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Laparoscopy-Assisted One-Stage Trans-Scrotal Orchiopexy Applicable to All Types of Maldescended Testes

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1. Introduction

So-called malposition of the testis includes congenital undescended testis (intra-abdominal, canal, and high scrotal), ectopic testis, retractile testis, vanishing testis and so on. An exact preoperative diagnosis has been mandatory for selecting an appropriate therapeutic modality for each type of malposition. Embryologically, undescended testis syndrome should be associated with a patent processus vaginalis (PPV) (Fonkalsrud, 1986). The principle of orchiopexy for undescended testis consists of the closure of the PPV high at its neck (Radmayr C. et al., 1999) and the placement of the pedunculated testis into the dartos pouch. Inguinal exploration has been a standard approach for this aim and Fowler-Stephens' one-stage or two-stage operation has been recommended for intra-abdominal testes (Kogan, 1992).

Laparoscopic PPV closure using an Endoneedle, which we specifically developed for PPV closure (Endo, et al., 2001) conducted us to its application to orchiopexy. And the procedures have been sophisticated to facilitate one-stage orchiopexy that is applicable to all types of malpositioned testes by combining a diagnostic/therapeutic laparoscopy and an orchiopexy through trans-scrotal incision, while rendering most of preoperative diagnostic modalities unnecessary. The purpose of this paper is to introduce our strategy for a systematic approach to cryptorchidism using laparoscopy, and to discuss the detailed operative procedures and its outcomes.

2. Materials and methods

[Surgical strategy]

Diagnostic laparoscopy was initially performed using a 5-mm telescope inserted through the umbilicus and 2-mm grasping forceps placed below the umbilicus to evaluate internal inguinal rings (IIRs). If a PPV was not present, the procedure advanced to pathway 1, 2 or 3, as shown in Fig. 1.

In the case of a mid-canal, low canal or high scrotal testis with or without inguinal hernia or hydrocele, the procedure advanced to pathway 4; in the case of intra-abdominal, peeping or high canal testis, the procedure advanced to pathway 5.

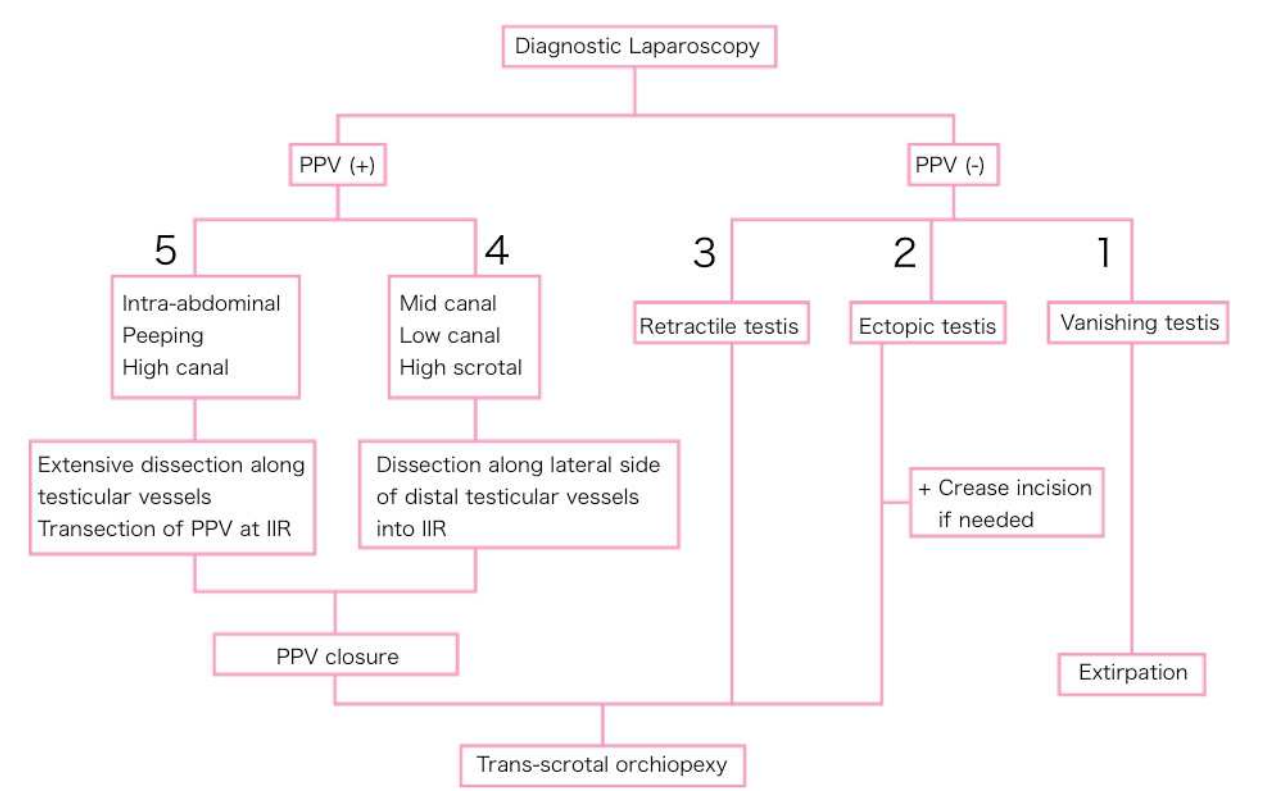


Fig. 1. Flow chart for systematic approach to malpositioned testes. Even in pathway 1, 2 or 3, PPV closure is performed if a concurrent PPV/cPPV is found.
Abbreviations; PPV, patent processus vaginalis; IIR, internal inguinal ring

Laparoscopic procedures: A 14-gauge sheath needle, which can be used as a port, is inserted immediately above the internal inguinal ring (IIR) or in the flank of the affected side at the same level as the umbilicus. For mid-canal, low canal, or high scrotal testes (pathway 4), small electrocautery incisions are made along the distal portion of the testicular vessels to separate the vessels from the peritoneum. Next, the spermatic cord is detached from the peritoneum. Dissection of the peritoneum and retroperitoneal tenacious tissues along the lateral side of the vessels at the IIR level allows the seminal cord to be mobilized (Fig. 2). These procedures are performed using a 2-mm grasper with monopolar electrocautery device and endo-scissors inserted through the 14-gauge sheath needle. For intra-abdominal, peeping or high canal testes, the peritoneum overlying the testicular vessels is incised along both sides of the vessels toward the mesentery root using electrocautery and endo-scissors. Thorough stripping of the vessels and cord is performed postero-laterally, and the peritoneal wall of the processus vaginalis is incised circularly at the IIR so as to transect the PPV. The gubernaculum is cut off if it is necessary for further mobilization of the testicular system. After thrusting the testicle into the processus vaginalis (PV) (Fig. 3), the proximal portion of the processus vaginalis is closed using an Endoneedle, placing the testicular vessels and cord outside of the ligature. In cases of contra-lateral PPV (cPPV), proximal portion of the PV was simultaneously closed using the same procedure. Details of the techniques for PPV closure have been reported previously (Endo, et al., 2009). *Trans-scrotal orchiopexy:* A 2 cm incision is made along the uppermost border of the scrotum. A dartos pouch is prepared toward the bottom of the scrotum by separating a layer between the dartos sheath and scrotal skin. The distal portion of the PV is identified and freed from

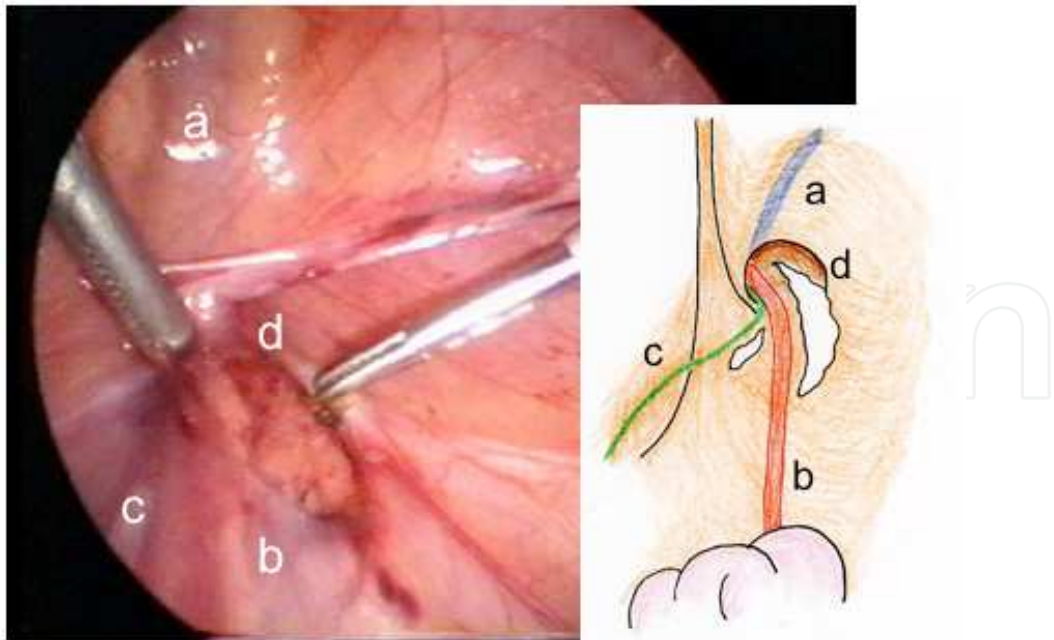


Fig. 2. Preparation of the distal testicular vessels for right sided mid canal testis. Dissection of the peritoneum and retroperitoneal tenacious tissue along the lateral side of the testicular vessels into the IIR so as to allow the medial and downward shift of the vessels.
Abbreviations; a, hypogastric vessels; b, testicular vessels; c, spermatic cord; d, orifice of PPV

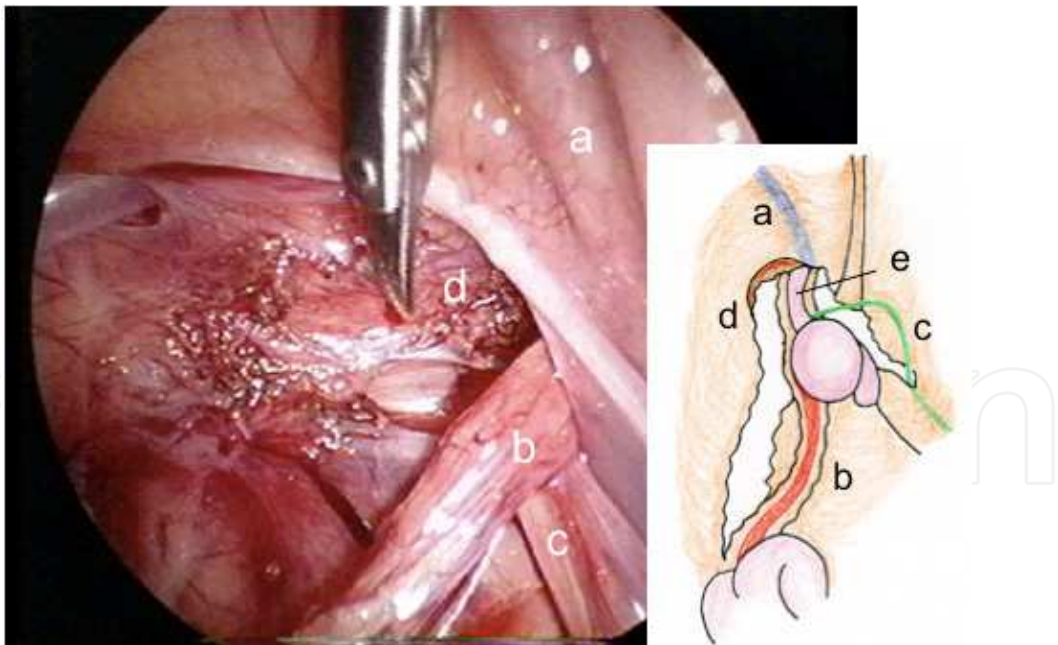


Fig. 3. Extensive dissection along the testicular vessels for left sided peeping testis. Thorough stripping of the vessels and cord from a postero-lateral aspect and transection of the PPV at the level of the IIR. Photograph shows endoscissors cutting off the tenacious tissue at the floor of the inguinal canal to loosen the seminal cord. The testis has been placed in transected PV, waiting for traction from the outside.
Abbreviations; a-d, same as figure 2; e, gubernaculum testis

the surrounding connective tissues high at its neck through the incision. The testis is drawn out through this incision and drawn past the lowest portion of the PPV. The seminal stalk is stitched to the dartos sheath at the cephalad leaf of the incision, which is retracted cranially by a hook while providing a gentle downward traction of the testis so as to place the stitch on the stalk at as high a point as possible. Finally, the pedunculated testis is placed inside the dartos pouch (Fig. 4).

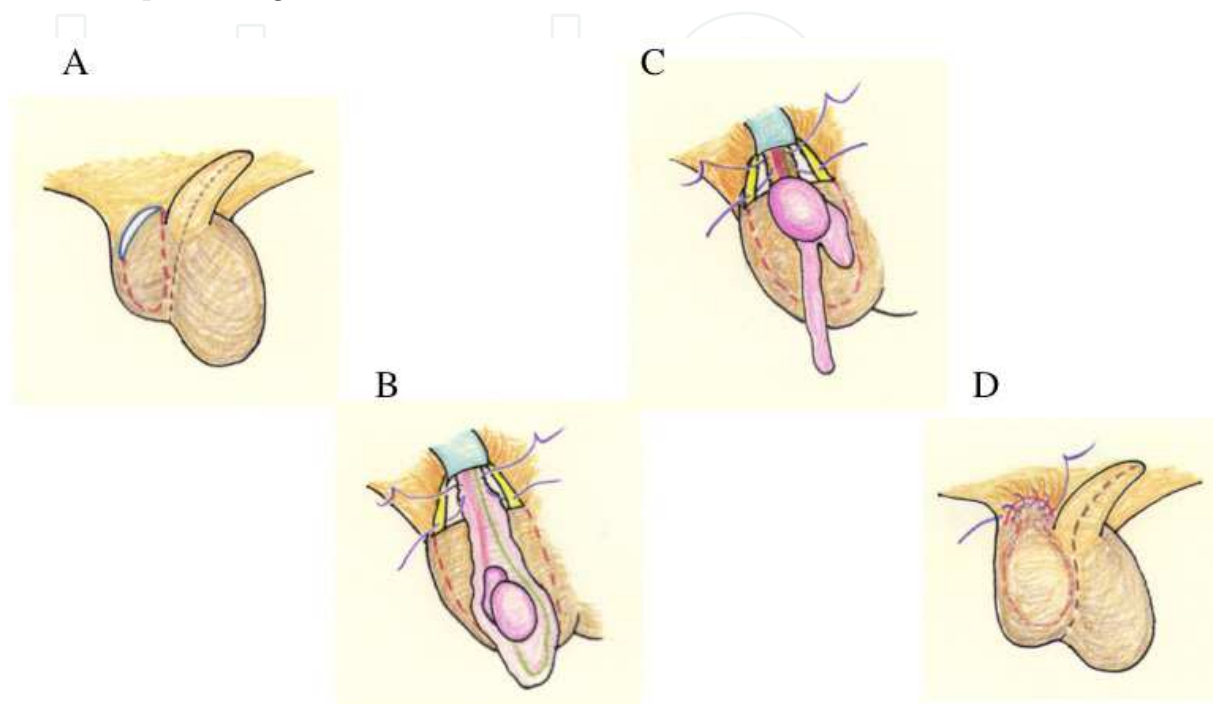


Fig. 4. Schematic drawing of trans-scrotal orchiopexy. A: A 2 cm incision is made along the uppermost line of the scrotum, and a large dartos pouch sufficient to accommodate the testis and attached structures is created. B: In cases of canal testis, the PPV containing the testis is drawn out, freed from tenacious connective tissue high at its neck, and trimmed along the testis and seminal cord, cutting away an excess vaginal tunic containing cremaster muscle fibers. The stalk is stitched to the dartos sheath of the cephalad leaf of the wound at a suitable height to accommodate the testis in the dartos pouch. C: In cases of intra-abdominal or peeping testis, the scrotal wound is retracted with a retractor. Sutures for fixation are applied to the tunica along the cord and vessels as high as possible. D: The scrotal skin is closed with a running suture.

[Study design]

Between May 2000 and December 2007, this procedure was performed in 159 boys with maldescended testes (191 testes). Preoperative diagnosis was conducted at our outpatient department and confirmed upon admission. Patient characteristics with regard to the testicular location and associated hernia/hydrocele are shown in Table 1.

This series included 23 boys with non-palpable testis (NPT) including 1 with hernia and 80 boys with canal testis, in whom 7 had bilateral canal testes, 12 (13.6%) had hernia and 5 (5.7%) with hydrocele. High scrotal testis was observed in 35 boys, in whom 6 had bilateral high scrotal testes, 3 (7.0%) had hernia and 26 (60.5%) had hydrocele. Eight out of 10 boys with retractile testis had bilateral retractile testes, and none of them exhibited hernia or hydrocele. The remaining 11 boys had maldescended testes in combination of varying locations.

Location of testes	Affected side			Total numbers of patients	Total numbers of testes
	Right	Left	Bilateral		
NPT	14	9		23	23
(with hernia)		(1)		(1, 4.3%)	(1, 4.3%)
Canal	27	46	7	80	87
(with hernia)	(6)	(4)	(right, 2)	(12, 13.6%)	(12, 12.6%)
(with hydrocele)	(2)	(3)		(5, 5.7%)	(5, 5.3%)
High scrotal	22	7	6	35	41
(with hernia)	(1)	(1)		(3, 7.0%)	(3, 6.1%)
(with hydrocele)	(17)	(5)	(right,1; bilateral, 2)	(26, 60.5%)	(28, 57.1%)
Retractile	1	1	8	10	18
Combined			11	11	22
NPT & Canal	NPT	Canal		1	2
NPT & High scrotal	High scrotal	NPT		1	2
Canal & High scrotal	Canal	High scrotal		3	6
(with hydrocele)		(1)			
Canal & Retractable	High scrotal	Canal		2	4
	Retractable	Canal		1	2
	Canal	Retractable		1	2
High scrotal & Retractable	Retractable	High scrotal		2	4
Total				159	191
(with hernia/hydrocele)				(47, 29.6%)	(49, 25.7%)

Table 1. Patient characteristics
Notes; The words in parenthesis indicate numbers and rates of associated hernia/hydrocele. Rates of associated hernia/hydrocele in the total numbers of patients and testes include each testis in combined cases individually.
Abbreviation; NPT, non-palpable testis

Age at operation ranged from 4 months to 13 years, with a median age of 2 years and 0 months. Ages of patients according to the testicular location generally decreased in proportion to a higher position.

Location of testes	Total number of patients	Age		
		Minimum	Maximum	Median
NPT	25	11m	10y8m	1y4m
Canal	87	9m	12y2m	1y11m
High scrotal	37	4m	13y0m	2y2m
Retractable	10	1y3m	4y7m	3y8m
Total	159	4m	13y0m	3y0m

Table 2. Age distribution according to the location of testes.
Note; In cases of combined locations, the higher location is represented.

Each boy underwent various operative procedures according to the flow chart shown in Fig. 1. Medical records of these children were analyzed to determine detailed location of testis, which was confirmed during the operation; patency of the PV; types of operative procedures used; operation times; and postoperative outcomes. Patients were followed up regularly at our outpatient department by physical examination, including periodical echogram, until 7 months, and once each year until adolescence, when seminal emission begins. Follow-up periods ranged from 3 years and 2 months to 10 years and 9 months.

3. Results

Percentages of associated PPV according to testis location determined during operation are shown in Table 3; overall, PPV was associated with 84.1% of all undescended testes, excluding the retractile and ectopic testes, which are not considered to be true undescended testes.

Location of testes	Affected side		Total numbers of testes	PPV	
	Right	Left		affected side	contralateral side
Intra-abdominal	1	3	4	4(100%)	2(50%)
Peeping	4	11	15	15(100%)	5(33.3%)
High canal	12	12	24	18(75%)	3(12.5%)
Midcanal	6	8	14	11(78.6%)	4(28.6%)
Low canal	26	26	52	41(78.8%)	17(32.7%)
High scrotal	26	16	42	38(90.5%)	22(52.4%)
Retractile	20	18	38	9(23.7%)	11(28.9%)
Ectopic	1	1	2	1(50%)	0(0%)
Total	96	95	191	127/151(84.1%)*	53/151(35.1%)*

Table 3. Location of testes defined from operation and concurrent presence of PPVs. Abbreviation; *, Numbers of retractile and ectopic testis were excluded from denominators.

All intra-abdominal and peeping testes had PPV. High scrotal testes exhibited the second highest rate of PPV (90.5%). Contra-lateral PPV was found in 35.1% of patients. All PPVs and cPPVs were closed in the same session.

Types of procedures performed included extensive dissection along the testicular vessels with transection of the PPV at the IIR (ExtVasDic) + laparoscopic PPV closure (LPC) + trans-scrotal orchiopexy (TSO) in 30 boys (average operation time, 99 +/- 23 minutes); preparation of the distal testicular vessels with peritoneal dissection along the lateral side of the IIR (DistVasPrep) + LPC + TSO in 11 boys (average operation time, 82 +/- 17 minutes), LPC + TSO in 67 boys (average operation time, 70 +/- 15 minutes), and a diagnostic laparoscopy (DiagLap) + TSO in 15 boys (average operation time, 48 +/- 13 minutes; see Table 4).

Operative procedure	Number of patients	Operation Time Mean +/- SD (minutes)
DiagLap + TSO	15	48 +/- 13
LPC + TSO	67	70 +/- 15
DistVasPrep + LPC + TSO	11	82 +/- 17
ExtVasPrep + LPC + TSO	30	99 +/- 23
Crease incision added	4	124 +/- 24
Bilateral TSO*	32	83 +/- 43

Table 4. Operative procedures and operation times. Abbreviations; DiagLap, diagnostic laparoscopy; LPC, laparoscopic closure of PPV; DistVasPrep, preparation of distal portion of testicular vessels; ExtVasPrep, extensive vascular preparation; *, Bilateral orchiopexy with various combinations of above the procedures (DiagLap+TSO and LPC+TSO occupied 97% of 62 procedures performed in 32 patients).

A crease incision was added in 4 boys: one with an intra-abdominal testis, 2 with high canal testes, and 1 with an ectopic testis. The crease incision was performed in the first case to ensure the anatomical relationship of laparoscopically prepared IIR from outside of the body, as this was the first time this type of procedure had been conducted; in the latter cases, incisions were made due of difficulty in finding the distal sac for the obliterated PV. This occurred near the beginning of the surgeons' learning curve. In all the cases, the testes were successfully repositioned, and they continued to descend toward the bottom of the scrotum after the operation (Fig. 5).

Testicular atrophy or hernia formation did not occur in any of the cases, and cosmesis was excellent in all the patients (Fig. 6).

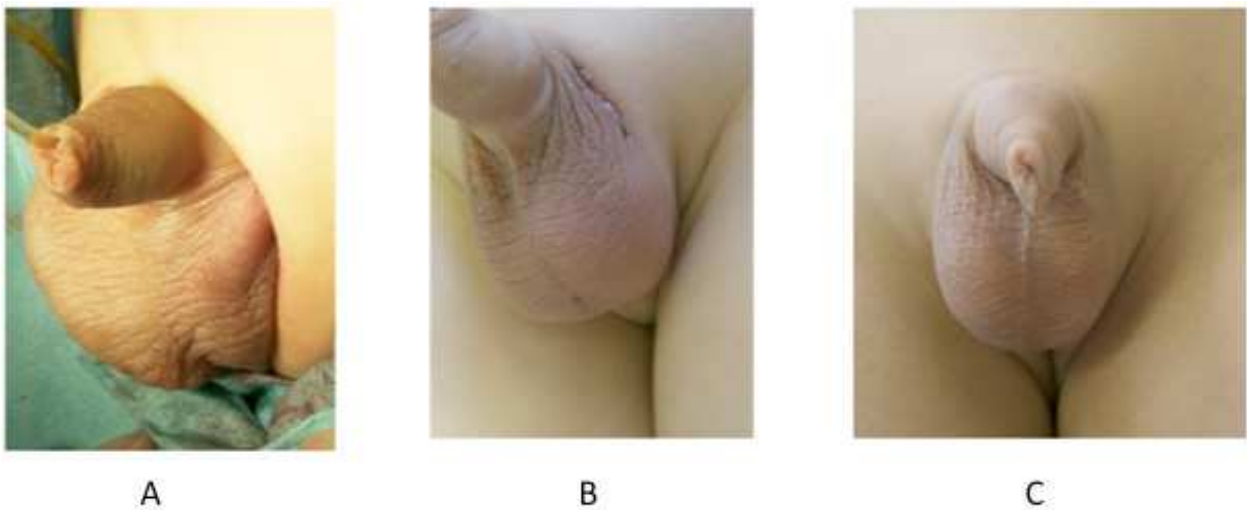


Fig. 5. Follow-up figures of trans-scrotal orchidopexy. A: Immediately after the operation, the closed wound is markedly retracted into the inguinal canal because of the short seminal cord. B: Three months later, the testicle has descended into the scrotum in conjunction with the retracted wound returning to the previous position. C: Six months after the operation, the wound has healed leaving no scar.

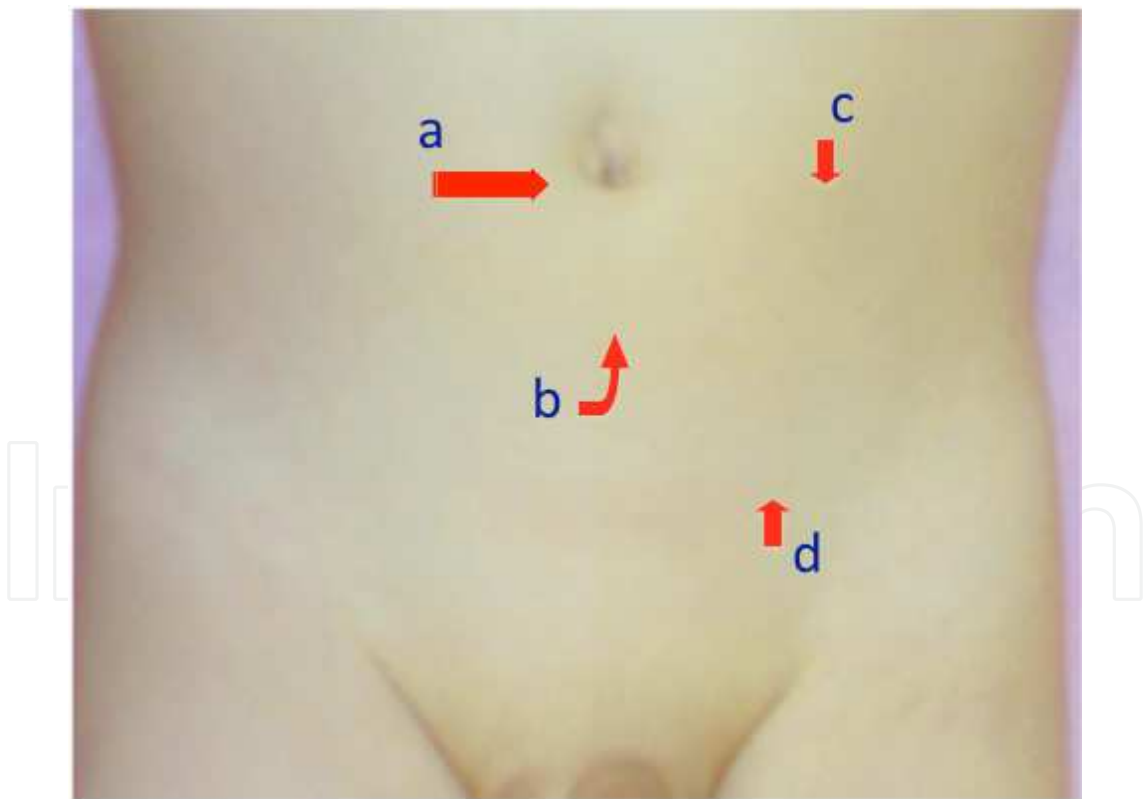


Fig. 6. Wound cosmesis 6 months after the operation in a boy who underwent orchiopexy for left canal testis. Actually invisible surgical wounds for a 5-mm laparoscope inserted through the umbilicus (a), a 2-mm grasping forceps placed below the umbilicus (b), a 14-G sheath needle used as a port for grasping forceps, electrocautery device or endoscissors (c) and 16-G Endoneedle for the closure of the PPV (d).

4. Discussion

The most effective strategy for treating undescended testes remains controversial. Patients with cryptorchidism have their testes in various locations from intra-abdominal region to a high scrotal position. Inguinal exploration has been a standard approach for managing undescended testis. Many surgical procedures have been devised as alternatives to this approach. Diagnostic and therapeutic laparoscopy has flourished as a treatment for nonpalpable testis. Jordan et al. reported a completely endoscopic approach to orchiopexy (Jordan, et al., 1992); since then, laparoscopic orchiopexy for intra-abdominal testis with direct transfer or a Fowler-Stephens (F-S) procedure has been developed, providing better results than the traditional open orchiopexy (success rates of 95% vs. 76%) (Samadi, et al., 2003). Moursy, et al. reported better outcomes using laparoscopic F-S procedures in comparison with laparoscopic direct orchiopexy, with overall success rates of 100% and 88.8%, respectively. Therefore, there is a higher tendency to perform F-S orchiopexy in patients treated laparoscopically, than in patients for which open orchiopexies were performed (Alam, et al., 2003).

A recent strategy for treating intra-abdominal testis under laparoscopic control has been the combination of laparoscopic direct and F-S orchiopexy, depending on the distance of the testis from the internal inguinal ring, in which the F-S orchiopexy occupies approximately 20-30% of total (Samadi, et al., 2003, Kim, et al., 2010). A recent meta-analysis of F-S orchiopexy reported a pooled estimated success rate of 80% for single F-S orchiopexy and 85% for 2-stage F-S orchiopexy. There was no difference in the success rate between laparoscopic and open techniques in either single or 2-stage F-S orchiopexy (Elyas, et al., 2010). On the other hand, laparoscopic procedures exhibit potential complications, including risk of testicular atrophy, with an overall F-S procedure success rate of 85% (Chang, et al., 2001).

Following the experiences of laparoscopic direct orchiopexy in intra-abdominal testis, the application of this technique to canalicular palpable testis has been attempted (Docimo, et al., 1995). Although, procedures for treating canalicular testis require increased laparoscopic skill and experience compared to those required for intra-abdominal testis treatment (Riquelme, et al., 2006), the reported success rates are promising, accounting for more than 95%, in comparison with the report of open method, in which the success rate was 82% (Docimo, 1995).

Trans-scrotal or pre-scrotal orchiopexy has been recently emerging as an alternative approach for testes that can be mobilized into the scrotum under general anesthesia. This procedure is advantageous due to less invasiveness and good cosmesis compared to the standard two-incision approach in selected cases (Yucel, et al., 2011, Dayanc, et al., 2007, Lais, Ferro, 1996). However, for palpable but immobile testes or testes located proximal to the external ring, the standard two-incision approach is recommended because of the difficulty in PV dissection and ligation at a sufficiently high level and shortness of the vascular pedicle (Dayanc, et al., 2007, Lais, Ferro, 1996). Our procedure involved only cutting off a portion of the PV wall, in which cremaster muscle fibers are included, along the spermatic pedicle, instead of the separation of the vas and vessels from the PV and ligation of the PV high at its neck, because the open IIR is closed from inside of the abdomen by the Endoneedle technique (Endo, et al., 2009).

For delivery of the testis, a neo-ring lateral to the bladder and medial to the median umbilical ligament has been widely utilized by employing an additional scrotal trocar for intra-abdominal and high canalicular testes (Poppas, et al., 1996, Docimo, et al., 1995, He, et

al., 2008). The presence of PPV is ignored in the description of operation procedures in most reports (Samadi, et al., 2003, Chang, et al., 2001, Kim, et al., 2010, Moursy, et al., 2010), and recent consensus in the literature has been to leave the ring open because of rare occurrence of postoperative inguinal hernia (Riquelme, et al., 2006, Mohta, et al., 2003), although Poppas et al. included closure of the defect using a stapling device if a hernia was present (Poppas, et al., 1996).

However, a potential disadvantage of laparoscopic orchiopexy, compared to the traditional open approach, is the subsequent development of an inguinal hernia or hydrocele (Baker, et al., 2001, Chang, et al., 2001, Metwalli, Cheng, 2002, Al-Mandil, et al., 2008, Palmer, Rastinehad, 2008). Ziylan O, et al. reported that patients requiring reorchiopexy had inadequate repair of inguinal hernia or PPV in 62.5% of cases, which was considered to be an important factor leading to failure after surgical treatment of undescended testis (Ziylan, et al., 2004). Essentially, cryptorchidism is frequently associated with PPV as He D., et al reported associated PPV in 90.3% of ipsilateral side and 15.6% of contralateral side (He, et al., 2008). In our series, 29.6% of patients had associated hernia/hydrocele, and 84.1% of patients had ipsilateral PPV and 35.1% had cPPV. Because second operations for subsequent hernia repair in a scarred wound can cause serious injury to the testicular blood supply, we strongly recommend the closure of the PV during orchiopexy (Metwalli, Cheng, 2002, Yucel, et al., 2011).

Retractile testis is defined as the testis that is usually located outside the scrotum, but can be drawn manually into the bottom of the scrotum, and has no associated PPV. It is considered not to be true undescended testis and does not require therapy (He, et al., 2008). We performed operations on 10 boys with preoperatively diagnosed retractile testis in whom the testis was not found inside the scrotum in more than 50% of occasions during parental observation. These operations were carried out after a period of observation at outpatient clinic and under informed consent. This explains why the averaged ages of this group was high, as indicated in Table 2. Four boys who had retractile testis as one of the combined maldescended testes underwent operation to prevent an expected imbalance of testicular location relative to the opposite side, where the true undescended testis had been relocated. Inan M., et al. observed smaller testicular volume in school age children with retractile testis and estimated some negative effects on the development of testicular volume of retractile testis (Inan, et al., 2008). Patients and their parents were very satisfied that the testes were always in the scrotum.

Our procedures provide a systematic approach using the algorithm shown in Fig. 1 to treat all types of maldescended testis. The primary advantage of our technique is that it can be used as a one-stage diagnostic and therapeutic modality to treat all types of maldescended testes, including routine PPV closures, orchiopexy through the natural embryological route, and trans-scrotal orchiopexy. Our laparoscopy-assisted one-stage trans-scrotal orchiopexy can free patients from many preoperative examinations, such as angiography, radioisotope, CT, and MRI, among others.

Retroperitoneum dissection and preparation of the testicular vessels from the mesentery root into the processus vaginalis in proportion to the testicular position provides the additional length required for proper mobilization of the testis into the dartos pouch. Preparation of the extra-abdominal seminal cord high at its neck can be easily performed through an incision placed in the uppermost region of the scrotum.

It is strongly advised to obtain a completely tension-free pedicle before fixing the testis into the scrotum (Yucel, et al., 2011). In our procedure, the testis does not need to be placed

enough into the scrotum, because during fixing of the seminal cord to the cephalad leaf of the incisional wound, the wound is retracted by a hook in a cranial direction, while the seminal cord is pulled down in a caudal direction. Therefore, the seminal cord can be sutured at its highest position to the dartos sheath of the retracted wound. The testis descends further into the scrotum as the sutured position descends along with the wound, returning to the previous position. Because laparoscopic orchiopexy performed without dividing the spermatic vessels does not affect normal testicular vascularization, the F-S procedure was not required in the present series. Eposito C, et al. successfully performed orchiopexy for intra-abdominal testis without division of the testicular vessels (direct pull-through into the scrotum), through the IIR, if this open, or through the Neo-Ring with subsequent closure of the IIR (Eposito, et al., 2000), which is in accordance with our procedure of pathway 5.

The testes were successfully repositioned and postoperatively continued to descend toward the bottom of the scrotum in all of the patients in this series. No testicular atrophy or hernia formation occurred, and cosmesis was excellent in all the patients.

5. Conclusion

We proposed a systematic approach to cryptorchidism, facilitating one-stage orchiopexy by combining a diagnostic/therapeutic laparoscopy and an orchiopexy through a trans-scrotal incision. This systematic approach was applied to 191 testes in 159 boys. The testes were provided additional length of the vascular stalk by dissecting the retroperitoneum in proportion to the testicular position under laparoscopic control. All concurrent PPVs were closed using the Endoneedle technique. And all the testes were delivered into the scrotum through the natural embryological route from the scrotal incision without necessitating any F-S procedures. This procedure was thought to be a useful one-stage diagnostic and therapeutic maneuver for all nonpalpable and palpable maldescended testes, enabling increased patient privacy owing to virtually invisible scars.

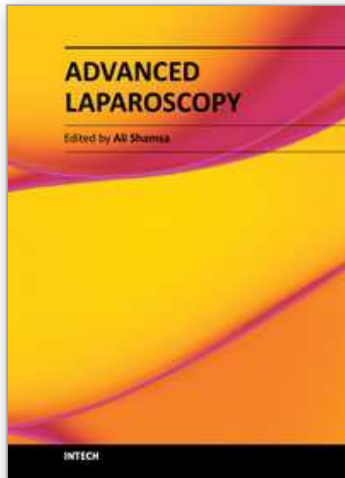
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The present book, published by InTech, has been written by a number of highly outstanding authors from all over the world. Every author provides information concerning treatment of different diseases based on his or her knowledge, experience and skills. The chapters are very useful and innovative. This book is not merely devoted to urology sciences. There are also clear results and conclusions on the treatment of many diseases, for example well-differentiated papillary mesothelioma. We should not forget nor neglect that laparoscopy is in use more extensively than before, and in the future new subjects such as use of laparoscopy in treatment of kidney cysts, simple nephrectomy, pyeloplasty, donor nephrectomy and even robotic laparoscopy will be researched further.

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