Retrospective Analysis of Surgical Outcomes Following Scarless Orchiopexy via Either Scrotal Incision or Single-Site Transumbilical Laparoscopy

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Purpose: The surgical approach to pediatric cryptorchidism has traditionally been the inguinal pathway. However, that has changed with the increased use of scrotal incision and single-site transumbilical laparoscopy, both of which result in a scarless surgical incision. We aimed to review our experience with the combined utilization of these two methods for the treatment of pediatric cryptorchidism and evaluate the surgical outcomes.

Materials and Methods: This retrospective case series included 267 children who underwent scarless orchiopexy between January 2019 and December 2022. Data were gathered from case and operative records. Testicular retraction, testicular atrophy, other complications, cosmetic outcomes, and parental satisfaction were evaluated.

Results: A total of 267 children (aged 1–7.4 years, median 1.8 years) with palpable and nonpalpable undescended testes underwent scarless orchiopexy at our center. Among them, 58 (21.7%) were treated with a scrotal incision and 209 (78.3%) underwent single-site transumbilical laparoscopic surgery. The follow-up period ranged from 6 to 53 months, with an average of 26.2 months. During the follow-up period, testicular retraction (4 cases, 1.5%) and atrophy (5 cases, 1.9%) occurred in the laparoscopic group. One child in the laparoscopic group developed a hydrocele but recovered after 3 months. In most cases (98.9%), the scars were invisible, indicating an excellent cosmetic effect.

Conclusion: The combination of scrotal incision and transumbilical laparoscopic orchiopexy can resolve cryptorchidism in children at different locations and achieve successful outcomes with a low rate of postoperative complications and good cosmetic results.

Keywords: undescended testis; cryptorchidism; orchiopexy; laparoscopy; scrotal approach

INTRODUCTION

Cryptorchidism, or undescended testis (UDT), is the most common genital disorder identified at birth. It is defined as the failure of a testis to descend into the scrotum.[1] The prevalence of UDT in full-term neonates and children aged 1 year is approximately 3% and 1%, respectively.[2] In addition to male infertility being the most important consequence of cryptorchidism, boys with UDT have a significantly higher risk of developing testicular tumors or testicular torsion and are also more prone to testicular trauma than boys with a normal testicular position.[3] The former standard approach for UDT treatment was inguinal orchiopexy. This procedure has been performed for more than a century with no major changes in surgical techniques.[4] Inguinal orchiopexy requires two incisions, one in the groin to release the testicle and the other in the scrotum to create a pocket to accommodate it, resulting in a visible surgical scar in the groin.

In 1989, Bianchi and Squire reported the first series of orchiopexies performed through a scrotal incision.[4] This approach has slowly gained acceptance despite the fear of inadequate mobilization of the spermatic cord. The scrotal incision is associated with a short operation time, accelerated healing, decreased pain, good maintenance of the testicular position, and excellent cosmetic results.[6] Laparoscopic orchiopexy, first introduced by Scott in 1982, has gradually become the most popular approach among pediatric urologists, especially for intra-abdominal testicles.[7] Owing to its advantages as a diagnostic and therapeutic tool, laparoscopy is now a well-accepted part of the standard armamentarium for the diagnosis and treatment of UDT. Currently, scars resulting from single-site transumbilical laparoscopic surgery have further diminished.[8]

Since 2009, single-site transumbilical laparoscopic orchidopexy has been performed in our department for nonpalpable undescended testes.[9] In recent years, our institution has also performed a single scrotal incision in selected children with UDT whose testis is palpable and can be easily pulled down near the scrotum. In this study, we combined both approaches to achieve scarless orchiopexy. The present study aimed to review our experience with the utilization of these two methods and to evaluate their surgical outcomes.

MATERIALS AND METHODS

The study was approved by the hospital's ethics committee (TJ-IRB202412063).

Study Population

This retrospective study included all children with UDT who underwent orchiopexy between January 2019 and December 2022.

Inclusion and Exclusion Criteria

The inclusion criterion was children diagnosed with

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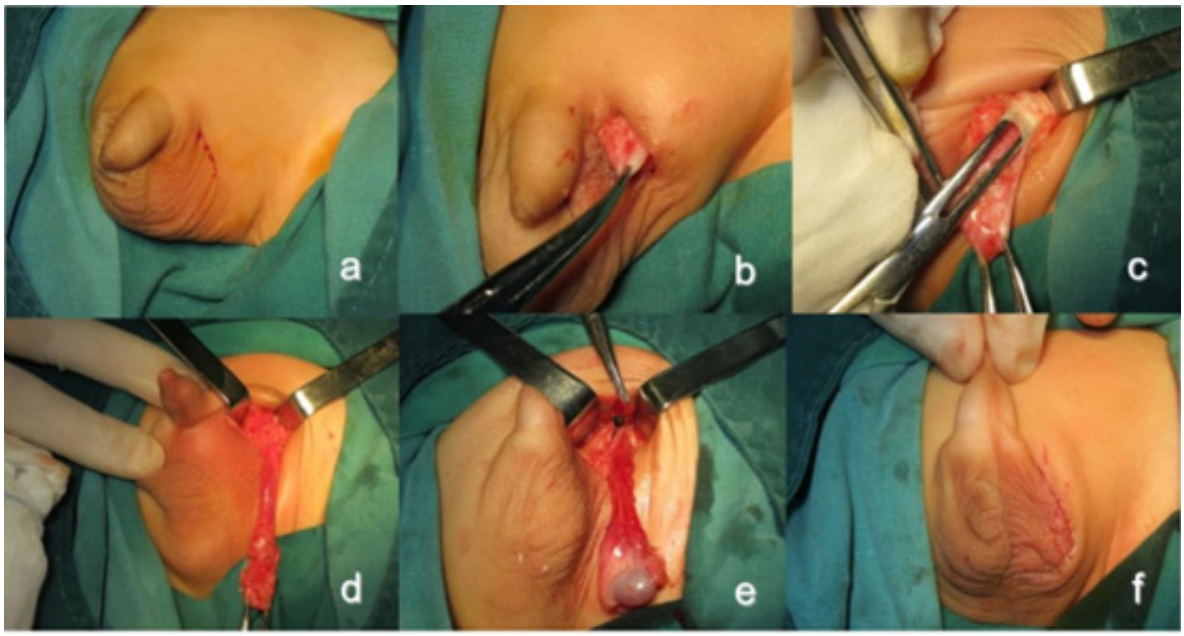

Figure 1. Procedure for scrotal incision orchiopexy. **(a)** A 2 cm curved skin incision was made along the superolateral border of the scrotum. **(b)** The tunica vaginalis with the testis inside was held with a clamp. **(c)** The tunica vaginalis was fully mobilized all the way to the external inguinal ring. **(d)** The external inguinal ring could be revealed properly by two small retractors through the scrotum incision. **(e)** The patent processus vaginalis was separated and ligated at the level of the external ring. **(f)** Appearance of the incision after orchiopexy.

unilateral or bilateral UDT requiring surgical treatment. Patients exhibiting the following conditions were excluded from the study:

1. A history of inguinal surgery, such as orchiopexy or hernia repair.
2. Underwent a further gonad biopsy to exclude disorders of sexual development.
3. Being unable to cooperate with follow-up.

Evaluations

Patients were identified and data were collected from three sources: electronic case records, operating records, and follow-up records. Outcomes evaluated included testicular retraction, testicular atrophy, cosmetic results, and other complications. Postoperative testicular atrophy and retraction were determined through physical examination and ultrasonography. If postoperative ultrasonography and physical examination indicated that the testicle was located outside the scrotum, testicular retraction was diagnosed. If the volume of the testicle detected using postoperative ultrasound continued to be significantly smaller than that before surgery and on the opposite side, testicular atrophy was diagnosed.

Procedures

At least two pediatric urologists performed physical examinations in all cases. Following our department's standards, we selected children with a palpable testis that could be pulled down to the upper part of the scrotum for a scrotal incision. Children with a non-palpable or palpable testis that could not be pulled down to the upper part of the scrotum underwent laparoscopic surgery. We performed laparoscopy in cases where the testis was in a marginal position and difficult to locate. In cases of bilateral UDT, we chose the procedure based on the higher side. In special cases where the testis could not be located via ultrasound and physical examination, laparoscopic exploration was performed. If the spermatic vessels and vas deferens ended in a blind pouch and the internal ring was closed, testicular agenesis was suspected. If the spermatic vessels and vas deferens converged at the internal inguinal ring and a small mass of tissue resembling a testicular structure was found at the distal end of the inguinal canal, testicular dysgenesis was suspected. In this case, we excised the tissue and conducted histopathological examinations to determine its origin and to assess any pathological conditions.

Scrotal incision orchiopexy was performed as follows: a 2 cm curved skin incision was made along the superolateral border of the scrotum. After the dartos fascia and fatty tissues were dissected, the surgeon milked the testis down toward the incision and held it in place, while the assistant grasped and pulled the tunica vaginalis with a clamp. The cremasteric fibers and surrounding tissues were separated, and the tunica vaginalis, along with the testis inside, was fully mobilized to the external inguinal ring. The external inguinal ring was properly revealed using two small retractors through the scrotal incision and could be cut open if further mobilization was required. The tunica vaginalis was then cut open to the bottom for a full assessment of the testis. The patent processus vaginalis was separated and ligated at the level of the external ring. The testis was then fixed to the tunica dartos at the proper position in the scrotum. Finally, the subcutaneous tissue was closed using absorbable sutures and the skin incision was sealed with wound glue. If the testis could not be repositioned without tension, even after full mobilization of the spermatic cord, transumbilical laparoscopic orchiopexy was planned to further mobilize the spermatic vessels intra-abdominally.

Laparoscopic orchiopexy was performed as described previously.[8] Briefly, three 5 mm cannulae were placed around the umbilicus. In most cases, the testis was located in the inguinal canal. The spermatic vessels and vas deferens were mobilized and the internal inguinal

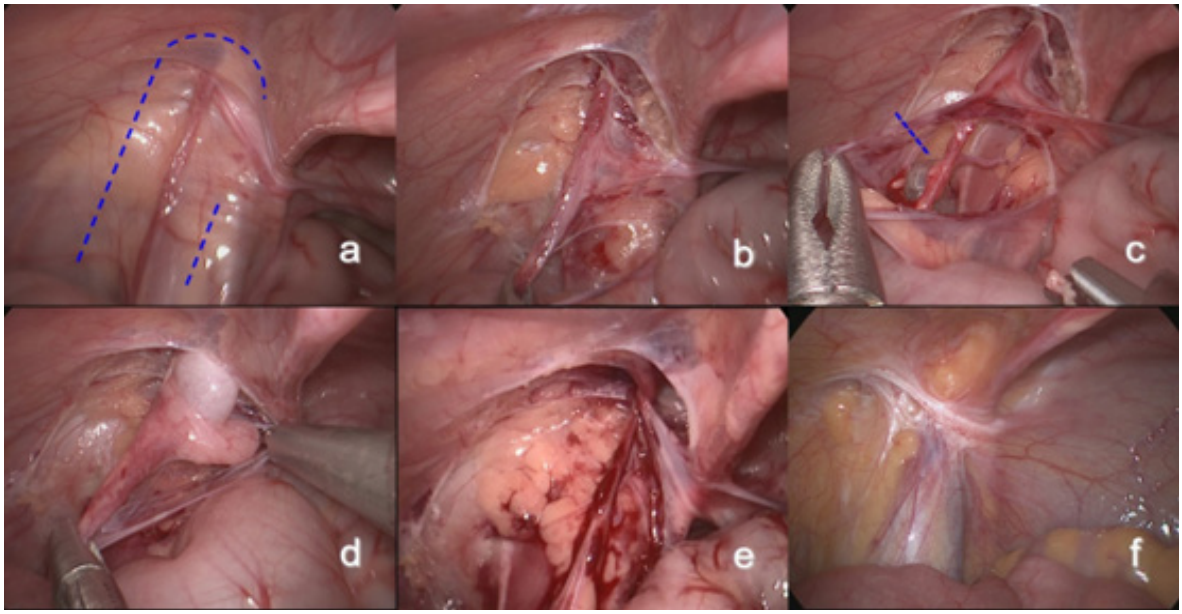

Figure 2. Procedure for laparoscopic orchiopexy. **(a)** The peritoneum and the internal inguinal ring were cut open (dashed line). **(b)** Appearance after cutting. **(c)** The peritoneum covering the spermatic vessels was separated and cut (dashed line). **(d)** The testis was pulled into the abdomen by dragging the spermatic cord, while the testis was pushed from the outside, similar to the manual reduction of an incarcerated hernia. **(e)** Internal appearance after orchiopexy. **(f)** Internal appearance of a case 1 year after laparoscopic orchiopexy.

ring was cut open. The testis was then pulled into the abdomen by dragging the spermatic cord while pushing the testis from the outside, similar to the manual reduction of an incarcerated hernia. Another 5 mm incision was made along the horizontal skin lines at the proper position of the scrotum. The testis was pulled down into the scrotum through this incision and fixed under the skin. The gubernaculum was left intact as far as possible. Rarely, even with complete mobilization, the testis could not reach the scrotum; in these cases, the one-stage Fowler-Stephens (F–S) procedure was used, which preserved the gubernaculum but transected the spermatic vessels. Before transecting the vessels, we routinely occluded them for 5–10 minutes; only when the color of the testis remained unchanged did we proceed with transection.

Statistical Analysis

The data collected for this investigation were analyzed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA). Quantitative variables are described as means or medians.

RESULTS

Between January 2019 and December 2022, 267 children with newly diagnosed UDT were included in this retrospective study.

The median age at presentation was 1.8 years (range, 1–7.4 years). Of the 267 cases (292 sides), the UDT was left-sided in 103 cases, right-sided in 139 cases, and bilateral in 25 cases (all in the laparoscopic group). A total of 58 children underwent scrotal incision orchiopexy and 209 underwent transumbilical laparoscopic surgery. Two children in the scrotal incision group required conversion to laparoscopic surgery. Thirty-four children in the laparoscopic group underwent contralateral ligation because a contralateral patent processus vaginalis was found intraoperatively. Of the 267 cases (292 sides), testicular agenesis was observed on 10 sides and 23 testes were identified as dysgenic. Three of the 23 dysgenic testes were resected through a scrotal incision, and 20 were excised laparoscopically. Postoperative pathology revealed undifferentiated seminiferous tubules with immature Sertoli cells in the resected testicular tissue. Single-stage orchiopexy was performed in the remaining 259 patients. No significant intraoperative complications were observed in either group.

The primary outcomes of the study were complications, such as testicular retraction and atrophy. The follow-up period ranged from 6 to 53 months. Four patients (1.5%) underwent reoperation due to retraction and five patients (1.9%) underwent resection due to atrophy. All nine cases were in the laparoscopy group. All children with testicular atrophy were older than six years, and all but one of the four children with testicular retraction were also older than six years. The secondary surgical outcomes were postoperative cosmetic results and other postoperative complications. Good cosmesis was achieved in both groups. In most patients, the scars were invisible. In the laparoscopy group, the incision scar was hidden within the umbilicus in most cases. In the open surgery group, the surgical scar was concealed in the skin of the scrotum. However, in three laparoscopic cases, an everted umbilicus was noticed postoperatively, and umbilicoplasty was performed. Only one child in the laparoscopic group developed a hydrocele, but recovered after 3 months.

DISCUSSION

We selectively performed two surgical procedures for the treatment of 267 children with UDT. A scrotal incision (58 cases) was used for low palpable testes and single-site transumbilical laparoscopic orchiopexy (209 cases) was used for high or nonpalpable testes. Most of the operations were successful, with low postoperative testicular retraction (1.5%) and atrophy (1.9%) rates

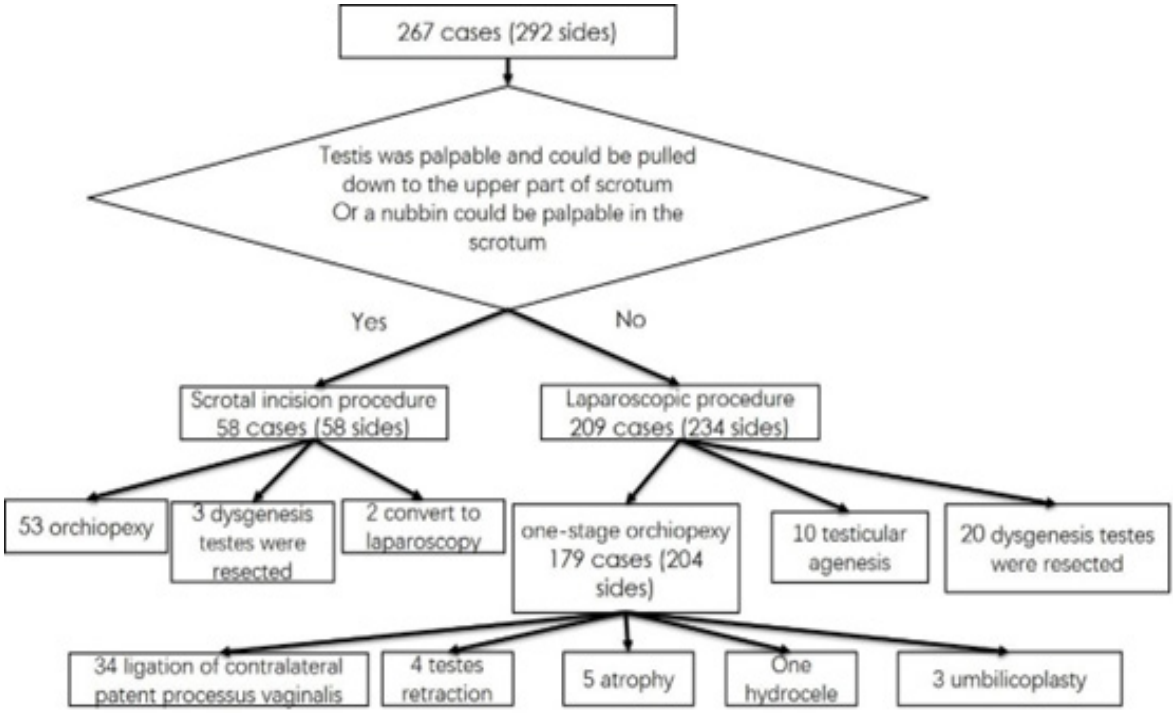

Figure 3. Case summary of the study.

and nearly invisible surgical scars compared with the traditional inguinal approach.

Parental concerns about the psychological effects of surgical scars on young children have catalyzed the advancement of scarless pediatric surgery. Numerous studies have shown that scars from skin cancer or burn injuries negatively affect children's self-esteem, leading to a high incidence of psychosocial stress[9,10] Although the psychological impact on children undergoing minor procedures such as orchiopexy has not been reported, we believe that improved postoperative cosmesis will be beneficial for the long-term psychosocial development of children. To achieve "scarless" operations and to minimize cosmetic damage in children, we modified established surgical procedures at our institution.[8,11] We aimed to minimize physical damage and visible scarring by selectively employing a scrotal incision or single-site transumbilical laparoscopic orchiopexy in children with UDT. The pursuit of aesthetic outcomes is premised on the safety and efficacy of surgery. This retrospective study indicates that both procedures are safe and effective, with a low complication rate and nearly invisible surgical scars compared to the traditional inguinal approach.

Orchiopexy is necessary for the treatment of UDT in pediatric patients. For a palpable testis, the current consensus is to perform open orchiopexy. Traditionally, inguinal orchiopexy is performed through an inguinal incision to release the testicle and a second incision in the scrotum to fixate the testicle. Since its introduction,

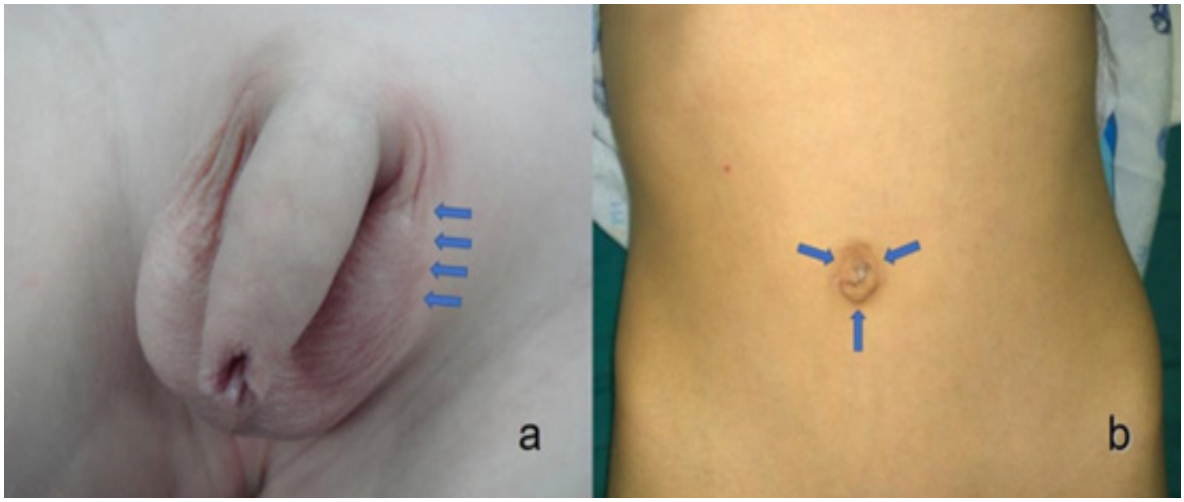

Figure 4. Incision scar was either concealed in the skin of the scrotum **(a)** or hidden within the umbilicus **(b)**. Blue arrows show the incision.

the single-incision transscrotal technique has gained popularity among pediatric urologists.[12,13] Compared with inguinal orchiopexy, the scrotal incision has the advantages of shorter operation time, shorter hospitalization duration, less postoperative pain, and better cosmetic effects.[14] Although two randomized controlled clinical trials found no significant difference in the incidence of postoperative complications between scrotal and inguinal orchiopexy,[15,16] the American Pediatric Surgical Association Outcomes and Evidence-based Practice Committee demonstrated that a scrotal incision was associated with lower rates of testicular atrophy.[17] In the current study, scrotal incision orchiopexy was successful in all patients, with no testicular retraction or atrophy. More importantly, small scars on the scrotum are almost invisible and can be covered by pubic hair in the future, thus avoiding the psychological burden of scarring on children and their parents.

For nonpalpable testicles, both the EAU and Nordic Consensus guidelines favor laparoscopy.[18,19] Laparoscopic orchiopexy has an accuracy of more than 98% for UDT diagnosis and allows the performance of orchiopexy in the same session. With this method, the exact location of the testis can be determined, thereby paving the way for direct surgery and preventing unnecessary inguinal or abdominal exploration. Single-site laparoscopy further reduces surgical scarring without compromising the effectiveness of the procedure.[18,19] Compared with other one-stage laparoscopic orchiopexy series (79%–86%),[17,20-21] the surgery performed at our center had a higher success rate. In our previous study, we performed single-site laparoscopic orchiopexy on 113 nonpalpable testes. Only one testis (0.9%) retracted through the external ring, and none of the children had testicular atrophy after the operation.[8] Out of the 209 cases of laparoscopic surgery in the present study, the overall complication rate was 4.3%, including testicular retraction (1.9%), testicular atrophy (2.4%), and postoperative hydrocele.

The high success rate achieved through laparoscopic surgery can be attributed to several factors: 1) The gubernaculum was left intact as far as possible. In our experience, the gubernaculum does not impede testis descent; thus, the testis can be mobilized without severing the gubernaculum. In contrast, the gubernaculum can provide an extra blood supply to the testis. Rarely, a testis without a gubernaculum could descend through the Prentiss maneuver after mobilizing the spermatic cord. 2) The collateral blood supply of the vas deferens is also carefully protected by preserving the posterior peritoneum around the vas deferens as well as between the vas deferens and spermatic vessels. 3) The spermatic vessels should be fully mobilized from the testis to behind the colon to decrease vessel tension. 4) All patients were advised to rest in bed for at least 1 week. We believe that this method reduces the incidence of retraction.

Notably, our data showed that all children with postoperative testicular atrophy were older than 6 years. Although it has been suggested that testicular position plays a more important role in testicular atrophy than surgical age,[22] Carson et al. proved that operating before the age of 1 year is safe in terms of minimizing postoperative testicular atrophy. Supporting this, Michikawa et al. found that older patients undergoing orchiopexy were more likely to have testicular morphological abnormalities (83.3% vs. 25.0 %, $p = 0.05$). At the same time, Allin et al. found that early orchiopexy was associated with a larger testicular volume and a higher number of spermatogonia per tubule, suggesting a better fertility prognosis.[23] Therefore, for children with cryptorchidism, orchiopexy should be performed early.

The additional complications noted in our study included everted umbilicus and postoperative hydroceles. An everted umbilicus was observed in three cases after laparoscopy. This result was attributed to the ligament attached to the umbilicus being severed by the trocars. Therefore, we now routinely stitch the umbilicus into the aponeurotic layer. A hydrocele, reported in only one case, healed after 3 months. One possible explanation for this is that the lymphatic tube of the spermatic cord was damaged during surgery. Instead of grabbing the spermatic cord, we stressed the peritoneum close to it during mobilization.

In addition, this study included three special cases. Typically, testicular agenesis and dysplasia are challenging to diagnose via a scrotal incision. However, in the present study, three cases of testicular dysplasia were excised through a scrotal incision. Preoperative ultrasonography revealed suspicious cord-like structures within the testicular tissue of these three pediatric patients. During physical examination, palpable nodules were detected in the scrotum, and all patients exhibited increased compensatory hypertrophy of the contralateral testis, consistent with findings reported by Shadpour et al.[24] Given that all three cases originated from rural areas where families faced significant financial constraints and lacked surgical insurance coverage, a scrotal incision was chosen as a cost-effective approach for confirmed unilateral testicular dysgenesis. Through a scrotal incision, the dysplastic testis and thinning vas deferens were observed and removed. The postoperative pathology confirmed the diagnosis.

Our study has several limitations. First, the study was retrospective; thus, case allocation may not have been random and may have had a selection bias. Furthermore, compared to traditional inguinal orchiopexy, the long-term psychological benefits of these “scarless” procedures should be further investigated.

CONCLUSIONS

Based on careful patient selection, we demonstrated through this study that most UDT cases could be corrected by selectively using either scrotal incision orchiopexy or single-site transumbilical laparoscopic orchiopexy depending on testicular location. This approach resulted in nearly invisible scar healing and minimal complications.

SUMMARY

For undescended testicles in children, two scarless surgical methods, scrotal incision and laparoscopy, are safe and effective, offering excellent cosmetic results and few complications based on the testicle's location.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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