World J Urol (2006) 24: 231–239
DOI 10.1007/s00345-006-0056-4

TOPIC PAPER

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Results of orchiopexy for the undescended testis

Received: 4 January 2006 / Accepted: 26 January 2006 / Published online: 5 May 2006

Abstract The undescended testis is one of the most common congenital abnormalities of the genitourinary system. Outcomes of orchiopexy include (1) having a viable, palpable testis in the scrotum, (2) fertility, as measured by paternity rates or semen analysis in adulthood and (3) risk of testicular cancer. Multiple operative techniques have been described and are associated with various success rates. In the past decade, success of orchiopexy for inguinal testes has been >95%. For abdominal testes, success for orchiopexy has been >85–90% in most series with single stage orchiopexy or two stage Fowler–Stephens orchiopexy, both with open surgical or laparoscopic technique. However, having a palpable testis in the scrotum does not assure fertility, as there are iatrogenic factors that may adversely affect the outcome. In adult men with a history of unilateral orchiopexy, fertility is nearly normal, but is significantly reduced following bilateral orchiopexy. The risk of testicular carcinoma is increased by a factor of 3.7 to 7.5 times. Tumor type is most commonly seminoma if the testis is undescended, whereas tumors that occur following orchiopexy are much more likely to be nonseminomatous.

Keywords Testis · Cryptorchidism · Surgery · Testis tumor · Infertility

Introduction

Approximately 1–2% of boys have an undescended testis, with 80–90% unilateral and 10–20% bilateral, depending on the clinical series. Although cryptorchidism is one of the most common congenital anomalies of the genitourinary system, its pathogenesis is uncertain. While most boys with cryptorchidism are diagnosed at birth, an increasing number are being diagnosed at a later age with an ascending testis [1]. Boys with an undescended testis have an increased risk of infertility, testicular cancer, testicular torsion, and inguinal hernia [2]. The goal of surgical therapy is to minimize these risks.

By 6 to 8 months of age, the undescended testis shows delayed germ cell development and maturation, specifically in the transformation of gonocytes into Ad spermatogonia, and delayed appearance of primary spermatocytes. These changes are progressive, and at puberty, germ cell aplasia is the norm [3]. Furthermore, the contralateral descended testis shows similar changes, though not as severe, beginning at 7 years of age [4]. Consequently, orchiopexy by 9 to 12 months is recommended [2].

Undescended testes may be inguinal, ectopic (superficial inguinal pouch or perineal), gliding, or abdominal. Some boys have a testis that is abdominal, but which can be pushed into the upper inguinal canal, termed a peeping testis. In boys with a nonpalpable testis, approximately half are abdominal or high inguinal, and the rest are atrophic secondary to testicular torsion in utero [5]. Although the undescended testis is thought to be congenital, an increasing number seem to have an ascending testis, in which the testis originally was found to be in a scrotal position, and with longitudinal growth, the testis moves to an undescended position [1]. Many of these boys are diagnosed with a retractile (descended) testis and over time it becomes undescended [6]. Boys with a congenital undescended testis typically have an inguinal hernia.

The goal of orchiopexy is to move the testis into the scrotum while preserving the arterial flow, and thereby maximize the chances for fertility, as well as correct the associated inguinal hernia. Numerous techniques of surgical correction have been described, and these often vary with the position of the undescended testis.

Outcomes of orchiopexy include (1) having a viable, palpable testis in the scrotum, occasionally with confir-

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mation by Doppler sonography, (2) fertility, as measured by paternity rates or semen analysis in adulthood; and (3) risk of testicular cancer.

Surgical technique

Inguinal orchiopexy

The main goal of surgical treatment of cryptorchidism is to establish a scrotal position of the testis without iatrogenic atrophy. Multiple operative techniques have been described and are associated with various success rates. These are summarized in Table 1.

Inguinal orchiopexy is the most common surgical approach to undescended testes. Through an inguinal incision, the testis is mobilized from within the tunica vaginalis. Typically, there is a patent processus vaginalis (hernia sac). The limiting factor in moving the testis into the scrotum is the length of the testicular artery and vein. Transecting the hernia sac and separating it from the cord structures often allows significant testicular mobilization. Division of the longitudinal cremasteric fibers running along the spermatic cord as well as dividing the external spermatic fibers and transversalis fascia generally free up the spermatic cord sufficiently to allow the testis to reach the scrotum [7]. If the spermatic cord is too short, however, then a Prentiss maneuver may be necessary, in which the testis and spermatic cord are moved medial to the inguinal canal. This technique significantly shortens the distance that the testis must travel to reach the scrotum by changing an angulated route to a much more direct route to the scrotum. Generally, the Prentiss maneuver is accomplished by taking down the floor of the inguinal canal, moving the spermatic cord to the medial aspect of the canal, and reclosing the floor of the inguinal canal.

The prescrotal (Bianchi) orchiopexy involves making an incision along the edge of the scrotum, mobilizing the testis and spermatic cord, repairing the inguinal hernia, if present, and placing the testis in the scrotum [8] (Fig. 1). The advantage of this approach is that the testis and spermatic cord often can be mobilized sufficiently for the testis to reach the scrotum through a single incision, with less post-operative pain and shorter operative time. With retraction of the superior aspect of the wound, often the hernia can be repaired also. If mobilization of the spermatic cord is inadequate through this incision, then an inguinal incision can be made. This technique is ideal for the ascending or ectopic testis located in the superficial inguinal pouch. It also seems ideal for the obese patient, in whom inguinal orchiopexy must be done through a larger incision.

Abdominal orchiopexy

When the testis is abdominal, it is usually anchored at the internal inguinal ring by the gubernaculums and there is a patent processus vaginalis. In contrast, in boys with prune belly syndrome, the testes are higher because no gubernaculum is present. With an abdominal testis, the inguinal approach usually is unsuccessful.

The abdominal testis generally needs more mobilization and a Prentiss maneuver. Ideally, the testicular blood supply should be preserved. One approach is the Jones technique, which involves an abdominal incision and extensive retroperitoneal dissection of the vascular pedicle [9].

The standard two-stage orchiopexy involves mobilizing the abdominal testis as much as possible, waiting 6 months, and then performing the orchiopexy a second time. Some surgeons wrap the testis in a silastic sheath following the first stage, to make it easier to identify the testis during the second stage. It is possible that mobilizing the testis and vessels stimulates growth factors in the vascular pedicle that allow the testis to reach the scrotum during the second stage. The advantage is that the testicular artery is preserved. The disadvantage is that during the second stage, the reproductive tract, including the vas deferens and epididymis, may be injured.

The Fowler–Stephens orchiopexy is utilized for boys in whom the testicular artery and vein are too short to allow the testis to reach the scrotum. Originally described for the abdominal testis with a long-looping vas deferens, the technique involves clamping and transecting the testicular vessels. Ideally, there is sufficient collateral arterial flow through the deferential (vasal) artery to allow the testis to survive. It is generally performed as a single stage procedure. Maintaining a strip of peritoneum on the vessels increases the likelihood of preserving the integrity of the vessels. Unfortunately, the deferential artery is often so small that it goes into vasospasm and the testis atrophies.

Table 1 Success rates of orchiopexy for inguinal or ectopic testes

Series	No.	Procedure	Success
Docimo [19]	1,566	Inguinal orchiopexy	1,388/1,566 (88.6%)
Clarnette et al. [24]	25	Prescrotal orchiopexy (Bianchi)	25/25 (100%)
Caruso et al. [20]	60	Prescotal orchiopexy (Bianchi)	58/60 (96.6%)
Parsons et al. [23]	71	Prescrotal orchiopexy (Bianchi)	71/71 (100%)
Russinko et al. [25]	78	Prescrotal orchiopexy (Bianchi)	77/78 (98.8%)
Rajimwale et al. [21]	100	Prescrotal orchiopexy (Bianchi)	99/100 (99%)
Dayanc et al. [22]	72	Prescrotal orchiopexy (Bianchi)	72/72 (100%)

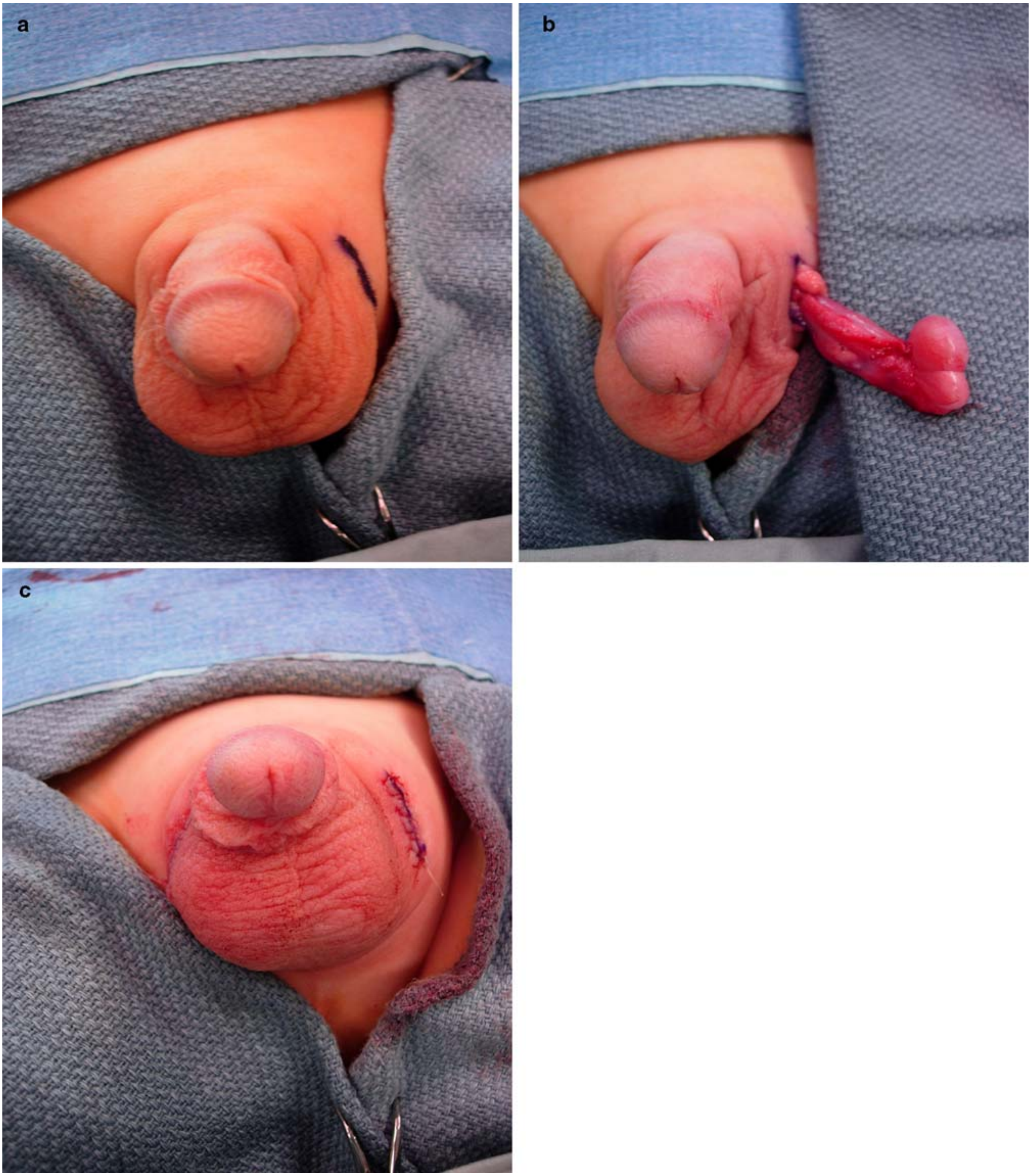

Fig. 1 Technique of prescrotal orchiopexy. Patient has left ectopic testis. **a** Incision made along the superolateral border of left hemiscrotum. **b** Testis exposed and spermatic cord mobilized. **c** Testis placed in dartos pouch

To improve the results, two modifications to the Fowler–Stephens orchiopexy have been described. The two-stage Fowler–Stephens orchiopexy involves ligating the testicular artery and vein, leaving the testis in situ, and then waiting for 6 months to mobilize the testis and then perform the orchiopexy. The advantage of this approach is that the undescended testis is allowed to develop collateral blood flow through the deferential artery with significantly reduced risk of vasospasm [10]. The effect of the staged Fowler–Stephens orchiopexy on testicular function has been studied.

Corbally et al. [11] demonstrated a 40% rate of testicular atrophy and a 46% decrease in testicular volume for abdominal or canalicular testes, with similar decrease in testicular volume for infracanalicular testes (43%), but no testicular atrophy. Sahin et al. [12] compared one- and two-stage orchiopexy in patients with bilateral nonpalpable testes. All patients had normal serum testosterone levels following the procedure, with 33% of patients in the two-stage orchiopexy group experiencing 30% testicular volume reduction, and 25% of patients in the one-stage orchiopexy group demonstrating 40% volume decrease. In contrast, Rosito et al. [13] found that although testicular size was preserved 6 months after ligation of the vessels, there was a significant reduction in number of spermatogonia and seminiferous tubular volume [14]. The second modification involves low spermatic vessel ligation. This single stage procedure takes into account direct collateral channels between the vasal artery and testicular artery just superior to the testis. By dividing the testicular artery close to the testis, blood flow to the testis is more likely to be maintained.

Laparoscopic or laparoscopic-assisted orchiopexy is being used in many centers in boys with an abdominal or peeping undescended testis. Virtually any aspect of the abdominal orchiopexy can be performed. In some cases, the first step of a two-stage Fowler–Stephens orchiopexy (vascular clipping) is performed, whereas in other cases the full abdominal orchiopexy with vessel preservation, single stage Fowler–Stephens orchiopexy, or both the first and second stages of the Fowler–Stephens procedure are performed using laparoscopic equipment.

Microvascular orchiopexy has been described for treatment of high intra-abdominal testes. This technique involves division of the testicular vessels and microscopic vascular anastomosis of the testicular artery and vein to the inferior epigastric vessels. This procedure is performed at only a few centers, because other procedures are efficacious and few pediatric urologists or pediatric general surgeons are skilled in microvascular surgery.

Techniques of testicular fixation

Two distinct surgical techniques of testicular fixation exist. Classic transfixation orchiopexy involves fixation of the testis to the scrotal wall by passing a suture through the tunica albuginea. In some cases, an external pledget is also used. In contrast, dartos pouch orchiopexy consists of the creation of a window in the dartos fascia, into which the testicle is passed, following by closure of the window [24].

A significant decrease in testicular weight as well as increased numbers of diploid cell fractions were demonstrated in animals undergoing transfixation orchiopexy compared to the dartos pouch technique [15]. Additionally, significant local inflammatory reaction was observed in animals that underwent suture fixation, regardless of suture size or material [16]. Pul et al. [17] observed abscess formation of 18.1, 36 and 72.7% when using polyglycolic acid, nylon or chromic suture, respectively. Additionally, complete absence of spermatogenesis was noted in the chromic fixed group, while spermatogenesis was normal in 72% of the polyglycolic acid and 18.1% of the nylon group. Alternatively, no abscess formation was noted in the dartos pouch group, and spermatogenesis was normal in 90.9% of the testes.

These experimental findings have been translated into increased infertility. Coughlin et al. [18] studied the relationship between parenchymal testicular suture and failure to conceive a child for 1 year or longer among formerly cryptorchid men. Testicular suture was strongly related to infertility, with a relative risk (RR) of 7.56, compared to bilateral cryptorchidism (RR 5.51) and varicocele (RR 4.72). These data strongly favor the use of the dartos pouch technique.

Anatomic testicular position: results of orchiopexy

One method of assessing results of orchiopexy is by assessing testicular position and size. Testicular atrophy is the most significant complication of orchiopexy. The more proximal the anatomical position of the testis, the lower the success rate [19]. Ischemic injury leading to testicular atrophy can be caused by over-skeletonization of testicular vessels, postoperative edema, or inflammation.

The largest review of the success rates of orchiopexy was performed by Docimo [19], who performed an extensive analysis of various techniques of orchiopexy. This analysis, published in 1995, compared published success rates in 64 articles including more than 8,000 undescended testes based on testicular position and technique. In addition, results in studies published before and after 1985 as well as boys older and younger than 6 years were compared. Fertility was not reviewed.

Inguinal testes (Table 1)

Inguinal orchiopexy—In the review by Docimo, the overall success rate was 88.6% (19). The success rate was higher in boys younger than 6 years. In addition, the success rate in studies published after 1985 was 91.2%, although it was not statistically significantly higher than in older studies. Currently, most pediatric urologists expect a success rate >95% for inguinal orchiopexy. It is likely that with subspecialization in pediatric urology, success rates of orchiopexy will improve.

Prescrotal orchiopexy—Following the initial report of this technique, the Bianchi orchiopexy has been performed in an increasing number of centers. Success rates have been high. In the report by Caruso et al. [20], only 4/60 needed an inguinal incision. In a more recent study from the same institution, only 6% underwent conversion to an inguinal approach [21]. Similarly, in the report by Dayanc et al. [22], only 4/72 (5.6%) needed an inguinal approach. In contrast, in the report by Parsons et al. [23], 20% had a patent processus vaginalis, and all underwent an inguinal incision to repair the hernia sac. Operative times generally were 18 to 25 min in these studies.

The clinician needs to be careful in comparing the data in these series. Docimo's review included many past historical series [19] and are probably not indicative of the high success in current practice. In addition, patients undergoing a prescrotal approach are given preference during selection. For example, in the series by Rajimwale et al. [21], the 100 who underwent this approach were selected from 178 boys with a palpable undescended testis [21].

Abdominal testes (Table 2)

Because of the difficulty associated with abdominal orchiopexy, numerous series have been published with a variety of techniques. Most of the more contemporary series begin with diagnostic laparoscopy to localize a nonpalpable testis, and then an orchiopexy is attempted with a variety of techniques, both open and laparoscopic. Most probably, some of the patients in these series had peeping testes, which are much easier to mobilize into the scrotum. Some testes are relatively easy to mobilize into the scrotum by dividing the testicular vessels, whereas others have a very short vascular pedicle. Despite this heterogeneity of anatomic settings, most series include patients managed by a single technique. However, the clinician should understand that not all abdominal testes need to be managed by a single technique. In addition, most series do not include patients who have undergone orchiectomy in their results. The clinician needs to understand that these are selected series from high volume pediatric urology centers, and less experienced centers or centers with inferior results are unlikely to report their experience.

Transabdominal Orchiopexy—Docimo reported an 81.3% success rate for transabdominal approach, with a 91% success rate after 1985 (19). More recent series have demonstrated an even higher success rate approaching 100%. Using an inguinal incision and extensive retroperitoneal vascular mobilization, described in detail by Hutcheson et al. [7], Kirsch et al. [26] were able to achieve satisfactory mobilization without vascular division in most cases. In contrast, transabdominal 2-stage orchiopexy with the testes brought as far distally as possible in the first stage, followed by scrotal positioning in the second stage (without vascular division), were shown to be 71.1% successful in early studies with 64.6% success rates after 1985 [19]. Presumably, these testes were quite high, but theoretically could have been mobilized satisfactorily with a Fowler–Stephens approach also.

Fowler–Stephens Orchiopexy—The reported success rates for Fowler–Stephens orchiopexy has improved significantly over the years. Docimo [19] reported a 67% success rate for the procedure. Subsequent reports have shown higher success rates. King [27] showed that leaving a strip of peritoneum attached to the lower spermatic cord in patients requiring spermatic vessels division resulted in scrotal position in 21 out of 22 patients, and none of the boys had testicular atrophy. Koff and Sethi [14] also had a high success rate with the modified Fowler–Stephens approach [14].

Table 2 Success rates of orchiopexy for abdominal and peeping testes (Series < 10 excluded)

Series	No.	Procedure	Success
Docimo [19]	80	Open transabdominal orchiopexy (not F-S)	65/80 (81.3%)
Gheiler et al. [9]	18	Open transabdominal orchiopexy (not F-S)	18/18 (100%)
Dhanani et al. [31]	28	Open transabdominal orchiopexy (not F-S)	28/28 (100%)
Docimo [19]	248	Open transabdominal orchiopexy, 2 stage (not F-S)	180/248 (72.5%)
Kirsch et al. [26]	33	Inguinal orchiopexy (not F-S)	32/33 (97%)
Docimo [19]	86	Microvascular autotransplantation	72/86 (83.7%)
Bukowski et al. [29]	27	Microvascular autotransplantation	26/27 (96%)
Docimo [19]	321	Fowler–Stephens orchiopexy (1 stage)	241/321 (66.7%)
King [27]	22	Fowler–Stephens orchiopexy (1 stage)	21/22 (95.4%)
O'Brien et al [32]	22	Fowler–Stephens orchiopexy (1 stage)	18/22 (82%)
Koff and Sethi [14]	27	Fowler–Stephens orchiopexy, low ligation (1 stage)	25/27 (93%)
Docimo, [19]	56	Fowler–Stephens orchiopexy (2 stage)	43/56 (76.8%)
Law et al. [33]	20	Fowler–Stephens orchiopexy (2 stage)	19/20 (95%)
Dhanani et al. [31]	55	Fowler–Stephens orchiopexy (2 stage)	48/49 (98%)
Baker et al. [28]	178	Laparoscopic orchiopexy (1 stage); includes peeping testes	173/178 (97.2%)
Esposito et al. [34]	20	Laparoscopic orchiopexy (1 stage)	20/20 (100%)
Radmayr et al. [35]	28	Laparoscopic orchiopexy (1 stage)	28/28 (100%)
Baker et al. [28]	27	Laparoscopic Fowler–Stephens (1 stage)	20/27 (74.1%)
Esposito and Garipoli [36]	33	Laparoscopic Fowler–Stephens (2 stage)	32/33 (97%)
Humphrey et al. [37]	10	Laparoscopic Fowler–Stephens (2 stage)	10/10 (100%)
Baker et al. [28]	58	Laparoscopic Fowler–Stephens (2 stage)	51/58 (87.9%)
Radmayr et al. [35]	29	Laparoscopic Fowler–Stephens (2 stage)	27/29 (93%)
El-Gohary [38]	31	Laparoscopic Fowler–Stephens (2 stage)	24/31 (77.4%)
Tackett et al. [30]	17	Laparoscopic-assisted testicular autotransplantation	15/17 (88.2%)

The staged Fowler–Stephens procedure, theoretically, should have a higher success rate. Indeed, in Docimo's review [19] the success rate was 77%. In contrast, more recent studies have success rates of 95% or more. Most of these patients underwent laparoscopic clipping of the vessels with open second stage orchiopexy 3 to 6 months later.

Laparoscopic Orchiopexy—Laparoscopy is frequently used for localization and treatment of nonpalpable testes. Laparoscopic orchiopexy has become a procedure of choice for many practitioners. In a series of patients from 10 different centers, Baker et al. [28] reported a 97% success rate with a single stage laparoscopic orchiopexy without division of the testicular vessels [28]. Laparoscopic Fowler–Stephens orchiopexy, both single and two stage, has had high success rates.

Microvascular Orchiopexy—Microvascular orchiopexy had a high success rate of 80.3% in Docimo's review. More recent series from a single institution, using both open [29] and laparoscopic-assisted microvascular anastomosis [30] have demonstrated impressive success, but not higher than contemporary series of standard abdominal or staged Fowler–Stephens orchiopexy, whether open or laparoscopic.

Cryptorchidism and infertility

Men with history of cryptorchidism have an increased risk of infertility. Outcomes relating to infertility include the paternity rate, semen analysis, measurement of serum inhibin B, and palpable size of the testis subjected to orchiopexy. Variables include age at orchiopexy, original position of the undescended testis, and technique of orchiopexy. For example, no documented fertility has been reported in men who underwent bilateral abdominal orchiopexy as children.

Undescended testes show reduced numbers of germ cells, delayed maturation of germ cells, and progressive interstitial fibrosis. Furthermore, the contralateral descended testis shows similar changes, though not as severe, starting around 7 years [39, 40]. Consequently, orchiopexy is generally recommended from 9 to 12 months to minimize these changes.

It is assumed that infertility in men who were formerly cryptorchid is secondary to impaired germ cell maturation. However, it may also be iatrogenic. For example, in a long-term follow-up study of 40 men who underwent orchiopexy between 1950 and 1960, a significant proportion had small testes, potentially from injury during orchiopexy [41]. In addition, the technique of orchiopexy may affect sperm transport. For example, in an experimental model, Smith et al. [42] demonstrated that skeletonization of the vas deferens may denervate the vas, creating a functional obstruction. The higher the undescended testis, the more likely that skeletonization of the vas will be necessary. In addition, 2/3 of undescended testes have an epididymal abnormality, most commonly a long looping epididymis [43]. Whether the epididymis in these men functions normally is unknown and this is impossible to study at present. Disjunction of the testis and epididymis as well as epididymal atresia may also occur, which undoubtedly causes infertility.

It is also assumed that orchiopexy at an early age improves the likelihood of eventual fertility. However, in a retrospective study by Okuyama et al. [44], the semen analysis in men who underwent bilateral orchiopexy between 2 and 5 years was compared with men who underwent bilateral orchiopexy between 9 and 12 years. None had a normal sperm count. Overall, 25% in each group had oligospermia and 75% had azoospermia, suggesting that orchiopexy at an early age does not improve fertility. However, there are two other potential explanations. First, it may be that waiting until the child reaches between 2 and 5 years to perform an orchiopexy is too late, and that doing the orchiopexy before 1 year would have increased the chances for fertility. The other explanation is that these may have been two different patient populations with undescended testes. It was unclear why so many underwent orchiopexy between 9 and 12 years—were they being monitored nonoperatively? It seems most probable that the younger population had congenital undescended testes, while the older group may have had ascending testes. Recently, Hack et al. [1] reported that their patients undergoing orchiopexy had a bimodal age distribution with 1/4 around 2 years and 3/4 around 10 years. In the older group, all the patients had had a previous physical examination documenting that the testis was in the scrotum . We have found that at least 1/3 of boys with a retractile testis develop an ascending testis and need to undergo an orchiopexy (6). In these boys, the epididymis is usually normal and only 13% have had a patent processus vaginalis, whereas with congenital undescended testes 70 to 80% have a patent processus. If these testes were normal histologically until they became ascended testes, then one might expect that fertility in this older age group would be similar to a younger population with congenital undescended testes. Rusnack et al. [45] compared the histology of 91 ascending testes with a control group of "primary" undescended testes and found that the number of germ cells per tubule was similar by age. However, 43% of the ascending group had a patent processus, suggesting that many of these were primary undescended testes.

For the above reasons, age at the time of orchiopexy is a variable that may not be meaningful.

The most reliable data have been reported by Lee et al. [46], who analyzed a large cohort of adult men who underwent orchiopexy at Children's Hospital of Pittsburgh between 1965 and 1974. This group demonstrated a 65.3% paternity rate in formerly bilaterally cryptorchid men, compared to formerly unilaterally cryptorchid (89.7%) and control men (93.2%). The bilateral group also had significantly reduced sperm density and inhibin B levels (suggestive of subfertility), while FSH and LH levels were elevated. In contrast, it is unclear whether surgical correction of unilateral cryptorchidism has an

Table 3 Rates of paternity in formerly cryptorchid patients who have attempted to conceive for more than 12 months compared to controls

Group	No.	Successful paternity rate
Bilateral	49	32/49 (65.3%)
Unilateral	359	322/359 (89.7%)
Control	443	413/443 (93.2%)

Data adapted from Lee [31]

Table 4 Relative risk of testicular cancer in patients with history of cryptorchidism

Series	No.	Relative risk
Pottern et al. [54]	271	3.7 (1.6–8.6)
Giwercman et al. [55]	506	4.7 (1.7–10.2)
Pinczowksi et al. [56]	2,918	7.4 (2.0–19.0)
Swerdlow et al. [57]	1,075	7.5 (3.9–12.8)
Herrinton et al. [58]	183	4.8 (1.9–11.8)

impact on fertility. Lee et al. [47] found that significantly more of formerly unilateral cryptorchid men were unable to conceive children (10.5%) compared to the control group (5.4%). However, later studies did not demonstrate decreased paternity rates among patients with a single testis compared to the general population, including men with cryptorchidism determined to have an atrophic testis at the time or orchiopexy or those men who subsequently underwent orchiopexy [48]. The latest large epidemiologic study by Lee [49] illustrates paternity rates among formerly cryptorchid and control men. These data are summarized in Table 3.

There is some evidence that perioperative hormonal stimulation of the testis may improve fertility, perhaps by stimulating germ cell maturation and increasing germ cell number. For example, administration of a buserelin (a luteinizing hormone-releasing hormone [LHRH] analogue) pre-operatively increased the germ cell number of the undescended testis to normal level in boys less than 7 years, whereas in boys over 7 years, the effect was not observed [50]. In addition, postoperative administration of LHRH analogues has improved post-pubertal sperm counts [51]. A recent prospective randomized trial by Schwentner et al. [52] demonstrated that preoperative administration of GNRH in the form of intranasal spray for 4 weeks improved fertility index in prepubertal males with unilateral and bilateral cryptorchidism.

Finally, the fertility prospects are greatly improved with advent of sperm extraction and intracytoplasmic sperm injection techniques in azoospermic of former cryptorchid patients. For instance, Lin et al. [53] reported successful paternity in a 32-year-old patient with bilateral undescended testes who underwent bilateral orchiopexy at the age of 18.

Cryptorchidism and testicular neoplasia

Cryptorchidism is an established risk factor for developing testicular cancer, with the reported relative risk ranging between 3.7 and 7.5 [54–58]. The results of select studies are summarized in Table 4. The risk appears to increase with increasing age at surgical correction and reaches the highest value in men whose undescended testes have not been corrected [54].

Intratubular germ cell neoplasia, also called carcinoma in situ (CIS) is a premalignant condition found with increased incidence in undescended testes. Krabbe et al. [59] demonstrated carcinoma in situ pattern in 8% of previously cryptorchid 50 men. Giwercman et al. [60] reported 1.7% of 300 patients with history of undescended testes having CIS on testicular biopsy [60]. However, the risk might be higher since two patients excluded from the study were treated for testicular cancer. The notion that all cases of intratubular germ cell neoplasia progress to invasive testicular cancer has been challenged by Engeler et al. [61]. In this study, 660 testicular biopsies of prepubertal patients with history of cryptorchidism were evaluated for intratubular germ cell neoplasia of the unclassified type (ITGCNU). None of the 15 patients that tested positive for ITGCNU with placental-like alkaline phosphatase antibody staining developed testicular cancer after two decades. Therefore, ITGCNU may not be a precursor of testicular cancer after orchiopexy. From a practical perspective, CIS is a diagnosis that has been recognized at only a handful of centers because it requires semithin section analysis of the biopsy, which is not performed commonly, and also because few centers perform testis biopsies at the time of orchiopexy. Furthermore, many pathologists find that CIS is a difficult diagnosis to recognize.

The risk of developing testicular tumors in cryptorchid men is not eliminated following orchiopexy [62]. However, early orchiopexy may decrease the risk of testicular cancer. For instance, Halme et al. [63] demonstrated decreased risk of seminoma after successful surgical treatment. Herrinton et al. [58] showed that men with history of cryptorchidism who had spontaneous testicular descendency or underwent an orchiopexy by their 11th birthday were not at increased risk of testicular cancer compared to controls [58]. In contrast, surgical correction after the 11th birthday was related to a 32-fold increased risk.

It is often stated that in men who develop a testis tumor following orchiopexy, approximately 10–15% involve the contralateral normal testis, and, therefore, it is at increased risk for neoplasia. In reality, if the relative risk of testis tumor is only 5 or 6 times that of a control population, then one would expect that 15% of the time the contralateral testis would be affected. Consequently, we do not think that the normal descended testis is at increased risk for germ cell tumor development.

Finally, there is also evidence that orchiopexy may affect the type of germ cell tumor. For example, if the testis is undescended, approximately 2/3 of the neoplasms are seminomatous, whereas if the testis has been subjected to orchiopexy, then nearly 2/3 are nonseminomatous [62].

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