Journal of Pediatric Surgery 58 (2023) 2020–2026

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.sciencedirect.com/journal/journal-of-pediatric-surgery

Medium-Term Results of Staged Laparoscopic Traction Orchiopexy for Intra-abdominal Testes: A Multicenter Analysis

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ARTICLE INFO

Article history:
Received 13 January 2023
Received in revised form
2 April 2023
Accepted 19 April 2023

Keywords:
Staged laparoscopic traction orchiopexy
Shehata-technique
Intra-abdominal testis

ABSTRACT

Background: Staged laparoscopic traction orchiopexy (SLTO) is a novel technique for the intra-abdominal testis (IAT) based on elongation of the testicular vessels without separating them. This multicenter study evaluated the medium-term results of this technique.
Methods: Data of SLTO performed in three pediatric surgical centers between 2013 and 2020 were analyzed retrospectively. In 2021, physical and Doppler ultrasound examinations were performed to determine the position and viability of testes. Success was defined as an intra-scrotal testicle without atrophy.
Results: SLTO was performed on 48 cases (55 testes, 7 bilateral). Mean age at first stage was 2.9 (0.8−12.6) years. High intra-abdominal testes were found in 16.4% and in 60% morphological abnormalities were observed. To fix the testes to the abdominal wall monofilament suture was used in 67.3%, braided in 29.1%. Mean time between the two stages was 16.4 weeks; three testes required redo traction.
Perioperative complications occurred in 21 patients (38.2%) including insufficient fixation (11), testicular atrophy (4), wound complications (4), adhesion of the spermatic cords (1) and hydrocele (1). In case of insufficient fixation monofilament sutures were used in 90.9%.
In 2021 38 patients (43 testes) had physical and 36 patients (41 testes) had ultrasound examinations. Mean follow-up was 2.7 (0.34−7.9) years. Altogether five atrophies were identified, and three testicular ascents (7.0%) occurred. The overall success rate was 82.2%.
Conclusions: SLTO may be a feasible alternative to conventional treatments of IATs. Additionally, braided suture seems to be a better option to fix the testicle to the abdominal wall.
Level of Evidence: LEVEL IV.

1. Introduction

Undescended testis (UDT) is the one of the most common disorders in boys concerning approximately 3.5% of male newborn's [1]. The etiology and pathogenesis seem to be multifactorial with potential contribution of several mechanisms, including genetic, hormonal, and mechanical factor [2]. There is a left-sided predominance, and association is possible with comorbidities such as cardiac or genitourinary anomalies, as well congenital syndromes [3].

The retained testes can be located anywhere between the abdominal cavity and the entrance of the scrotum, typically along the normal path of descent [4]. Generally, 20% of UDTs are non-palpable (NPT) and 15−34.1% of NPTs falling into intra-abdominal category [3,5]. Testes situated ≥2 cm proximal to the ipsilateral internal inguinal ring are defined as high intra-abdominal testes (HIT) (Ain Shams classification Type 4) [6]. Currently, diagnostic laparoscopy has been universally accepted and recommended, as gold standard, for identifying IAT and to determine the further treatment [7,8].

Recent guidelines such as recommendations of the American Urological Association (AUA) and The European Association of

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https://doi.org/10.1016/j.jpedsurg.2023.04.013
0022-3468/

Abbreviations

AUA	American Urological Association
DSD	disorders of sex development
EAU	The European Association of Urology
FSO	Fowler Stephens orchiopexy
HIT	high intra-abdominal testes testis
IAT	intra-abdominal testis
NPT	nonpalpable testis
SLTO	staged laparoscopic traction orchiopexy
UDT	undescended testis
US	ultrasound

Urology (EAU) advocate orchiopexy between 6 and 18 months of age to maximize fertility potential and to decrease the risk of malignant changes [8–10]. Despite the high prevalence, surgical treatment of intra-abdominal testis (IAT) is still challenging. The main limiting factor is the shortness/brevity of testicular vessels, hindering adequate and tension-free placement of the testis into the scrotum. Moreover, too much stretching on the testicular vessels may cause circulatory disorder, sometimes atrophy of the testis. To overcome this factor numerous treatment options have been described. If the testis can reach the scrotum without any tension after careful dissection and mobilization, typically one-stage laparoscopic orchiopexy is performed with a great (85–100%) success rate [3,11].

If the vessels are too short, staged orchiopexy should be chosen. One of the most popular techniques is the two stage Fowler Stephens orchiopexy (FSO), performed laparoscopically, where the spermatic vessels are transected to gain length to bring the testes to an orthotopic location. An alternative and technically demanding approach is the microvascular testicular auto-transplantation, where the vessels are transected, the testis is brought down to the scrotum, where vessels are re-anastomosed to the inferior epigastric vessels [1,3,12,13]. Pooled estimated success rate of FSO is 80%–85% and 88% of microvascular orchiopexy, although the functional effect and fertility outcomes are still questionable [3,14,15].

To reduce the rate of testicular atrophy Shehata et al. revisited the laparoscopic traction technique with preservation of the main blood supply of the testis in 2008 (Shehata technique or two-stage laparoscopic traction orchiopexy [SLTO]). At the first stage, after dissecting the gubernaculum and the lateral peritoneal attachments, the intra-abdominal testis is fixed up to the abdominal wall near the contralateral anterior superior iliac spine. After three months, the testis is detached and brought down to the scrotum via the anatomical way or by Prentiss maneuver. In between the two stages the elongation of the cross-stretched testicular vessels is carried out by gradual traction due the weight of intestine as well because of the respiratory movements of the abdominal wall [16].

So far, surgical results of Shehata technique are mostly single centric, including mainly low number of cases with relatively short-term follow-up. The aim of the present national multicenter study was to retrospectively analyze the medium-term results on a larger cohort.

2. Methods

2.1. Study design

Patients with NPT treated with SLTO were enrolled in the study from three Hungarian centers between January 2013 and October 2020. Medical records were retrospectively reviewed for demographic data, operative findings, and details as well as post-operative events.

The follow-up of the patients was carried out by the surgeon's own preference.

All patients were called back for an additional check-up in 2021 to collect the actual status of their testicles. The position of the testes was determined by physical examination. The viability was controlled by Doppler ultrasound (US) examination: testicular atrophy was diagnosed if no testicular tissue or no blood flow was detectable. Relocation or ascent was identified if the testicle was placed outside the scrotum. Success was defined as proper scrotal position and blood flow on Doppler US. Furthermore, testicular size was assessed by US and compared to the contralateral descended testicle.

The study was approved by the ethical committees of the institutions (IRB numbers and date of approval: 87/2017-SZTE, 22/05/2017).

2.2. Inclusion criteria

All boys diagnosed with non-palpable testes were subjected to diagnostic laparoscopy. Atrophic IATs or remnants were removed. If a viable IAT was found, stretching test was performed to determine the feasibility of SLTO: in case the testis reached the contralateral internal inguinal ring tension free – it could be mobilized to the scrotum without tension – standard single stage laparoscopy was done. When single stage laparoscopy was not feasible the testis was mobilized to the fixation point: if it occurred with moderate tension the patient underwent the first step of SLTO.

2.3. Operative technique

Operative technique was performed according to the initial description of Shehata et al. [7,17]. The patient was positioned in supine position. Re-examination was done under general anesthesia and if the testis was nonpalpable, diagnostic laparoscopy was carried out. Testicular morphology was evaluated by inspection.

After dividing the gubernaculum, stretching test was performed. The testis was mobilized with the division of the lateral peritoneal attachments and was fixed to the abdominal wall one inch above and medial to the contralateral anterior superior iliac spine using a single stitch, which was a 3-0 braided, non-absorbable suture with 17 mm ½ circle round needle or 3-0 monofilament, non-absorbable suture with 17 mm ½ circle round needle. The suture was inserted through a small skin incision at the determined point into the abdominal cavity. After taking an appropriate amount from the testis, the suture was pulled out through the skin incision, tied extracorporeal and buried subcutaneously.

The second stage was performed average 3 months after the first operation. The abdominal cavity was inspected for any adhesive bands, internal herniation, slippage of the suture, or adhesion of the spermatic cords in bilateral surgeries. The atrophic testes were removed. Degree of elongation of testicular vessels was measured indirectly by passing a forceps behind them at the midline and by elevating them toward the anterior abdominal wall. Then, the fixation stitch was divided, and the testis was delivered to the contralateral internal inguinal ring (stretching test). If the testis can't be brought to the contralateral internal ring, redo traction (refixation of the testis) was performed.

If the length of testicular vessels was appropriate, an ipsilateral scrotal incision was made, and the testis was delivered through a new hiatus medial to the inferior epigastric vessels (Prentiss maneuver) or through the inguinal canal into a sub-dartos pouch and sutured to the scrotal wall using an absorbable suture.

2.4. Follow-up details

Testicular blood flow, position, and size were prospectively analyzed in 2021. Physical examination occurred to determine the position of the testes. The viability was controlled assessed by Doppler US examination: testicular atrophy was diagnosed if no testicular tissue or no blood flow was detectable. Relocation or ascent was identified if the testicle was placed outside the scrotum. In these cases, our treatment strategy was redo open orchiopexy. Success was defined by appropriate scrotal position by physical examination, with appropriate flow on Doppler US. Testicular volume was determined by scrotal US, testicular dimensions were measured and volume was calculated using the ellipsoid formula (volume = r1 × r2 × r3 × 0.52). In unilateral surgeries testicular volume of the operated testis was compared to descended contralateral one.

2.5. Statistical analysis

Demographics including age, laterality, comorbidities, and operative data such as intraoperative testicular location, testicular morphology, type of suture used for testicular fixation to the abdominal wall, fixation of the testis in the scrotum, time interval between first and second stages, number and outcomes of redo tractions, conversions and perioperative complications were analyzed retrospectively. Prospectively testicular viability, location, size, and success rate were assessed, and follow-up period was described.

Descriptive statistics were used to analyze the data. Categorical variables were expressed as frequencies and/or percentages in each category. Continuous variables were presented as mean (range).

3. Results

Patient demographics, operative data, and details of follow up are listed in Table 1. The course of the clinical study is summarized in Fig. 1. In the study period, 48 patients (55 testes) were treated with SLTO in the participating centers. From these, 23 IAT were right-sided, 18 were left-sided and 7 bilateral surgeries occurred. The latter were operated in the same session. Associated conditions – partial androgen insensitivity and Prune Belly syndrome – were seen in two patients. Mean age at first stage was 2.9 (0.8–12.6) years. At the operation, the majority (52.1%) of the children was older than 1.5 years, in addition 16.7% of the patients were beyond 6 years. High IAT were found in 16.4% of the cases. Morphological abnormalities (testicular hypoplasia or vas deferens and epididymis anomaly) were observed in 60%. The type of suture used for testicular fixation to the abdominal wall was monofilament in 67.3% and braided in 29.1%. In 3.6% the suture material was not recorded.

The mean elapsed time between the two stages were 16.4 (5.1–48.1) weeks. The traction interval passed uneventfully without any serious complications. Failure to achieve adequate elongation occurred in three cases (5.5%); redo traction was done in all of them. Testicular atrophy developed in four cases between the two stages, two of them after re-do redo traction. All the removed testes already showed morphological abnormalities at the first visual evaluation during the first stage and histology examination showed hypoplasia in all four cases. In three out of the four atrophic testes, slippage of the traction stitch leading to insufficient elongation was observed as well. The fourth case was a bilateral IAT, where cross adhesions between the testicular vessels was reported due to the simultaneous cross traction. After separation of the spermatic cords, one testicle was successfully brought down to the scrotum and the other atrophic testicle was removed. Slippage of the fixation stitch (which means that the suture cut through and the testis was found floating in the abdomen) occurred in 11 cases (20%), where 10 from 11 (90.9%) were monofilament suture material.

Table 1
Demographics, operative data and follow up details.

Demographics	mean (range)	n (%)
Laterality		
Unilateral		41 (85.4)
Bilateral		7 (14.6)
Age distribution at the first stage		
Age at first stage (years)	2.9 (0.8–12.6)	
≤1.5 years		23 (47.9)
1.5–6 years		17 (35.4)
≤6 years		8 (16.7)
Operative data		
Time interval between first and second stages (weeks)	16.4 (5.1–48.1)	
Intraoperative testicular location		
High intra-abdominal testis		9 (16.4)
Low intra-abdominal testis		46 (83.6)
Testicular morphological characteristics		
Hypoplasia and/or dissociation		33 (60.0)
Normal or not mentioned		22 (40.0)
Fixing suture		
Monofilament, non-absorbable		37 (67.3)
Braided, non-absorbable		16 (29.1)
Not recorded		2 (3.6)
Fixation of the testis in the scrotum		
Prentiss maneuver		36 (70.6)
Through the inguinal canal		15(29.4)
Redo traction		3 (5.5)
Perioperative complications		
Fixation suture slippage		11 (20.0)
Attached spermatic cords		1 (1.8)
Surgical site infection		4(7.3)
Hydrocele		1(1.8)
Intraoperative testicular atrophy		4(7.3)
Follow up (assessment in 2021)		
Available for physical examination (testes)		43 (84.3)
Available for ultrasound examination (testes)		41 (80.4)
Follow-up duration (years)	2.7 (0.34–7.9)	
Outcomes		
Testicular atrophy		1 (2.4)
Testicular retraction		3 (7.0)
Success rate		82.2%

Testicles were brought down scrotum using Prentiss maneuver in 70.6%, and via the inguinal canal in 29.4% of the cases. One conversion was necessary due to technical problem. Postoperatively, four wound healing disorders (7.3%) and one temporary hydrocele (1.8%) were reported. The wound healing disorders included two cases of mild port-site wound inflammation, a case of port-site seroma, and a case of suture granuloma. All complications resolved spontaneously. Scrotal testicular position was achieved in 51 (92.7%) cases.

Thirty-eight patients (43 testes) showed up on control physical examinations and thirty-six patients (41 testes) had US examinations available as well. The mean follow-up period was 2.7 (0.34–7.9) years. Forty testes (93.0%) were found in adequate scrotal position. Testicular ascent occurred in three patients (7.0%). Color Doppler US identified testicular atrophy in one case (2.4%). In the remaining 97.6% of the patients, the circulation in the testes to the was appropriate. The overall success rate of the surgery was 82.2%. In unilateral SLTOs, size of the operated testes measured by US was compared to the contralateral one and the average volume difference was 34.3%. In two out of the three relocated cases redo open orchiopexy was performed via inguinal approach and the scrotal location has been satisfactory ever since. In the third case open orchiopexy is planned.

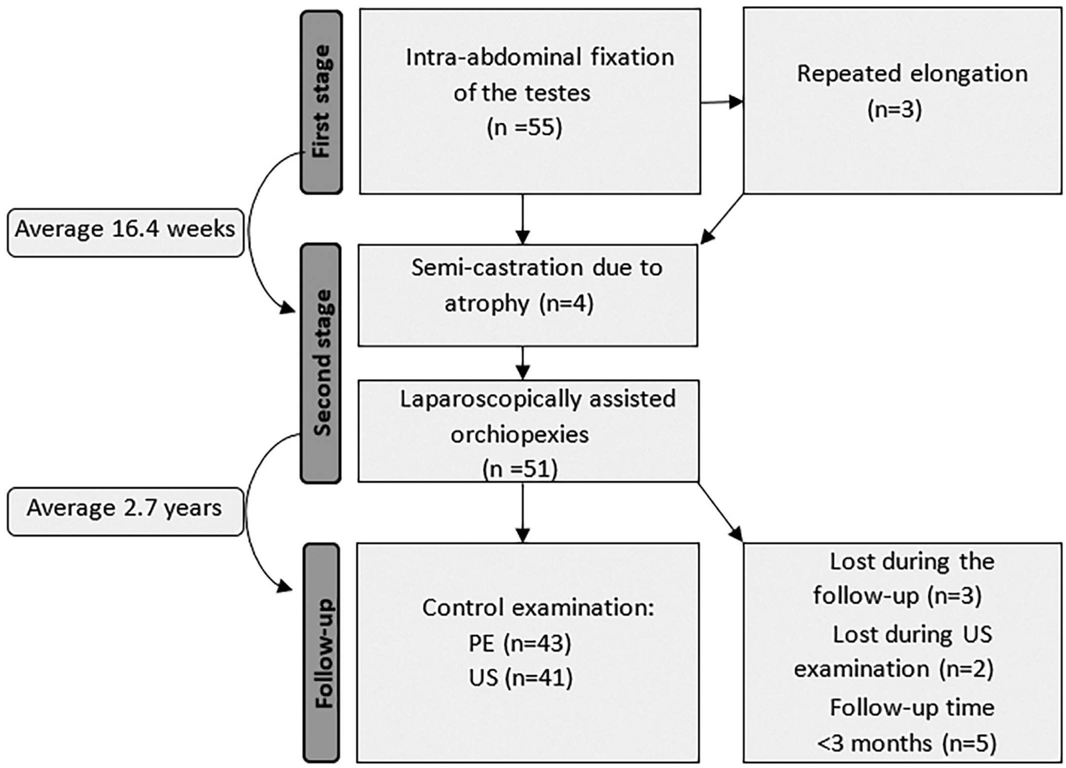

Fig. 1. Flow diagram describing the course of study (PE – physical examination, US – ultrasound).

4. Discussion

Until now, surgical results of Shehata technique were mainly resulted from a single center, including relatively low number of cases with short- or medium-term follow-up. Since 2008, six articles were published providing results of 249 SLTOs (Table 2) [17–22]. Our recent study is the second largest and represent the longest follow-up series of IATs treated with SLTO after Shehata's procedure up to now. In our study, additional color Doppler US was performed to confirm the viability of the operated testes.

All study, listed in Table 2., support that SLTO is a safe and feasible treatment of IATs, with comparable success rates with FSO and microvascular autotransplantation.

4.1. General considerations

In our clinical practice, the management of UDTs is based on the current EAU Guidelines on Paediatric Urology [8]. Accordingly, in the diagnostic of NPTs, imaging modalities are not routinely used: following a thorough physical examination, laparoscopy is our first choice. In cases of NPTs or bilateral UDTs and any sign of disorders of sex development (DSDs), like concomitant hypospadias, genital ambiguity, or scrotal hyperpigmentation, urgent endocrinological and genetic evaluation is performed.

Treatment of IATs is planned between 6 and 18 months of age. The cause of the relatively high mean age (2.9 years) at the first stage of the surgery is due to the delayed referral to the participating pediatric surgical centers. This treatment performed late may have an adverse effect on the outcomes, such as relatively greater mean size difference between the operated testis and the contralateral one, as well as a higher atrophy rate, compared to previous studies. Despite this, our results can still be considered successful. With our publication, we would like to draw attention to the importance of timely referral of UDTs to pediatric surgical or urological units.

Following the encouraging results of the Shehata technique, our primary treatment for IAT – which are not suitable for one-stage laparoscopic orchiopexy – became SLTO. We reserve the Fowler-Stephens technique for cases where the testis cannot reach the fixation point without undue tension. The operative technique of SLTOs followed the initial description of Shehata et al. [7,17]. In this study, we did not routinely perform testicular biopsy during orchiopexy in high IATS. In the future, we are planning further examinations to evaluate more accurately the success of the surgery, involving its long-term impact on future fertility, in which a testicular biopsy can be considered in order to predict future testicular function.

Postoperative follow-up is carried out by the surgeon's own preference: in general, the patients are being followed up in the outpatient clinic after at 7 days and at 3, 6 and 12 months. Testicular US is not routinely performed, therefore the use of it was part of the study itself.

4.2. Complications

In our series, perioperative complications occurred altogether in 38.2% of the operations including insufficiency of the fixation suture, adhesion of the spermatic cords, testicular atrophy, wound healing disorders and a hydrocele. We have found that the recommended traction period (12 weeks) is sufficient to achieve adequate elongation of the testicular vessels without any signs of inflammation or other drawbacks. We believe that this timeframe is suitable to achieve adequate elongation and good results.

4.2.1. Internal herniation, intestinal obstruction

Traction interval passed uneventfully without any serious complications. Although, there is a theoretical chance for internal herniation and/or strangulation of the intestines through testicular vessels passing across the abdominal cavity, this complication did not occur neither in the previous reports nor in our series [17–22].

Table 2
Outcomes of published staged laparoscopic traction orchiopexies (NR – not reported).

	Shehata 2016	Elsherbeny 2018	Abouheba 2019	Liu 2021	Bawazir 2021	Dawood 2021	Present study	All results
Number of SLTOs	140	22	34	22	11	20	55	304
Mean follow-up (years)	1.3	1	0.5	2	1	0.7	2.7	1.4
Success rate (%)	**84**	**90.5**	**NR**	**100**	**81.8**	**65**	**82.2**	**84.1**
Completed with orchiopexy	140	21	34	22	9	18	51	295
Followed operations	125	20	34	21	11	18	41	270
Atrophies	0	0	0	0	0	0	1 + 4	1 + 4
Relocations	20	1	NR	0	0	5	3	29

Bold values signifies the success rate is the most frequently used indicator of the success of the operation.

However, it is important to consider its possibility and inform parents accordingly.

4.2.2. Fixation suture insufficiency

Slippage of the stitch which fixes the testis to the abdominal wall during the traction period was the significant complication following the traction technique causing insufficient elongation of testicular vessels as well as inappropriate scrotal positioning. Therefore, redo traction is sometimes necessary before the second stage. In our investigation fixation suture insufficiency occurred in 11 cases (20%) due to cutting through the suture, while In in the previous studies, this complication was reported between 0 and 27.3% of the cases [17–22]. In two publications about Shehata technique, this complication was reported limited to older children, in which Abouheba observed it in children older than 6 years and Dawood in children older than 7 years of age considering consequence of limited stretchability and elasticity of short testicular vessels [19,22]. Interestingly, in our study only 27.3% of the children with fixation suture insufficiency were out of the recommended age. We observed that insufficient fixation 10 out of 11 testes happened when monofilament sutures were used, in contrast to the braided sutures: braided suture seems to be a better choice to fix the testes up to the abdominal wall. Earlier reports support our observation: the frequency of this complication was higher with monofilament suture material (27.3% vs. 9.1–14.7%) [17–19,21,22]. Although further research is required to clarify this reason for this observation.

4.2.3. Adhesion of the spermatic cords while a bilateral fixation at the same time

According to the original description of Shehata technique, the technique can be applied for bilateral cases simultaneously at the same time [17], however our experience shows, that it can lead to complications: cross adhesion of spermatic cords and subsequent division of them affords the possibility of testicular vessel and/or spermatic duct injury with consequent testicular atrophy and impaired fertility.

Adhesion between the crossed structures was reported to be 10.5% [17–19]. In our investigation, the frequency of this complication was 14.3%. Additionally, this adhesion caused consequent unilateral testicular atrophy in one case, which cannot be neglected. To avoid this complication, separate traction intervals are recommended in bilateral cases.

4.2.4. Testicular atrophy

Testicular atrophy is the most serious complication of orchiopexy affecting testicular function and fertility. In the earlier studies of Shehata technique the diagnosis of atrophy was mostly based on the percentage of testicular volume-loss compared to preoperative data or to contralateral testis. Because IATs are frequently underdeveloped compared to the contralateral testes we also used US to check the viability of testes. Atrophy defined as undetectable testicular tissue or lack of blood flow on Doppler US examination. In previous studies on SLTO, the reported atrophy rate was zero [17–22]. In contrast, in our analysis the sum atrophy rate was 11.1%. Four atrophies occurred between the two stages of the surgery requiring hemicastration of affected testes unilateral orchiectomies, two of them following redo traction. In all four cases, a macroscopically shrunk testis was found intraoperatively, and after removal, histology confirmed the hypoplasia with structural abnormalities. Probably, the reason for this is insufficient circulation in the already underdeveloped testes. During the follow up, testicular atrophy evolving after the second stage was detected only in one patient. In all of these, morphological abnormalities (testicular hypoplasia or vas deferens and epididymis anomaly) were already documented at the first operation. Furthermore, three of them were originally localized in high abdominal position, which may have a negative effect on our results.

There is no consensus on what constitutes an adequate determination of testicular viability postoperatively [23]. In our study Color Doppler US provided a reliable tool for evaluation of testicular atrophy: in our all cases the presence or absence of testicular circulation was obviously determinable and due to the lack of testicular vascularity testicular atrophy was clearly identified. Comparing the results of physical examination with US findings no remarkable difference was observed.

4.2.5. Other (minor) complications

In this series, the noted minor postoperative complications, such as wound healing disorders and hydrocele recovered spontaneously. In previous publications adhesions to the abdominal wall was reported in one case managed uneventfully.

4.3. Redo traction

According to the original description of Shehata, in case of fixation insufficiency, refixation of the testis is recommended for another 12 weeks to achieve an adequate elongation [17]. This technique was employed in four of the six earlier studies on SLTO and occurred in 9.1–14.7% of testes in corresponding articles, in total of 24 cases. In three publications the refixation-period lasted for 12 weeks, and in one report this time interval was not available. All testes that have undergone redo traction were successfully brought down to the scrotum [17–19,21].

In our study, if the testis did not reach the scrotum after the traction interval, redo traction was performed. Three testes required refixation; two of them because of slippage of the traction stitch. Time frame was defined by the surgeon's own preference, the mean retraction interval was 10.5 (7.7–14.4) weeks. One of them was brought down successfully to the scrotum and two testes have atrophied requiring unilateral orchiectomy. In the atrophied cases, macroscopic morphological abnormalities were already documented at the first stage.

Due to poor outcomes of redo traction in our series, other options can be considered. Elsherbeny et al. reported two cases with failure to achieve adequate elongation. In one of them the vessels were cut (converted to FSO), and the testis was brought to the scrotum, while in the other one, the vessels were spared, and the testis was brought to the upper part of the scrotum [18]. Dawood et al. presented two cases with suture slippage and consecutive inadequate elongation; they underwent staged FSO following the first stage [22]. Testis fixed in the upper part of the scrotum or inguinal area can also be attempted to be brought down to the scrotum later during another operation. In addition, microvascular testicular auto-transplantation can be also a possible treatment.

4.4. Testicular ascent

Appropriate scrotal location is desirable to maximize fertility and for early detection of possible malignancy [14]. However, there is no consistent definition of adequate testicular position following orchiopexy: in some of the previous studies low or mid scrotal testis was considered successful, while in others the proper position of the testes in the scrotum has not been defined. In our study adequate scrotal position was defined as intra-scrotal testis determined by physical examination. In the previous reports about Shehata technique proper position was achieved in 72.2–100% [17–22]. Our study showed similar results to the earlier outcomes: 92% of testes were in adequate scrotal position and three cases showed evidence of testicular ascents requiring redo open orchiopexy.

While 70.6% of the testes were brought down to the scrotum with Prentiss maneuver, in some cases the elongation was so successful, that the testicle could be brought down directly through the inguinal canal itself. However, the most preferred way was the Prentiss maneuver. During the follow up relocation was detected in similar proportion: in 6.7% of the cases of Prentiss maneuver and in 8.2% of the cases when the testis was brought down through the inguinal canal.

4.5. Testicular volume difference

Evaluating the results, Shehata determined normal testicular size – defined within 75–100% of the other side by US examination or to normal controls – as one of criteria of the success of the operation [17]. Except for Dawood et al., the other authors did not apply the exact volume difference of the testes as a criteria of the success of SLTO [18–22].

In our case series the mean volume difference between the operated and descended testes was 34.3%. Despite this, we do not consider our operations unsuccessful. It is well known, that IATs are usually smaller than the contralateral physiologically descended testes, and because of this volume difference this should not be considered a surgical complication [21].

Abdelhalim et al., in 2019 studied the testicular volume changes in laparoscopic staged FSO. They found that small testicular volume following staged FSO is mostly the result of abnormal development – at follow up, 83.3% of the testes, which were smaller than the mean (50th percentile) for age measured by US, were small for age at baseline – and less commonly due to damage of blood supply during the operation [24]. This is supported by our results too: morphological abnormalities such as testicular hypoplasia or anomaly of the vas deferens and epididymis were observed in 60% of the cases. For this reason, we consider the marked volume difference in our results a consequence of abnormal testicular development.

4.6. Success-rate

Overall success rate is defined as proper scrotal position with no testicular ascent without any signs of atrophy. According to this definition in our study the success rate was 82.2%, which is comparable to the previously reported series (65–100%) [17–22].

Traditionally, if an IAT can't be mobilized intraabdominally toward to contralateral internal inguinal ring without tension after careful dissection, one- or two- FSO is performed [3]. Two-stage method may be significantly superior [11]. In a few large series of two-stage FSO success rate was reported between 67 and 98% [25]. According to the same studies, in two-stage FSO the number of atrophies and relocations contributes to the failure of surgery similarly: atrophy occurs in 3.5–10.3% and ascent in 1.7–8.8% [24,25].

According to the original hypothesis of SLTO the gradual on lengthening of the intact testicular vessels may lead to lower atrophy rate in contrast to dividing them [7]. The previous studies supported this theory: according to the results, the main difference between SLTO and FSO was, that in SLTO, the failure of the surgery arise completely from testicular ascent (11.4%) while no testicular atrophy was reported [17–22]. However, our results with 11.1% testicular atrophy do not support this previously expected excellent atrophy rate, though, the overall success rate turned out to be beneficial. However, further long-term studies are required to provide more information about the success of this technique.

4.7. Limitations

The present study has some limitations.

Firstly, its retrospective nature with a relatively low number of patients and different follow-up periods. Although, the number of patients of our multicenter study is the 2nd highest published so far, still, to draw the proper conclusions even bigger cohort is needed. Our plan is to continue our study in order to obtain more data and longer-term results.

Secondly, mean age of the children at the surgery was relatively old compared to the current recommendations. Although this may have an adverse effect on the outcomes, our results were favorable.

5. Conclusion

Staged laparoscopic traction orchiopexy is a safe and feasible method for the treatment of intra-abdominal testes with good medium-term results. Doppler US findings confirmed that preservation of the testicular vessels provides appropriate circulation of the testes with low atrophy rate. According to our results, braided suture seems to be better to fix the testicle to the abdominal wall. Additionally, in bilateral cases separate traction intervals instead of simultaneous operation should be considered.

Further studies are still needed to evaluate the success of the surgery, involving very importantly its long-term impact on future fertility.

Previous communication

None.

Funding

University of Szeged Open Access Fund; Grant number: 5976.

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