comparison of five different hormonal treatment protocols for children with cryptorchidism. Scand J Urol Nephrol 2003; **37**: 246.

192. Huff DS, Snyder HM, Rusnack SL et al: Hormonal therapy for the subfertility of cryptorchidism. Horm Res 2001; **55**: 38.

193. Schwentner C, Oswald J, Kreczy A et al: Neoadjuvant gonadotropin-releasing hormone therapy before surgery may improve the fertility index in undescended testes: A prospective randomized trial. J Urol 2005; **173**: 974.

194. Cortes D, Thorup JM and Beck BL: Quantitative histology of germ cells in the undescended testes of human fetuses, neonates and infants. J Urol 1995; **154:** 1188.

195. McAleer IM, Packer MG, Kaplan GW et al: Fertility index analysis in cryptorchidism. J Urol 1995; **153**: 1255.

196. Wood HM and Elder JS: Cryptorchidism and testicular cancer: separating fact from fiction. J Urol 2009; **181**: 452.

197. Kollin C, Karpe B, Hesser U et al: Surgical treatment of unilaterally undescended testes:

testicular growth after randomization to orchiopexy at age 9 months or 3 years. J Urol 2007; **178**: 1589.

198. Coughlin MT, Bellinger MF and Lee PA: Age at unilateral orchiopexy: effect on hormone levels and sperm count in adulthood. J Urol 1999; **162**: 986.

199. Miller KD, Coughlin MT and Lee PA: Fertility after unilateral cryptorchidism. Paternity, time to conception, pretreatment testicular location and size, hormone and sperm parameters. Horm Res 2001; **55**: 249.

200. McAleer IM, Packer MG, Kaplan GW et al: Fertility index analysis in cryptorchidism. J Urol 1995; **153**: 1255.

201. Walsh TJ, Dall'Era MA, Croughan MS et al: Prepubertal orchiopexy for cryptorchidism may be associated with lower risk of testicular cancer. J Urol 2007; **178**: 1440.

202. Tuazon E, Banks K, Koh CJ et al: Re: Prepubertal orchiopexy for cryptorchidism may be associated with lower risk of testicular cancer. J Urol 2009; **182**: 783.

203. Pettersson A, Richiardi L, Nordenskjold A et al: Age at surgery for undescended testis and risk of testicular cancer. N Engl J Med 2007; **356**: 1835.

204. Bianchi A and Squire BR: Trans-scrotal orchidopexy: orchidopexy revised. Pediatr Surg Int 1989; **4**: 189.

205. Na SW, Kim SO, Hwang EC et al: Single Scrotal Incision Orchiopexy for children with palpable low-lying undescended testis: Early outcome of a prospective randomized controlled study. Korean J Urol 2011; **52**: 637.

206. Al-Mandil M, Khoury AE, El-Hout Y et al: Potential complications with the prescrotal approach for the palpable undescended testis? A comparison of single prescrotal incision to the traditional inguinal approach. J Urol 2008; **180**: 686.

207. Koyle MA, Walsh R, Caruso A et al: Scrotal (Bianchi) approach to patent processus vaginalis in children. Tech Urol 1999; **5**: 95.

208. Stec AA, Tanaka ST, Adams MC et al: Orchiopexy for intra-abdominal testes: factors predicting success. J Urol 2009; **182:** 1917.

209. Baker LA, Docimo SG, Surer I et al: A multi-institutional analysis of laparoscopic orchidopexy. BJU Int 2001; **87:** 484.

210. Chang B, Palmer LS and Franco I: Laparoscopic orchidopexy: a review of a large clinical series. BJU Int 2001; **87:** 490.

211. Dhanani NN, Cornelius D, Gunes A e al: Successful outpatient management of the nonpalpable intra-abdominal testis with staged Fowler-Stephens orchiopexy. J Urol 2004; **172:** 2399.

212. Kim J, Min GE and Kim KS: Laparoscopic orchiopexy for a nonpalpable testis. Korean J Urol 2010; **51:** 106.

213. Ferro F, Spagnoli A, Zaccara A et al: Is preoperative laparoscopy useful for impalpable testis? J Urol 1999; **162**: 995.

214. Chandrasekharam VV: Laparoscopy vs inguinal exploration for nonpalpable undescended testis. Indian J Pediatr 2005; **72**: 1021.

215. Escarcega-Fujigaki P, Rezk GHP, Huerta-Murrieta E et al: Orchiopexy-laparoscopy or traditional surgical technique in patients with an undescended palpable testicle. Journal of Laparoendoscopic and Advanced Surgical Techniques 2011;**21**:185.

216. Lintula H, Kokki H, Eskelinen M et al. Laparoscopic versus open orchidopexy in children with intra-abdominal testes. J Laparoendosc Adv Surg Tech A 2008; **18**: 449.

217. Steinhardt GF, Kroovand RL and Perlmutter AD: Orchiopexy: planned 2-stage technique. J Urol 1985; **133:** 434.

218. Chang M and Franco I: Laparoscopic Fowler-Stephens orchiopexy: the Westchester Medical Center experience. J Endourol 2008; **22:** 1315.

219. Comploj E, Mian M, Koen M et al: Single- vs. Two-stage fowler-stephens orchidopexy: Are two operations better than one? A retrospective, single -institutional critical analysis. Curr Urol 2011; **5:** 12.

220. Belman AB and Rushton HG: Is the vanished testis always a scrotal event? BJU Int 2001; **87**: 480.

221. Boeckx W, Bereecken R and Depuydt K: Microsurgery for intra-abdominal testicular retention. Eur J Obstet Gynecol Reprod Biol 1998; **81**: 191.

References

222. Bukowski TP, Wacksman J, Billmire DA et al: Testicular autotransplantation: a 17-year review of an effective approach to the management of the intra-abdominal testis. J Urol 1995; **154**: 558.

223. Frey P and Bianchi A: Microvascular autotransplantation of intra-abdominal testes. Prog Pediatr Surg 1989; **23**: 115-25.

224. Oesterwitz H and Fahlenkamp D: Microsurgical technique and results of testicular autotransplantation in children--essential venous anastomosis. Int Urol Nephrol 1993; **6**: 587.

225. Wollach Y, Shaher E, Schachter A et al: Fertility and sexual development after bilateral orchiopexy for cryptorchidism. Isr J Med Sci 1980; **16**: 707.

226. Mack WSL: Discussion on male fertility. Proc R Soc Med 1953; **46**: 840.

227. Cromie WJ: Cryptorchidism and malignant testicular disease, in Hadziselimovic F (ed): Cryptorchidism: Management and Implications. New Yeok, Springer-Verlag, 1983; 83.

228. Swerdlow A, Higgins C and Pike M: Risk of testicular cancer in a cohort of boys with cryptorchidism. BMJ 1997; **314**: 1507.

229. Campbell H: The incidence of malignant growth of the undescended testis: a reply and re-evaluation. J Urol 1959; **81**: 663.

230. Johnson D, Woodhead D, Pohl D et al: Cryptorchidism and tumorigenesis. Surgery 1968; **63**: 919.

231. Walsh TJ, Dall'Era MA, Croughan MS et al: Prepubertal orchiopexy for cryptorchidism may be associated with lower risk of testicular cancer. J Urol 2007; **178**: 1440.

232. Pettersson A, Richiardi L, Nordenskjold A et al: Age at surgery for undescended testis and risk of testicular cancer. N Engl J Med. 2007; **356**: 1835.

233. Bremhol RT, Ingerslev HJ and Hostrup H: Bilateral spontaneous descent of the testis after the age of 10: subsequent effects on fertility. Br J Surg 1988; **75**: 820.

234. Gilhooly PE, Meyers F and Lattimer JK: Fertility prospects for children with cryptorchidism. Am J Dis Child 1984; **138**: 940.

235. Fallon B and Kennedy TJ: Long-term follow-up of fertility in cryptorchid patients. Urology 1985; **25**: 502.

236. Gracia J, Sánchez Zalabardo J, Sánchez García J et al: Clinical, physical, sperm and hormonal data in 251 adults operated on for cryptorchidism in childhood. BJU Int 2000; **85**: 1100.

237. Trsinar B and Muravec UR: Fertility potential after unilateral and bilateral orchidopexy for cryptorchidism. World J Urol 2009; **27**: 513.

238. Lee PA, O'Leary LA, Songer NJ et al: Paternity after unilateral cryptorchidism: A controlled study. Pediatrics 1996; **98**: 676.

239. Lee PA, Coughlin MT: A single testis: Paternity assessment after presentation as unilateral cryptorchidism. J Urol 2002; **168**: 1680.

240. Lee PA, Coughlin MT and Bellinger MF: Paternity and hormone levels after unilateral cryptorchidism: Association with pretreatment testicular location. J Urol 2000; **164**: 1697.

241. Kraft KH, Canning DA, Snyder HM et al: Undescended testis histology correlation with adult hormone levels and semen analysis. J Urol 2012; **188**: 1429.

242. Cortes D and Thorup J: Histology of testicular biopsies taken at operation for bilaterally maldescended testes in relation to fertility in adulthood. Br J Urol 1990; **68**: 285.

243. Cortes D, Thorup JM and Lindenberg S: Fertility potential after unilateral orchiopexy: Simultaneous testicular biopsy and orchiopexy in a cohort of 87 patients. J Urol 1996; **155**: 1096.

244. Cortes D, Thorup JM and Lindenberg S: Fertility potential after unilateral orchiopexy: An age-independent risk of subsequent infertility when biopsies at surgery lack germ cells. J Urol 1996; **156**: 217.

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CONFLICT OF INTEREST DISCLOSURES

All panel members completed COI disclosures. Relationships that have expired (more than one year old) since the panel’s initial meeting, are listed. Those marked with (C) indicate that compensation was received; relationships designated by (U) indicate no compensation was received.

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While these guidelines do not necessarily establish the standard of care, AUA seeks to recommend and to encourage compliance by practitioners with current best practices related to the condition being treated. As medical knowledge expands and technology advances, the guidelines will change. Today these evidence-based guidelines statements represent not absolute mandates but provisional proposals for treatment under the specific conditions described in each document. For all these reasons, the guidelines do not pre-empt physician judgment in individual cases.

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