Original Article

Techniques of staged laparoscopic orchidopexy for high intra-abdominal testes in children: A systematic review and meta-analysis

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Abstract

Background: Laparoscopic exploration is currently considered the gold standard for managing nonpalpable intraabdominal testes. The problem of short vascular pedicle is addressed in Fowler-Stephen (FS) technique by the division of testicular vessels and in Shehata technique (ST) by traction on testicular vessels. There is a lack of the consensus among pediatric surgeons on the choice of one technique over other. This analysis compares the reported outcomes of staged laparoscopic orchidopexy by ST with the time tested FS technique in managing high intraabdominal undescended testis.

Materials and Methods: The present systematic review and meta-analysis was conducted as per the preferred reporting items for the systematic review and meta-analyses guidelines. Only randomized controlled trials and comparative studies were included. The primary outcomes compared were the incidence of testicular atrophy, testicular retraction/ascent rate, and operative time of Stage I and Stage II orchidopexy.

Results: The present analysis was based on three randomized studies with a total of 119 undescended testes in 117 patients satisfying the inclusion criteria. The operative time was less in Stage I FS technique; however, there was no statistically significant difference in operative time of both procedures during the Stage II laparoscopic orchidopexy. Pooled analysis of postintervention testicular atrophy, testicular retraction rate, and duration of postoperative hospitalization showed no difference between both procedures.

Conclusion: Both FS and STs are comparable in terms of postintervention testicular atrophy, testicular retraction/ascent; however, the mean operative time is significantly less with FS technique in Stage I laparoscopic orchidopexy.

Keywords: Intra-abdominal, laparoscopic, orchidopexy, staged, techniques, undescended testes

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Received: 17.01.2023, **Accepted:** 21.08.2023, **Published:** 15.11.2023.

INTRODUCTION

Undescended testis (UDT) is a common congenital genitourinary abnormality in boys.[1] Its reported the incidence ranges between 3.4% and 5.8% in full-term infants. The incidence is still higher (9.2%–30%) in premature male infants. UDT can descend spontaneously over time, occupying the scrotal sac in 70% of infants. Hence, the prevalence is approximately 1% after 1 year

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/ua.ua_11_23

How to cite this article: Borkar NB, Tiwari C, Mohanty D, Vepakomma D, Nagdeve N. Techniques of staged laparoscopic orchidopexy for high intra-abdominal testes in children: A systematic review and meta-analysis. Urol Ann 2024;16:64-70.

of age, similar to that in adults.[2-4] The risk factors include premature birth, small for gestational age at birth and birth weight <2.5 kg.[5-8] Prenatal exposure to endocrine-disrupting chemicals (e.g., diethylstilbesterol and pesticides) is also a known risk factor for UDT.[9]

The UDT is divided into palpable and nonpalpable based on the ability to palpate the testis outside the scrotal sac. The examination under anesthesia is the first step in the surgical management of the clinically nonpalpable testis. Laparoscopic exploration for the nonpalpable testis is diagnostic and potentially therapeutic for clinically nonpalpable testis. The laparoscopic approach is accepted as the gold standard for managing nonpalpable testis. The first surgical objective of laparoscopy is to determine whether or not the testis is present. If the testis is identified laparoscopically, then a decision is to be made for bringing it down to the scrotum in the same setting or as a staged procedure. Approximately 10% of infants with nonpalpable testes are found to have blind-ending testicular vessels, indicating an absent testicle.[10] Laparoscopic classification of nonpalpable testis was initially proposed by Hay *et al*.[11] in 1999 and later updated by Abou Zeid *et al*.[12] in 2012. This classification divides the intraabdominal testis into four types depending on its location in relation to the deep ring. The laparoscopic approach to bring the testis down to the scrotum is technically challenging in patients with insufficient testicular vascular pedicle length. The techniques such as single-stage/two-staged Fowler Stephens (FSs) orchidopexy as well as the staged laparoscopic traction orchidopexy (Shehata) can be offered to these patients.

In FSs orchiopexy, the division of the testicular vessels is essential to gain adequate length for testis relocation into the scrotum. Once the testicular vascular pedicle is ligated, the viability of the testis depends on the collateral blood supply from the inguinal canal vessels, gubernacular vessels, and hypertrophied artery of the vas. In the Shehata technique (ST),[13] the testicular vessels are not divided and anchored to the anterior abdominal wall, which spares the main testicular blood supply while allowing gradual and gentle traction on the stretched testicular vessels. The weight of the intestine on the stretched testicular vessels is responsible for this gradual traction on the testicular pedicle.[13] The movement of the abdominal wall muscles during respiration also aids this traction and elongation of the testicular vessels. Nondivision of the testicular vessels is an added advantage of the ST over the FSs technique. Fixation of the testes to the opposite side of the abdominal wall leads to a theoretical possibility of band obstruction in the ST. The single-stage FS orchidopexy was associated with a considerable rate of testicular atrophy in the initial days. Later on, the two-stage procedure was adapted to minimize this complication. FSs technique has a testicular atrophy rate of around 10%.[14] Although FSs procedure is well tested over time, the ST has recently gained acceptance as it has very negligible testicular atrophy rate due to intact vascular supply as compared to the incidence of 10% in the FS technique. Testicular slippage after Stage I ST is not observed in FS technique.[13,15] Shehata reported a success rate of more than 90% in boys younger than 2 years and 64% in boys older than 6 years over around 85% success rate FS orchidopexy.[15] The drawback of the ST is the longer operative time for the Stage I procedure, along with a considerable slippage rate. This study systematically reviews the outcomes of staged laparoscopic traction orchidopexy by the ST and FS technique in managing intra-abdominal testes.

MATERIALS AND METHODS

What should be the laparoscopic technique of choice for managing high intraabdominal undescended testis?

Types of studies

We included only Randomized Controlled Trials and comparative studies for the present meta-analysis. Studies reported as abstracts with desired data, conference proceedings, and unpublished data were also included. We included studies that have been published in any language.

The inclusion criteria considered as follows:

- Participants/Population: All children under 18 years of age with unilateral or bilateral intraabdominal testis who required staged laparoscopic orchidopexy
- Intervention(s): Patients undergoing staged laparoscopic orchidopexy by ST
- Comparator(s)/control: Patients undergoing staged laparoscopic orchidopexy by FS technique
- Primary outcome(s): The incidence of testicular atrophy, testicular retraction rate, and operative time in Stage I and Stage II orchidopexy
- Secondary outcome: Duration of hospitalization.

Studies where laparoscopic orchidopexy were performed by techniques other than FS or ST and studies without the outcome of our interest were excluded from the final statistical analysis.

Electronic searches

The present systematic review and meta-analysis have been conducted as per the Preferred reported items for the systematic review and meta-analysis (PRISMA)

guidelines.[16] Extensive literature search was conducted to identify all the published and unpublished randomized controlled trials and comparative studies in all languages. Medline, Embase, CENTRAL, and Scopus databases were searched extensively. The US National Institutes of Health Ongoing Trials Register (clinicaltrials. gov) and WHO International Clinical Trials Registry Platform were searched for both completed and ongoing studies. The reference list of all primary studies was also reviewed. The search terms used were: nonpalpable testis OR intraabdominal testis OR impalpable testis AND laparoscopic staged orchidopexy OR Fowler Stephens orchidopexy OR laparoscopic traction orchidopexy OR Shehata orchidopexy.

Data collection and analysis

Selection of studies

Two authors (CT and DM) independently screened titles and abstracts for the inclusion. We retrieved the full text of potentially eligible studies and two review authors (CT and DM) independently screened the entire text and identified the studies for the inclusion. They also identified and recorded the reasons for excluding the ineligible studies. Both authors resolved their disagreements through discussion and when required, they consulted a third review author (NB) for clarification. We identified and excluded duplicate and collated multiple reports of the same study so that each study rather than each report is the unit of interest in this review. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram.

Data extraction and management

We used a standardized data collection form for the study characteristics and outcome data. Two review authors (CT and DV) independently extracted the study characteristics from the included studies. Two review authors (NN and DM) independently extracted outcome data from the included studies. Later, the data entry was performed by another author (NB) into an Excel sheet.

Methodological quality assessment

Two independent reviewers (CT and DM) conducted the methodological quality assessment utilizing modified Downs and Black Scale.[17] This checklist can evaluate both Rrndomized controlled as well as noncontrolled trials. The scale has 27 assessment points, yielding a score of 0–28. A third reviewer (NB) compared reviewers' results and discrepancies were resolved by mutual consensus. Subsequently, the Kappa statistics were used to adjudicate the interobserver reliability. Based on kappa values, the levels of agreement were defined as almost perfect (0.81–1.00), substantial (0.6–0.80), moderate (0.41–0.60), fair (0.21–0.40), slight (0.00–0.20), and poor (<0.00).

Measures of treatment effect

We analyzed the present data using Review Manager (RevMan) [Computer Programme]. Version 5.4. The Cochrane Collaboration, 2020. The dichotomous data were expressed as risk ratios (RRs) with 95% confidence intervals (CIs) and continuous data were presented as the mean difference (MD). We used the I^2 statistics to measure heterogeneity among the trials in each analysis. The individual patient was the preferred unit of analysis in our study. Heterogeneity was identified by the visual assessment of the studies' CIs in the forest plot (snowball search). Quantification of heterogeneity was done on the basis of following ranges of I^2 statistics:[18]

- 0% to 40%: might not be important;
- 30% to 60%: may represent moderate heterogeneity;
- 50% to 90%: may represent substantial heterogeneity;
- 75% to 100%: considerable heterogeneity.

RESULTS

Study characteristics

A total of 249 studies were identified through an extensive literature search. The search and selection process has been represented in PRISMA flow diagram [Figure 1]. After removing the duplicate studies, 222 records were screened for title and abstract. A total of 14 articles were retrieved for full-text screening, following which only three studies[19-21] were included for the final statistical evaluation.

Three studies including 117 children (119 testis), 65 in the FS group and 52 in the ST group met our inclusion criteria. The baseline characteristics of these included studies are summarized in Table 1.

Results of individual studies

The outcomes mentioned in the included studies are summarized in Table 2.

Methodological quality assessment

Modified Down and Black scores were assigned by two authors to each study and calculated. These are depicted in Table 3. The score ranged from 18 to 23. A study by Dawood *et al*.[21] was found to have the maximum score, whereas the study by Liu *et al*.[20] had the minimum score. There was a very high and positive correlation between the variables by rater 1 and rater 2 with $r = 0.87$. Thus, this sample has a very high positive association between rater 1 and 2.

Meta-analysis of the outcome

Mean operative time

All included studies had mentioned the mean operative

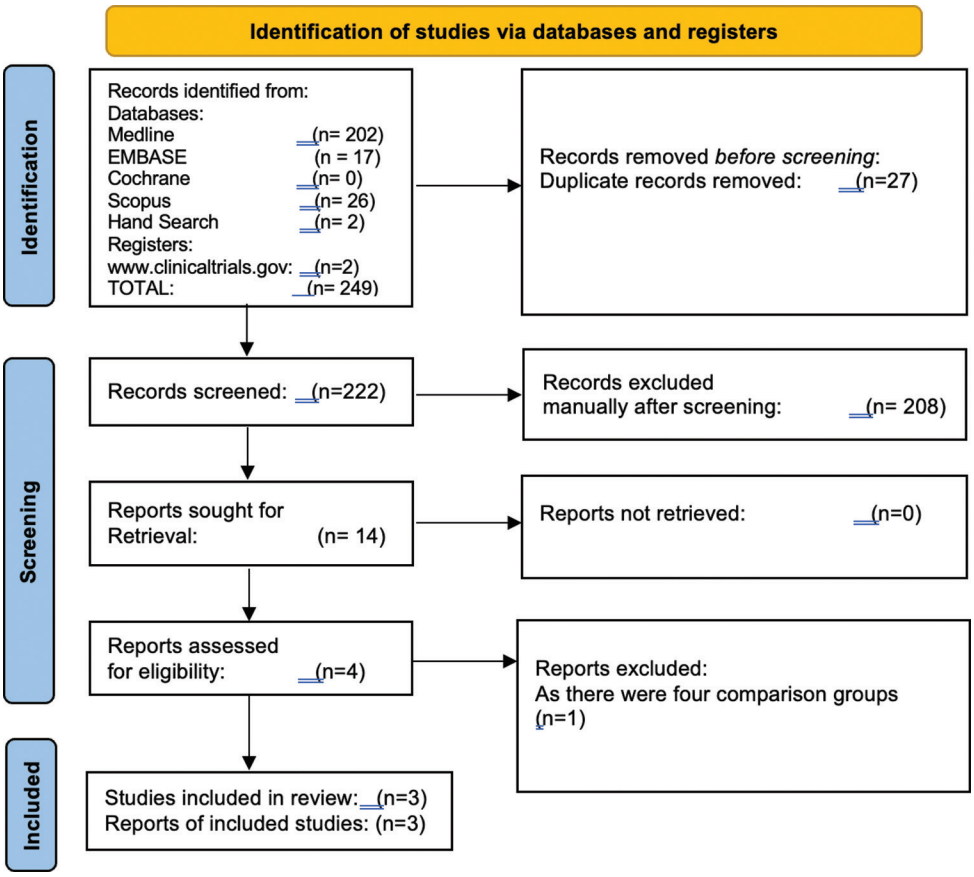

Figure 1: Preferred Reporting Items for Systematic Review and Meta-Analyses flow diagram

Table 1: Baseline characteristics of all included studies

Studies	Setting	Study period	Design	Patients (*n*)	Mean age	FS and SS	Follow up (months)	Reported outcomes
Liu *et al*. 2021[20]	China	April 2016–April 2020	Retrospective review	Total: 43 FST: 22 STT: 21	FST: 15.30±2.38 STT: 15.28±2.14	22 patients – 23 testes 21 patients – 22 testes	FS: 22.23±2.513 months ST: 23.71±1.487 months	Operation time, size and location of testis, testicular atrophy, testicular retraction
Dawood *et al*. 2021[21]	Egypt	June 2017–December 2019	Prospective randomized	Total: 45 FST: 25 patients, STT: 20 patients	FST: 29.5±27.1 months SST: 32.6±27.3 months (Range: 8–100 months)	25 patients: FST 20 patients: STT	6 months FS: 7±2.2 ST: 8.72±1.4	Total operative time, intra-operative complications, success rate, final scrotal site position, testicular size and vascularity
Bawazir *et al*. 2021[19]	Saudi Arabia	February 2017–February 2020	Retrospective cohort study Multicentric	Total: 30 FST: 18 patients STT: 11 patients	FST: 24.39±17.53 months SST: 20.27±10.57 months	18 patients: FS 11 patients: ST	12 months	Total operative time, Intra-operative findings, testes' size, position and consistency

FST: Fowler stephen technique, ST: Shehata traction, STT: ST technique, FS: Fowler Stephens, ST: Shehata Technique

time of both stages of the laparoscopic orchidopexy. We analyzed the data as the mean operative time for stage I and stage II procedures.

Mean operative time of stage I-Liu *et al*.[20] operated on one patient with bilateral orchidopexy in ST technique and Fowler Stephen technique group. We contacted the author inquiring whether it was the operative time per testis or patient. As per the author, the reported mean operative time is per the patient data. Pooled analysis of the three studies shows that mean operative time is less in Stage I in the FS group compared to the ST group which is statistically significant (MD, 10.14, CI, −12.39, −7.89) with considerable heterogeneity [Figure 2a].

Mean operative time of Stage II-Pooled analysis shows that the difference between mean operative time in FS and ST groups in Stage II is not statistically significant (MD, 4.84 CI,

Table 2: Summary outcome table

Study	Technique	Total (*n*)	Mean operative time (min)		Number of atrophic testis	Testicular ascent/retraction (outside scrotum)	Duration of hospitalisation	Testicular slippage after ST stage 1
			Stage 1	Stage 2				
Liu *et al*.[20]	FS	22 (23 testes)	62.75±6.02	60.90±5.13	1	4	Stage 1: 1.575±0.173 Stage 2: 1.692±181	-
	ST	21 (22 testes)	63.57±5.78	60.41±5.36	0	0	Stage 1: 1.476±0.143 Stage 2: 1.483±0.261	1
Dawood *et al*.[21]	FS	25	31.7±4.6	41.9±7.3	4 (one after stage I and 3 after stage II)	1	NA	-
	ST	20 (18 patients had stage II)	44.2±5.9	35.4±6	0	1	NA	2
Bawazir and Maghrabi[19]	FS	18	34.6±6.43	58±9.39	3	2	NA	-
	ST	11	76±12.23	74.18±12.62	0	2	NA	3

FS: Fowler stephen, ST: Shehata traction

Table 3: Summary of down and black scoring for qualitative assessment of the included studies

Study ID	Reviewer I	Reviewer II
Liu *et al*. 2021[20]	18/28	20/28
Bawazir *et al*. 2021[19]	19/28	20/28
Dawood *et al*. 2021[21]	20/28	23/28

−1.58, 24.81) with considerable heterogeneity (I^2 = 83%) [Figure 2b].

Testicular atrophy

All the included studies had reported testicular atrophy as the outcome measure. We calculated the testicular atrophy rate at maximum follow-up mentioned in the studies. There were no patients with testicular atrophy among the 53 testis in the ST group, but eight testis developed testicular atrophy among the 66 testis (12.12%) in the FS group. One out of the eight patients developed testicular atrophy following the stage I FS procedure and the other seven had testicular atrophy after the stage II FS procedure. The pooled analysis of all the included studies showed no significant difference in both comparison groups (RR 0.23, CI 0.04, 1.27) without statistical heterogeneity [Figure 2c].

Testicular retraction/ascent

This complication had been reported in all three studies. We considered the testicular position out of scrotum retraction/ascent as failure. As per Dawood *et al*.,[21] out of 20 only 18 patients underwent Stage II Shehata traction orchidopexy; hence, we calculated this number for pooled analysis. Three patients with testicular ascent/retraction were reported in the ST group (5.88%) and seven in the FS group (10.60%). Pooled analysis of all three studies shows no statistical difference in testicular ascent/retraction between both groups (RR 0.61, CI 0.19, 1.97) with insignificant heterogeneity [Figure 2d].

Duration of hospitalization had been reported only by Liu *et al*.[20] for both Stage I and Stage II procedure. There is no statistically significant difference in postoperative hospitalization among FS and ST group in Stage I and Stage II orchidopexy (P = 0.499, P = 0.528 respectively).

Testicular slippage is the complication observed only with ST. In our meta-analysis, there are 6 slippages among 53 testes making the slippage rate around 11.3%.

DISCUSSION

Summary of result

Three studies met our inclusion criteria. The pooled analysis of the mean operative time showed less duration in Stage I of the FS group. We found the difference in the testicular atrophy rate and testicular ascent/retraction rate to be statistically insignificant on pooled analysis.

The classical and popular approach for high intraabdominal testis has been a staged approach with the division of testicular vessels in Stage I followed by mobilization of the testis into the scrotum in Stage II. Division of testicular vessels is needed to achieve the necessary mobilization to place the testis inside the scrotal sac. Despite the high success rate of this approach, various reports have addressed the varying degree of damage to the testis after the interruption of testicular blood supply. This injury is much more significant on histopathological evaluation than the changes observed on gross examination of the testis. Esposito *et al*.[22] reported a 10-year follow-up data of the FS technique with reasonable success in terms of the final position of the testis; however, the operated testes were significantly smaller than the average size. With this concern, Shehata[13] in 2008 published a new concept of laparoscopically assisted gradual and controlled traction on the testicular vessels in managing the abdominal testis. Historically, Franz Torek[23] in 1909 and Cabot and Nesbit[24] in 1931 have described different techniques using traction on the high intra-abdominal testis. Although the principle of traction on testicular vessels appears exciting, a high incidence of stretch-associated testicular atrophy in the

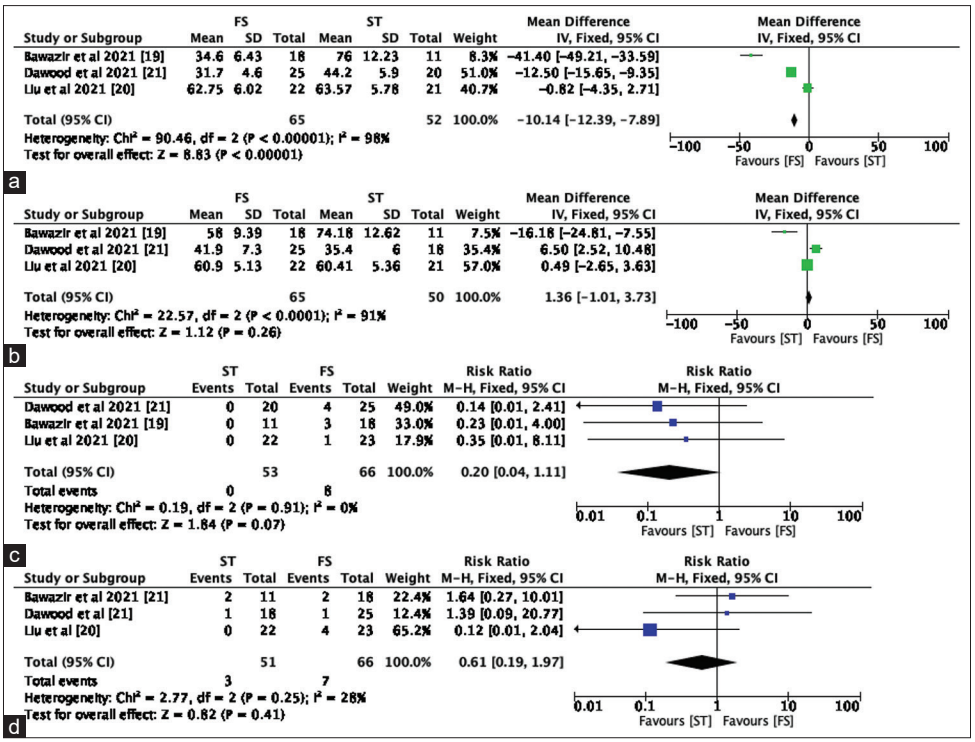

Figure 2: Forest plots. (a) Mean Operative time Stage – I, (b) mean operative time stage-II, (c) testicular atrophy, (d) testicular retraction/ascent

above-mentioned techniques is worrisome for surgeons. Acute and uncontrolled traction on the testicular vessels instead of gradual traction was the plausible reason for this complication. Subsequently, these techniques had now become obsolete.

The recent modification of the traction concept by Shehata *et al*.[15] has achieved wider acceptance than the older direct traction techniques on testicular vessels. The fixation point in the ST is on the abdominal wall rather than a fixed, nonyielding point. The mechanism of lengthening is achieved by gentle and gradual pressure of the weight of the bowel over the testicular vessels. The presence of testis inside the abdominal cavity prevents the formation of dense adhesions while placing the testis in the subcutaneous tissues during two-stage operations or similar traction techniques. The ST preserves the testicular vessels, achieves remarkable lengthening by gentle and gradual traction and is free from complications of testicular atrophy, as seen in other techniques.

Going through the result of our meta-analysis concerning testicular atrophy, even though there is no atrophy among the ST group and the different rate of atrophy among the ST and FS group is statistically insignificant. Case series by various authors,[25,26] including Shehata *et al*.,[15] have also reported no testicular atrophy among their operated cases by the ST of orchidopexy. In Stage I of ST, the testes are anchored to the anterior abdominal wall, so there is a possibility of internal herniation of the bowel behind the testicular vessels; however, none of the studies included in the metanalysis or any other studies[25,26] have reported this complication.

Slippage of the traction stitch from ST is a complication associated with ST only. It can sometimes be as high as 11% as reported by Shehata *et al*.[15] self and other authors up to 16%.[27] Once testis had lost its traction it was subjected to redo traction by Morshed G *et al*.[27] has subjected such testis to FS technique. FS is widely used method for laparoscopic orchidopexy and ST is emerging technique for the similar indication. Both techniques have similar success rate. Atrophy is a well-known complication related to FS and traction slippage with ST. As atrophy rate is the main clinical outcome and satisfaction for the patient with orchidopexy, ST has advantage over FS as testicular atrophy has not been reported in studies included in our meta-analysis or case series also.

Limitation of the study

Only three comparative studies satisfied the criteria for inclusion in our meta-analysis. The number of patients in these studies is relatively less, which is a major limitation of our meta-analysis. ST has a high success rate in patients of <2 years of age. We cannot determine the age-wise success rate of the procedures in our meta-analysis as this outcome has not been reported in the studies.

CONCLUSION

Our meta-analysis does not find a significant difference between both techniques regarding testicular atrophy or testicular retraction/ascent; however, the mean operative time is significantly less in the FS group in Stage I orchidopexy.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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