

Outcomes of Laparoscopic Varicocele Ligation in Patients Presenting with Painful Varicocele

Kanchan Devi, Riaz Hussain Laghari, Haris Hassan Qureshi, Syed Arslan Shehzad Shah, Adibul Hasan Rizvi

ABSTRACT

Objectives: To determine the outcomes of laparoscopic varicocele ligation in patients presenting with painful varicocele, in terms of pain response after surgery and associated clinical parameters.

Study Design and Setting: This prospective longitudinal study was conducted at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), Karachi, from 3rd June 2025 to 3rd January 2026.

Methodology: A consecutive sampling method was used to enrol 54 male patients aged 18 to 70 years presenting with painful varicocele. Laparoscopic varicocele ligation was performed, and pain response, pampiniform plexus vein diameter and testicular volume were assessed at one week and three months. Data were analysed using paired t-tests, independent t-tests and Fisher's exact test, with significance set at $p = 0.05$.

Results: The mean age was 27.31 ± 9.05 years. Complete pain resolution occurred in 46 patients (85.2%; 95% CI 73.4–92.3). At three months, VAS scores declined from 6.43 ± 1.32 to $1.09 \pm$ [SD from SPSS] (mean change 5.33; 95% CI 4.60–6.06; $p < 0.001$). The pampiniform plexus diameter decreased from 3.72 ± 0.66 mm to 2.37 ± 0.81 mm (mean change 1.35 mm; 95% CI 1.24–1.46; $p < 0.001$), and testicular volume increased from 15.93 ± 3.15 ml to 16.97 ± 2.64 ml (mean change 1.03 ml; 95% CI 0.08–1.98; $p = 0.033$). Baseline characteristics showed no significant association with treatment response.

Conclusions: In this small single-centre cohort, laparoscopic varicocele ligation was associated with reduced varicocele-related pain and improved ultrasonographic parameters at three months. Larger comparative studies with longer follow-up are needed.

Keywords: Laparoscopy; Pain Measurement; Treatment Outcome; Varicocele

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INTRODUCTION:

Varicocele is defined as an abnormal dilatation and tortuosity of the pampiniform venous plexus within the spermatic cord, arising from retrograde venous reflux in the internal spermatic

veins, as described in the European Association of Urology (EAU) guidelines on male sexual and reproductive health.¹ It is one of the most common and surgically correctable conditions encountered in the adult male population and is clinically important because of its association with scrotal pain, testicular dysfunction and impaired fertility in a proportion of affected men.^{1,2} Varicocele is identified in a substantial share of the general male population and in an even higher proportion of men presenting for infertility evaluation, which underlines its clinical and public health relevance.² The pathophysiology of varicocele involves impaired venous drainage and consequent venous hypertension, which in turn contribute to testicular hyperthermia, oxidative stress, Leydig cell dysfunction and microcirculatory disturbance.²⁻⁴ These mechanisms not only compromise spermatogenesis but may also generate the nociceptive stimuli responsible for chronic scrotal discomfort. Painful varicocele represents a symptomatic phenotype characterised by chronic dull or dragging scrotal pain that is typically aggravated by prolonged standing or physical exertion and relieved by recumbency, and it can adversely affect daily activity and quality of life.⁵ In clinical practice the condition is graded from subclinical disease to grade

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three, with higher grades reflecting more pronounced venous reflux on physical examination and the Valsalva manoeuvre.⁶

Beyond its impact on fertility, painful varicocele imposes a considerable burden on quality of life, with affected men frequently reporting limitation of physical activity, occupational disruption and psychological distress related to chronic scrotal discomfort. Objective and reproducible assessment of the treatment response is therefore important. The visual analogue scale (VAS) is a simple, validated instrument for quantifying pain intensity and monitoring change after intervention, whereas scrotal colour Doppler ultrasonography provides an objective measure of pampiniform venous calibre, reflux and testicular volume. The combined use of subjective and objective measures permits a more complete evaluation of surgical outcome than either approach alone and has been advocated in the contemporary assessment of varicocele.⁶

Varicocele may be managed conservatively or surgically, and surgical ligation aims to interrupt venous reflux and restore testicular thermoregulation. Several operative approaches are available, including open inguinal and subinguinal techniques, microsurgical varicocelectomy, radiological embolisation and laparoscopic ligation. Laparoscopic ligation has emerged as a minimally invasive option that offers magnified visualisation, selective vascular control and a shorter convalescence compared with conventional open surgery.^{5,7} Evidence from prospective and retrospective cohorts indicates that surgical correction of symptomatic varicocele relieves pain by reducing venous pressure and testicular congestion.^{8,9} Series of varicocelectomy for painful varicocele have reported high rates of complete or partial pain resolution, with recurrence and complications also reported in the literature.^{9,10} Comparative evidence continues to examine differences among operative approaches and their perioperative outcomes.^{7,11} Despite the increasing use of laparoscopic varicocelectomy, the literature describing outcomes specifically in symptomatic painful varicocele remains limited, particularly in low- and middle-income countries. Published Pakistani studies have reported outcomes following laparoscopic varicocelectomy, but data specifically focused on painful varicocele remain limited.¹² This gap in pain-specific regional evidence limits context-appropriate clinical decision making and the development of standardised management pathways. In view of the limited pain-specific regional data on symptomatic varicocele in Pakistan, an evaluation of the pain response and related clinical changes after laparoscopic varicocele ligation is clinically justified. The present study was therefore undertaken to generate local evidence on the outcomes of laparoscopic varicocele ligation in patients presenting with painful varicocele, with the aim of supporting evidence-based surgical practice and informing patient counselling in comparable settings.

METHODOLOGY

This prospective longitudinal study was conducted at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), Karachi, from 3 June 2025 to 3 January 2026, following approval from the SIUT Ethical Review Committee (ERC approval number: SIUT-ERC-2025/A-536; approval issued on 25 February 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki and was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.¹³ Written informed consent was obtained from every participant before enrolment, after the purpose of the study and the nature of the procedure had been explained, and the confidentiality of patient information was maintained throughout.

Adult male patients between 18 and 70 years of age presenting with painful varicocele were eligible for inclusion. Varicocele was assessed by physical examination, including the Valsalva manoeuvre, and scrotal colour Doppler ultrasonography. Clinically palpable varicoceles were graded according to the standard clinical classification, while non-palpable (subclinical) varicoceles identified on Doppler ultrasonography were also included when they presented with clinically attributed varicocele-related pain and had no alternative identifiable cause of scrotal pain.⁶ Painful varicocele was defined as ipsilateral testicular or scrotal pain or discomfort clinically attributed to the varicocele, typically aggravated by prolonged standing or physical exertion. Pain severity was assessed using the visual analogue scale (VAS).⁵ Patients whose scrotal pain was attributable to other identifiable causes, including testicular torsion, inguinal hernia, epididymitis, trauma or testicular tumour, were excluded. Patients presenting primarily for evaluation of infertility were also excluded. Alternative causes of scrotal pain were assessed clinically and by scrotal ultrasonography / Doppler evaluation where indicated.

A total of 54 patients were enrolled using a consecutive sampling technique. The sample size was estimated using the formula for a single population proportion, taking an anticipated complete pain resolution rate of 83.8% reported in a comparable series,⁹ with a 95% confidence level and an absolute precision of 10%. Baseline information, including age, duration of pain and clinical grade of varicocele, was recorded on a structured proforma at enrolment. All procedures were performed by a consultant urologist with a minimum of five years of post-fellowship experience. Laparoscopic varicocele ligation was performed using a standard transperitoneal approach. The internal spermatic vessels were identified at the level of the deep inguinal ring, dissected and ligated, with preservation of the testicular artery and lymphatic channels where feasible. The operative approach was standardised across patients. Postoperative analgesia, discharge instructions and scheduled follow-up were standardised according to institutional practice.

The primary outcome was the pain response after surgery, assessed using the VAS, and the secondary outcomes were the change in pampiniform plexus vein diameter and the change in testicular volume. The pampiniform plexus diameter was measured in millimetres and testicular volume in millilitres using colour Doppler ultrasonography.^{6,14} Patients were reassessed at one week and three months after surgery. The number of patients completing each scheduled follow-up was recorded. The three-month assessment was used for the primary outcome analysis, and all 54 patients completed both scheduled postoperative follow-up assessments. Complete response was defined as complete resolution of varicocele-related pain at the final follow-up. Partial response was defined as a reduction in pain severity compared with baseline but persistence of pain at final follow-up, whereas no response was defined as no reduction or worsening of pain. Recurrence was defined as return of varicocele-associated pain after initial complete resolution. Hydrocele was defined as a new scrotal fluid collection detected clinically or on ultrasonography after surgery. Testicular atrophy was defined as a clinically or ultrasonographically evident reduction in testicular size. Reintervention was defined as any further procedure for persistent or recurrent varicocele. Other adverse events included any surgical or port-site complication. These were recorded when clinically identified.

Data were analysed using IBM SPSS Statistics version 26. Normality of continuous variables was assessed using the [Shapiro–Wilk] test before analysis. Descriptive statistics were expressed as mean $\pm$ standard deviation with 95% confidence intervals for continuous variables and as frequency and percentage for categorical variables. Pre- and postoperative parameters were compared using the paired t-test. Baseline continuous variables were compared between responders and non-responders using the independent t-test, and the association between varicocele grade and treatment response was assessed using Fisher's exact test because of small cell counts. All analyses were patient-based. A p-value of ≤ 0.05 was considered statistically significant. All data were recorded on a coded proforma and entered into a secure database accessible only to the investigators. No patient identifiers were included in the analysis dataset, and the anonymity of participants was preserved at every stage. Patients were free to withdraw from the study at any time without any effect on their routine clinical care.

RESULTS

A total of 54 male patients who underwent laparoscopic varicocele ligation for painful varicocele were included in the analysis. The demographic and clinical characteristics of the participants are summarised in Table I. The mean age of the cohort was 27.31 ± 9.05 years, and the mean duration of pain before presentation was 12.26 ± 6.67 months. The distribution of varicocele presentations was as follows: subclinical varicocele identified on Doppler ultrasonography

(2 patients; 3.7%), grade 1 (5 patients; 9.3%), grade 2 (15 patients; 27.8%) and grade 3 (32 patients; 59.3%). The comparison of pain intensity, pampiniform plexus diameter and testicular volume before and three months after laparoscopic varicocele ligation is presented in Table II. There was a significant reduction in pain intensity, with the mean VAS score declining from 6.43 ± 1.32 preoperatively to $1.09 \pm$ [SD from SPSS] at three months (mean change 5.33 ± 2.69 ; 95% CI 4.60–6.06; $p < 0.001$). Similarly, the mean pampiniform plexus diameter decreased from 3.72 ± 0.66 mm to 2.37 ± 0.81 mm (mean change 1.35 ± 0.40 mm; 95% CI 1.24–1.46; $p < 0.001$). A statistically significant increase in testicular volume was also observed, with the mean volume rising from 15.93 ± 3.15 ml to 16.97 ± 2.64 ml (mean change 1.03 ± 3.48 ml; 95% CI 0.08–1.98; $p = 0.033$). The association between baseline characteristics and treatment response is summarised in Table III. Of the 54 patients, 46 (85.2%; 95% CI 73.4–92.3) achieved a complete response and 8 (14.8%) showed no response. No patient had a partial response. The mean age did not differ significantly between complete responders and non-responders (27.67 ± 9.60 versus 25.25 ± 4.68 years; $p = 0.490$), nor did the mean duration of pain (12.02 ± 6.78 versus 13.63 ± 6.25 months; $p = 0.536$). Grade 3 was the most frequent presentation among complete responders, while grade 2 was most frequent among non-responders. The association between varicocele presentation and treatment response was not statistically significant (Fisher's exact test, $p = 0.158$).

DISCUSSION

Painful varicocele is a clinically relevant urological condition that adversely affects scrotal comfort, daily functioning and reproductive potential. Its pathophysiology is underpinned by venous hypertension, impaired thermoregulation and oxidative stress within the pampiniform plexus, which together contribute to testicular microcirculatory disruption and nociceptive signalling.^{3,4,6,7} Surgical correction is directed at eliminating venous reflux and decompressing the pampiniform plexus, and laparoscopic ligation has gained popularity because of its minimally invasive profile and superior intraoperative visualisation compared with open techniques.^{5,8} The present prospective longitudinal study evaluated the outcomes of laparoscopic varicocele ligation in a cohort of patients presenting specifically with painful varicocele, an indication that remains comparatively under-reported in the regional literature.

In this study, laparoscopic ligation was associated with substantial improvement in varicocele-related pain, with 85.2% of patients reporting complete resolution of pain at three months. The mean VAS decreased significantly from 6.43 to 1.09 ($p < 0.001$), a finding consistent with previous reports describing pain improvement after varicolectomy.^{8,9} Reported resolution rates vary considerably across series. Abd Ellatif et al. reported complete pain resolution in 83.8% of followed patients, with additional partial responses, a

Table 1. Demographic and Clinical Characteristics of Study Participants (n=54)

Characteristic	Value
Age in years, mean $\pm$ SD	27.31 $\pm$ 9.05 (95% CI: 24.84–29.79)
Duration of pain in months, mean $\pm$ SD	12.26 $\pm$ 6.67 (95% CI: 10.44–14.08)
Varicocele presentation, n (%)	
Subclinical	2 (3.7)
Grade 1	5 (9.3)
Grade 2	15 (27.8)
Grade 3	32 (59.3)

Table 2. Comparison of Pain, Pampiniform Vein Size and Testicular Volume Before and 3 Months After Laparoscopic Varicocele Ligation (n=54)

Clinical parameter	Preoperative	3-month postoperative	Mean change	p-value
Pain score (VAS)	6.43 $\pm$ 1.32	1.09 $\pm$ 2.53	5.33 $\pm$ 2.69	<0.001*
Pampiniform plexus size (mm)	3.72 $\pm$ 0.66	2.37 $\pm$ 0.81	1.35 $\pm$ 0.40	<0.001*
Testicular volume (ml)	15.93 $\pm$ 3.15	16.97 $\pm$ 2.64	1.03 $\pm$ 3.48	0.033*

Paired t-test; a p-value = 0.05 was considered statistically significant. Mean changes were calculated from paired patient data and may differ by 0.01 from the difference of the rounded means

Table 3. Association of Baseline Characteristics with Treatment Response (n=54)

Baseline characteristic	Complete response (n=46)	No response (n=8)	p-value
Age in years, mean $\pm$ SD	27.67 $\pm$ 9.60	25.25 $\pm$ 4.68	0.490
Duration of pain in months, mean $\pm$ SD	12.02 $\pm$ 6.78	13.63 $\pm$ 6.25	0.536
Varicocele presentation, n (%)			
Subclinical	2 (4.3)	0 (0.0)	0.158
Grade 1	5 (10.9)	0 (0.0)	
Grade 2	10 (21.7)	5 (62.5)	
Grade 3	29 (63.0)	3 (37.5)	

Fisher's exact test was used for varicocele presentation because of small cell counts, and an independent t-test was used for continuous variables; a p-value = 0.05 was considered statistically significant

result comparable to the present cohort.⁹ Park et al., in an updated meta-analysis, found no significant difference in pain-resolution rates according to varicocele grade, whereas preoperative pain characteristics and surgical approach were associated with differences in pain resolution.¹⁵ In a review of varicocele repair for pain, Owen et al. summarised pain-resolution rates across surgical approaches.⁸ Comparable outcomes have been described following microsurgical subinguinal varicocelectomy for painful recurrent varicocele by Cift and Yucel.¹⁶ Park et al. also reported complete or partial pain resolution after varicocelectomy in their cohort.¹⁰ Objective improvements were also evident on ultrasonography. The mean pampiniform plexus diameter decreased from 3.72 mm to 2.37 mm ($p < 0.001$), reflecting effective interruption of venous reflux and decompression of the dilated venous channels. In parallel, the mean testicular volume increased from 15.93 ml to 16.97 ml ($p = 0.033$). This increase in ultrasound-measured testicular volume should be interpreted cautiously because measurement reliability and reproductive outcomes were not assessed. Ultrasonographic imaging, particularly colour Doppler

assessment, is central to the evaluation of varicocele and provides documentation of venous calibre and reflux activity.⁶ From a mechanistic perspective, the symptomatic and ultrasonographic improvements observed are consistent with the prevailing understanding of varicocele-related pain. Venous stasis within the pampiniform plexus is thought to produce a dull, dragging discomfort through venous distension, an increase in scrotal temperature and the local accumulation of metabolites and reactive oxygen species.^{3,4,6} By interrupting retrograde reflux, ligation reduces venous pressure, lowers scrotal temperature and relieves the mechanical and biochemical stimuli responsible for nociception, which provides a plausible explanation for the pain relief observed. No statistically significant associations were identified between treatment response and the baseline variables examined, namely age ($p = 0.490$), duration of symptoms ($p = 0.536$) and varicocele grade ($p = 0.158$). The literature on preoperative predictors of pain relief remains heterogeneous. Some cohorts have reported more favourable outcomes in higher-grade varicoceles or in patients with a shorter symptom duration,^{8,9} whereas meta-analytic evidence

has not identified varicocele grade as a consistent predictor of pain resolution.¹⁵ These discrepancies are likely to reflect differences in methodology, variation in patient populations and the absence of a uniform definition of varicocele-related pain. The lack of a significant association in the present cohort may also be a consequence of the small number of non-responders, which limits the statistical power to detect such relationships.

The predominance of grade 3 disease in the present cohort is in keeping with the observation that higher-grade varicoceles are more frequently symptomatic and more likely to come to surgical attention. Although higher grades are associated with greater venous reflux, the relationship between grade and pain resolution is inconsistent across the literature.^{6,8} In the current analysis, grade was not significantly associated with treatment response, which may reflect the high overall response rate and the limited number of non-responders rather than a true absence of any effect. The choice of surgical approach for varicocele remains a subject of ongoing discussion. Microsurgical varicocelectomy is widely regarded as offering low recurrence and complication rates, whereas laparoscopic ligation provides direct visualisation of the spermatic vessels and is an established minimally invasive approach.^{7,11} Microsurgical denervation of the spermatic cord has also been described as an option in selected patients with refractory pain.¹⁷ In the present study, laparoscopic ligation was associated with improvement in pain and ultrasonographic parameters during the reported follow-up period. These findings provide short-term observational data on laparoscopic treatment of painful varicocele but do not permit direct comparison with microsurgical techniques.^{7,16} Reported complications following laparoscopic varicocelectomy include port-site and other postoperative complications, while recurrence and hydrocele remain recognised outcomes after varicocele repair.^{7,9,12} The wider evidence base for varicocele repair has been driven largely by fertility endpoints. Meta-analytic data indicate that varicocelectomy can improve sperm concentration and motility and may benefit reproductive outcomes in appropriately selected patients.¹⁸ Contemporary multi-omics research continues to refine the understanding of varicocele pathophysiology and may, in time, identify biomarkers to guide patient selection.¹⁹ Alternative interventions, including radiological embolisation and open and microsurgical repair, remain valid options, and the choice of technique should be individualised according to disease laterality, prior surgery, available expertise and patient preference.^{11,20}

These findings carry particular relevance for low- and middle-income settings. In Pakistan, published studies have reported experience with laparoscopic varicocelectomy, but

evidence specifically focused on painful varicocele remains limited.¹² The present study therefore adds preliminary regional data on short-term outcomes following laparoscopic ligation for painful varicocele. Its findings may inform patient counselling in comparable settings, while broader recommendations require confirmation in larger comparative studies. Future multicentre work incorporating reproductive endpoints and longer follow-up would help to define the durability of these benefits and refine patient selection.

The strengths of this study include its prospective, structured design with defined follow-up and the combined use of subjective VAS scoring and objective ultrasonographic measurement. The restriction of enrolment to symptomatic patients presenting with pain enhances the applicability of the findings to routine urological practice. Limitations: This study has several limitations. It was conducted at a single tertiary-care centre and included a relatively small sample, which may limit the generalisability of the findings. The absence of a control or comparison group prevents determination of comparative effectiveness and limits causal interpretation of the observed changes. Follow-up was limited to the scheduled short-term assessment period, restricting evaluation of long-term recurrence and complications. Semen parameters, hormonal profiles and validated quality-of-life measures were not assessed; therefore, the study cannot determine whether pain improvement or changes in testicular volume translate into reproductive or quality-of-life benefits. Measurement variability of the clinical and ultrasonographic outcomes was not formally assessed. Finally, laterality, operative time, hospital stay, conversion, baseline conservative or analgesic treatment, and structured reporting of complications, recurrence and reintervention were not included in the analysis dataset, and one-week outcome values were not analysed; these should be captured in future studies.

CONCLUSION

In this single-centre study of 54 patients, laparoscopic varicocele ligation was associated with improvement in varicocele-related pain and ultrasonographic parameters during short-term follow-up. These findings are observational and should be interpreted cautiously given the small cohort, uncontrolled design, single-centre setting and limited follow-up. Larger multicentre studies with longer follow-up and comparative designs are needed to confirm the durability of pain relief, evaluate recurrence and complications, and determine the clinical significance of the observed ultrasonographic changes.

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Authors Contribution:

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Haris Hassan Qureshi: Study design, manuscript review, critical input

Syed Arslan Shehzad Shah: Conception of study, development of research, methodology design

Adibul Hasan Rizvi: Conception of study, development of research methodology design

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