

OUTCOMES OF TWO-STAGE LAPAROSCOPIC FOWLER-STEPHENS ORCHIOPEXY FOR INTRA-ABDOMINAL UNDESCENDED TESTES IN CHILDREN UP TO 12 YEARS: A RETROSPECTIVE-PROSPECTIVE OBSERVATIONAL STUDY

Arun T Sen¹, Varun Sabari², Asok Kumar G M³

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Corresponding Author:

Dr. Arun T Sen,
Email: aruntsen1@gmail.com.

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¹Assistant Professor in Pediatric Surgery, Government Medical College, Kottayam -686008, Kerala, India.

²Assistant Professor Paediatric Surgery, Government Medical College, Trivandrum, Kerala, India.

³Senior Consultant, Department of Pediatric Surgery, KIMSHEALTH, Thiruvananthapuram, India.

ABSTRACT

Background: Intra-abdominal undescended testes (IAT) with short spermatic vessels represent the most surgically challenging form of cryptorchidism. The two-stage Fowler-Stephens (FS) laparoscopic orchiopexy remains the standard approach, yet age-stratified postoperative testicular size data from developing-country settings remain limited. Aim of the study was to evaluate testicular size and scrotal position after two-stage laparoscopic FS orchiopexy and to determine the influence of age at surgery on outcomes. **Materials and Methods:** A combined retrospective-prospective observational study was conducted over 60 months (January 2015–December 2019) at a tertiary paediatric surgical centre. Forty children (age 1–12.5 years) with intra-abdominal non-palpable undescended testes were included. Testicular size was assessed at 6 months using a Prader orchidometer and classified as comparable (>75%) or smaller (<75%) relative to the contralateral testis. Chi-square and McNemar tests were applied. **Results:** Mean age was 5.98 ± 3.73 years. Left-sided involvement was more frequent (57.5%). Pre-operatively, 67.5% had a smaller testis. At 6-month follow-up, 70% achieved comparable testicular size ($p < 0.001$, McNemar test). All children aged ≤ 7 years attained comparable size, whereas only 20% of those aged > 9 years did so. Age at surgery was a significant predictor (chi-square=22.857, $df=4$, $p < 0.001$). Wound infection occurred in 7.5% and resolved with topical antibiotics. **Conclusion:** Two-stage laparoscopic FS orchiopexy achieves satisfactory testicular outcomes in 70% of children, with markedly superior results in those operated before 7 years. Early surgical referral and timely intervention are critical.

INTRODUCTION

Cryptorchidism, the failure of one or both testes to descend into the scrotum, is the most common genitourinary congenital anomaly in male children, affecting approximately 1–4% of full-term male neonates and up to 30% of premature infants.^[1,2] Although spontaneous descent occurs in the majority during the first postnatal months, approximately 1% of males remain cryptorchid at one year of age.^[3] The condition is associated with impaired spermatogenesis, elevated risk of testicular germ cell tumour, torsion, inguinal hernia, and significant psychological consequences in the affected individual.^[2,4]

Non-palpable testes account for about 20% of all undescended testes, and about 50% of these are truly

intra-abdominal.^[5] The intra-abdominal location with short spermatic vessels precludes standard orchiopexy and necessitates specialized surgical techniques. The Fowler-Stephens (FS) technique, originally described in 1959, involves deliberate ligation of the internal spermatic vessels and relies on collateral blood supply through the vasal and cremasteric vessels to sustain testicular viability.^[6] Since the widespread adoption of laparoscopy in paediatric surgery, two-stage laparoscopic FS orchiopexy has become the gold standard for high intra-abdominal testes: Stage 1 involves testicular vessel ligation, and Stage 2, performed about 6 months later, accomplishes testicular mobilization and scrotal fixation.^[7,8]

Despite its established role, the two-stage FS procedure carries reported testicular atrophy rates

ranging from 0% to 35% across published series. Factors influencing outcome include age at surgery, preoperative testicular size, the length of the inter-stage interval, technical precision, and collateral vessel anatomy.^[9,10] International guidelines recommend orchiopexy by 6–18 months of age to preserve germ cell potential and fertility; however, late presentation remains a significant clinical challenge in low- and middle-income countries.^[3,11] Data specifically examining the interaction between age at orchiopexy and postoperative testicular growth outcomes in a South Asian tertiary setting are scarce. This study therefore evaluated outcomes of two-stage laparoscopic Fowler-Stephens orchiopexy with respect to testicular size and scrotal position at 6 months postoperatively, and identified age-related predictors of outcome.

MATERIALS AND METHODS

Study Design and Setting

A combined retrospective (January 2015–June 2017) and prospective (July 2017–December 2019) observational study was conducted in the Department of Paediatric Surgery, SAT Hospital (Government Medical College), Trivandrum, Kerala, India, over a total study period of 60 months. The Institutional Ethics Committee approved the study, and guardians of all enrolled patients provided informed consent.

Study Population and Sampling

A census-type sampling method was employed. All consecutive patients attending the Paediatric Surgery outpatient and inpatient services who satisfied the eligibility criteria during the study period were included, yielding a total sample of 40 cases.

Eligibility Criteria

Inclusion Criteria

1. Children aged 12 years or below at the time of the second-stage procedure.
2. Diagnosis of non-palpable intra-abdominal undescended testis with short spermatic vessels confirmed at stage-1 laparoscopy.
3. Completion of both stages of the Fowler-Stephens procedure.
4. Minimum postoperative follow-up period of 6 months.

Exclusion Criteria

1. Palpable undescended testes (inguinal or at the external ring).
2. Single-stage laparoscopic orchiopexy cases.
3. Patients or guardians unwilling to provide informed consent.
4. Follow-up of less than 6 months after Stage 2.

Surgical Technique

Stage 1 (Vessel Ligation)

Under general anaesthesia, a standard three-port laparoscopic approach was employed. The intra-abdominal testis was identified and assessed for size relative to the contralateral testis, using Maryland dissecting forceps as a visual reference. Testicular size was classified as comparable (>75% of

contralateral volume) or smaller (<75%). The internal spermatic vessels were then ligated with titanium clips or monopolar diathermy at least 2 cm proximal to the testis, ensuring preservation of the vas deferens and its accompanying vasal vessels (deferential artery). No traction sutures were placed. Stage 2 (Orchiopexy) — performed 6 months after Stage 1

A three-port laparoscopic approach was repeated. The testis, now relying entirely on the vasal and cremasteric collateral blood supply, was mobilized on a wide peritoneal pedicle. A retroperitoneal tunnel medial to the inferior epigastric vessels was created, and the testis was delivered into a subdartos scrotal pouch through a separate scrotal incision. Adequate tension-free scrotal positioning was confirmed before closure.

Outcome Measures

The primary outcome was testicular size at 6 months post-Stage 2, assessed using a Prader orchidometer. The testis was classified as comparable (>75% of the contralateral side) or smaller (<75%). Secondary outcomes included scrotal position of the orchidopexy testis and wound complications, assessed at 2 weeks and 6 months postoperatively.

Statistical Analysis

Data were recorded on a semi-structured proforma, entered into Microsoft Excel, and analyzed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages. The Pearson Chi-square (χ^2) test was used to examine the association between age group and testicular size. The McNemar test was applied to assess the statistical significance of the change in paired pre- and post-operative testicular size data. A p-value of <0.05 was considered statistically significant.

RESULTS

Among the 40 children included in the study, the age ranged from 1 to 12.5 years, with a mean age of 5.98 ± 3.73 years. Children younger than 3 years constituted the largest age group (30%), followed by those older than 9 years (25%). Left-sided undescended testes were more common than right-sided involvement (57.5% vs 42.5%). At Stage 1 laparoscopy, 27 patients (67.5%) had a testis smaller than 75% of the contralateral testicular volume, whereas 13 (32.5%) had comparable testicular size. At 6 months following Stage 2, 28 patients (70%) demonstrated comparable testicular size, while 12 (30%) remained smaller. Scrotal wound infection occurred in 3 patients (7.5%) and resolved with topical antibiotic therapy; no cases of testicular torsion, testicular loss, or hematoma were observed. Age was significantly associated with pre-operative testicular size ($\chi^2 = 26.933$, $df = 4$, $p < 0.001$). Among children younger than 3 years, 10 of 12 (83.3%) had comparable-sized testes, while all children aged 5 years or older had smaller testes at Stage 1. This

association persisted at 6 months postoperatively, with age remaining significantly associated with testicular size outcome ($\chi^2 = 22.857$, $df = 4$, $p < 0.001$). All children younger than 7 years achieved comparable testicular size at follow-up. In the 7–9-year group, 4 of 8 (50%) achieved comparable size, whereas only 2 of 10 (20%) children older than 9 years achieved comparable size. These findings demonstrate a clear age-related pattern in both pre-operative testicular size and postoperative size outcome.

The McNemar test demonstrated a statistically significant overall improvement in testicular size

following Stage 2 of the Fowler-Stephens procedure ($p < 0.001$). Of the 27 patients who had a smaller testis pre-operatively, 15 (55.6%) achieved comparable size at 6 months, while 12 (44.4%) remained smaller. All 13 patients with comparable pre-operative testicular size remained comparable postoperatively, with none showing a size reduction. Overall, the proportion of patients with comparable testicular size increased from 32.5% preoperatively to 70% at 6 months, indicating significant improvement after the procedure.

Table 1: Study population

	Frequency (n=40)	Percentage (%)
Age (years)		
< 3	12	30
3 – 5	5	12.5
5 – 7	5	12.5
7 – 9	8	20
> 9	10	25
Side		
Right	17	42.5
Left	23	57.5
Pre-operative Size		
Smaller (< 75% contralateral)	27	67.5
Comparable ($\geq$ 75% contralateral)	13	32.5
Post-operative Size		
Smaller (< 75% contralateral)	12	30
Comparable ($\geq$ 75% contralateral)	28	70
Wound Infection		
Present	3	7.5
Absent	37	92.5

Table 2: Age Group and Testicular Size Before and 6 Months after Fowler-Stephens Procedure

Age group (years)	Pre-op smaller n (%)	Pre-op comparable n (%)	Post-op smaller n (%)	Post-op comparable n (%)
< 3	2 (16.7)	10 (83.3)	0 (0)	12 (100)
3–5	2 (40.0)	3 (60.0)	0 (0)	5 (100)
5–7	5 (100)	0 (0)	0 (0)	5 (100)
7–9	8 (100)	0 (0)	4 (50.0)	4 (50.0)
>9	10 (100)	0 (0)	8 (80.0)	2 (20.0)

Table 3: Pre-operative vs Post-operative Testicular Size Comparison (McNemar Test)

Pre-op Size	Post-op Smaller n (%)	Post-op Comparable n (%)
Smaller (n=27)	12 (44.4)	15 (55.6)
Comparable (n=13)	0 (0.0)	13 (100.0)

DISCUSSION

This study presents outcomes of two-stage laparoscopic Fowler-Stephens orchiopexy in 40 children with intra-abdominal undescended testes treated at a tertiary paediatric surgical centre in South India over five years. The overall rate of satisfactory testicular outcome, defined as a testicular size comparable ($>75\%$) to the contralateral side, was 70% at 6-month follow-up. This is consistent with published series reporting success rates between 65% and 85% for the two-stage FS approach.^[7,8,9]

The age distribution in this series reflects delayed presentation typical of resource-limited settings. While 30% of patients were under 3 years of age, an age group with the best prognosis, a significant 25%

were over 9 years, a cohort with substantially worse outcomes. This is a clinically important concern, as current international guidelines recommend orchiopexy between 6 and 18 months of age to minimize germ cell apoptosis, preserve spermatogonial reserve, and reduce malignancy risk.^[1,3,11] Late presentation attributable to delayed referral, limited awareness, and restricted access to paediatric surgical care remains an unresolved challenge in South Asian healthcare systems.

The statistically significant association between younger age at surgery and superior post-operative testicular size outcomes ($\chi^2 = 22.857$, $p < 0.001$) is one of the key findings of this study. All children under 7 years achieved comparable post-operative testicular size, whereas only 20% of those over 9 years did. This age-response gradient closely mirrors

findings from Schneuer et al., who, in a large population-based cohort, showed that children undergoing orchiopexy before 24 months had significantly lower rates of testicular atrophy, complications, and re-operation than those treated later.^[4] Alagaratnam et al. similarly identified age at second-stage surgery as an independent predictor of testicular outcome in their laparoscopic FS cohort, with younger patients showing consistently better results.^[8]

The pre-operative observation that all children aged 5 years and above had a smaller testis at Stage 1 laparoscopy, compared with only 16.7% in the under-3 age group, provides direct intraoperative evidence of progressive testicular hypotrophy with prolonged maldescent. This is consistent with histopathological evidence showing a significant decline in germ cell number and tubular fertility index in cryptorchid testes beyond the second year of life.^[2,11] Hadziselimovic documented that even following technically successful early orchidopexy, azoospermia can develop when the initial germ cell reserve is already critically reduced, underscoring the biological urgency of early intervention.^[13]

The McNemar test confirmed a highly statistically significant improvement in testicular size following two-stage FS orchiopexy ($p < 0.001$). Remarkably, of the 27 cases with pre-operatively smaller testes, 15 (55.6%) improved to comparable size post-operatively, and all 13 cases with pre-operatively comparable testes maintained that status. This post-operative testicular growth likely reflects the beneficial effect of scrotal temperature regulation, re-established venous drainage, and hormonal stimulation in a normal scrotal environment.^[6,7] The two-stage approach, by allowing neovascularization of the testis over 6 months before the second stage, provides a physiological rationale for its superior outcomes compared to single-stage long-loop vas orchiopexy in high IAT.^[7,14]

The left-sided predominance (57.5%) observed in this cohort has been reported in other cryptorchidism series and may reflect embryological differences in gubernacular descent timing, differences in the angle of internal spermatic vein drainage, or higher intra-abdominal pressure in the left inguinal region.^[15] The wound infection rate of 7.5%, all restricted to the scrotal wound and treated conservatively with topical antibiotics, is consistent with published minor complication rates for this procedure.^[16,17] No major complications, including testicular loss, vascular injury, or torsion, were recorded.

The study is limited by its single-centre retrospective-prospective design and the relatively modest sample size of 40 cases. Testicular size was assessed by orchidometer comparison rather than by ultrasound volumetry, which may introduce inter-observer variability. Follow-up was limited to 6 months post-Stage 2; long-term surveillance for pubertal testicular growth, semen analysis, hormonal function, and eventual paternity were beyond the scope of this study. Prospective, multicentric studies with longer

follow-up incorporating objective ultrasonographic volumetry and hormonal outcomes are warranted.

CONCLUSION

Two-stage laparoscopic Fowler-Stephens orchiopexy is an effective and safe procedure for intra-abdominal undescended testes, yielding satisfactory testicular size outcomes in 70% of children at 6-month follow-up. Age at surgery is the single most important modifiable predictor of outcome: all children operated on under 7 years achieved comparable testicular size, compared with only 20% of those aged over 9 years. These findings provide strong evidence-based support for early diagnosis through neonatal examination programmes, timely referral to paediatric surgical centres, and completion of orchiopexy before 2 years of age wherever feasible. Postoperative improvement in testicular size was statistically significant (McNemar test, $p < 0.001$), affirming the therapeutic value of the staged approach in preserving testicular volume. Long-term prospective studies assessing pubertal testicular development, fertility, and oncological surveillance are essential to characterize outcomes in this population

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