



Original Article

To Study the Outcome of Varicocele Ligation in Improving the Semen Parameters in Cases Undergoing Varicocele Surgery

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ABSTRACT

Background: Varicocele is one of the most common surgically correctable causes of male infertility and is frequently associated with abnormal semen parameters and impaired spermatogenesis. Despite decades of research, controversy persists regarding patient selection and the magnitude of benefit following varicocele ligation. Semen parameters including sperm concentration, motility, morphology, and vitality remain the cornerstone for assessing spermatogenic function and treatment response.

Aim: To study the outcome of varicocele ligation in improving semen parameters in cases undergoing varicocele surgery.

Materials and Methods: This prospective observational study was conducted in 50 men aged 18–42 years with clinically palpable unilateral or bilateral varicocele who underwent inguinal varicocele ligation. Baseline clinical evaluation, scrotal ultrasonography, hormonal profile, and semen analysis were performed prior to surgery. Semen parameters were reassessed three months postoperatively using the same methodology. Preoperative and postoperative values were compared to evaluate changes in sperm concentration, motility, morphology, semen volume, vitality, and testosterone levels. Appropriate statistical tests were applied, and p-values <0.05 were considered significant.

Results: The mean age of participants was 28.9 ± 5.1 years, and primary infertility constituted 72% of cases. Baseline semen analysis demonstrated oligozoospermia, asthenozoospermia, and teratozoospermia in a substantial proportion of patients. After varicocele ligation, significant improvements were observed in sperm concentration (+39.0%, $p=0.002$), total sperm count (+45.2%, $p=0.004$), total motility (+33.7%, $p<0.001$), progressive motility (+48.3%, $p<0.001$), normal morphology (+30.2%, $p=0.019$), and sperm vitality (+7.4%, $p=0.042$). Serum testosterone levels also increased significantly ($p=0.018$). Overall, marked or moderate improvement in semen parameters was seen in 68.8% of patients. Normozoospermia increased from 8.3% preoperatively to 22.9% postoperatively. Postoperative complications were mostly minor, with scrotal edema being the most common (18%).

Conclusion: Varicocele ligation results in significant improvement in semen parameters and hormonal profile in a majority of patients and represents an effective treatment option for selected infertile men with varicocele.

Keywords: Varicocele, Varicocelectomy, Semen parameters, Male infertility, Spermatogenesis.

INTRODUCTION

Infertility is a growing global health problem with profound medical, psychological, social, and economic consequences, and male factors contribute either alone or in combination in nearly half of infertile couples. Among the various etiologies

of male infertility, varicocele remains one of the most frequently encountered and potentially correctable conditions, yet its exact role in impairing spermatogenesis continues to be debated. A varicocele is defined as abnormal dilatation and tortuosity of the pampiniform venous plexus and internal spermatic veins, leading to impaired venous drainage of the testis and disruption of the testicular microenvironment. Varicocele has been consistently associated with abnormalities in sperm concentration, motility, morphology, and DNA integrity, although not all affected men exhibit infertility, suggesting heterogeneity in disease expression and response to treatment. Proposed mechanisms include scrotal hyperthermia, testicular hypoxia, oxidative stress, reflux of toxic metabolites, hormonal dysregulation, and impaired Sertoli and Leydig cell function. Surgical correction of varicocele has been shown by several investigators to improve semen parameters, testosterone production, and pregnancy rates, whereas others report variable or modest benefits. This ongoing controversy underscores the need for well- designed clinical studies evaluating outcomes of varicocele ligation in defined patient populations. The present study was therefore undertaken to assess the effect of varicocele ligation on semen parameters and spermatogenesis in patients undergoing varicocele surgery at a tertiary care medical teaching hospital.

AIM AND OBJECTIVES

Aim: To study the outcome of varicocele ligation in improving the semen parameters in cases undergoing varicocele surgery.

Objectives:

1. To study the changes in sperm morphology.
2. To study the changes in sperm, count and sperm motility
3. To study clinical profile of varicocele patients.
4. To study the effect of varicocele ligation on spermatogenesis

MATERIAL AND METHOD

This prospective observational study included 50 male patients aged 18–42 years with clinically palpable unilateral or bilateral varicocele confirmed by ultrasonography, who were admitted for varicocele ligation and provided informed consent. Patients with recurrent varicocele, azoospermia, total necropermia, or secondary varicocele were excluded. All patients underwent detailed history taking, physical examination, grading of varicocele using the Dubin and Amelar classification, scrotal ultrasonography, baseline semen analysis after 3–5 days of abstinence according to WHO guidelines, and hormonal evaluation. Varicocele ligation was performed using the inguinal approach under spinal anesthesia. Repeat semen analysis and hormonal evaluation were performed three months postoperatively using identical methodology. Data were analyzed using appropriate statistical tests, and p-values <0.05 were considered statistically significant.

Study Design: Prospective comparative study.

Study Setting: Department of General Surgery, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh.

Study Period: 18 months.

Sample Size: Sample size(n)= Z^2PQ/E^2

$$=(1.96)^2 \times 0.15 \times 0.85 / (0.10)^2$$

$$=48.96 \approx 50$$

Inclusion criteria

1. Patients with clinically palpable unilateral or bilateral varicocele (grades 1-3).
2. Age group 18-42 years.
3. Ultrasound proven cases

Exclusion criteria:

1. Patients with recurrent varicocele.
2. Patients with azoospermia or total necropermia.
3. Patients with secondary varicocele.

RESULTS

Table1: Demographic and Clinical Profile of Study Participants(N=50)

Characteristic	Value (Mean ± SD / n %)
Age (years)	28.9 ± 5.1

Body Mass Index (kg/m ²)	23.7 ± 3.5
Duration of infertility (months)	29.6 ± 17.3
Primary infertility	36 (72.0%)
Secondary infertility	14 (28.0%)
Presenting complaint – Infertility only	34 (68.0%)
Scrotal pain/discomfort only	8 (16.0%)
Both infertility and pain	8 (16.0%)
Smoking	15 (30.0%)
Alcohol consumption	12 (24.0%)
Diabetes mellitus	3 (6.0%)
Hypertension	4 (8.0%)
Left unilateral varicocele	35 (70.0%)
Bilateral varicocele	15 (30.0%)
Grade I varicocele	8 (16.0%)
Grade II varicocele	26 (52.0%)
Grade III varicocele	16 (32.0%)
Testicular volume discrepancy (>2 mL)	22 (44.0%)
Reflux duration >2 seconds	41 (82.0%)

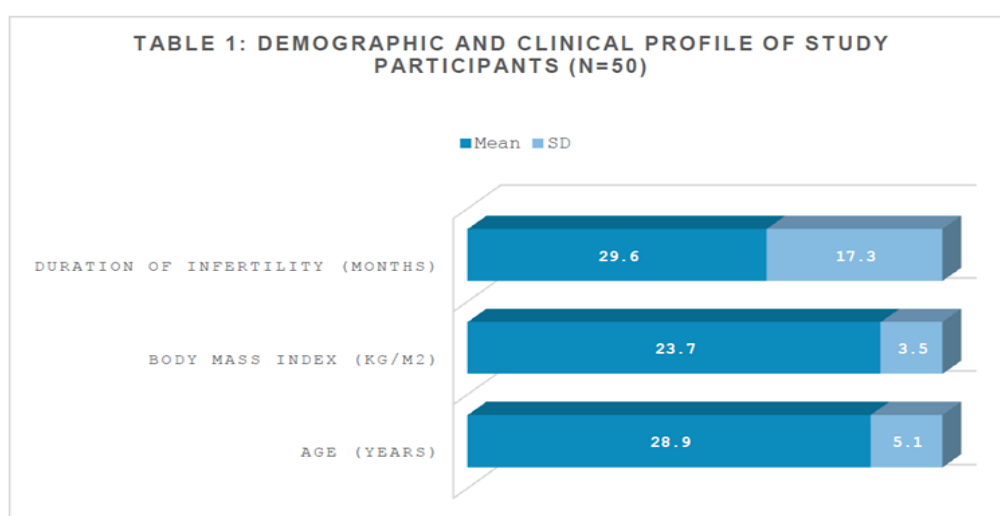
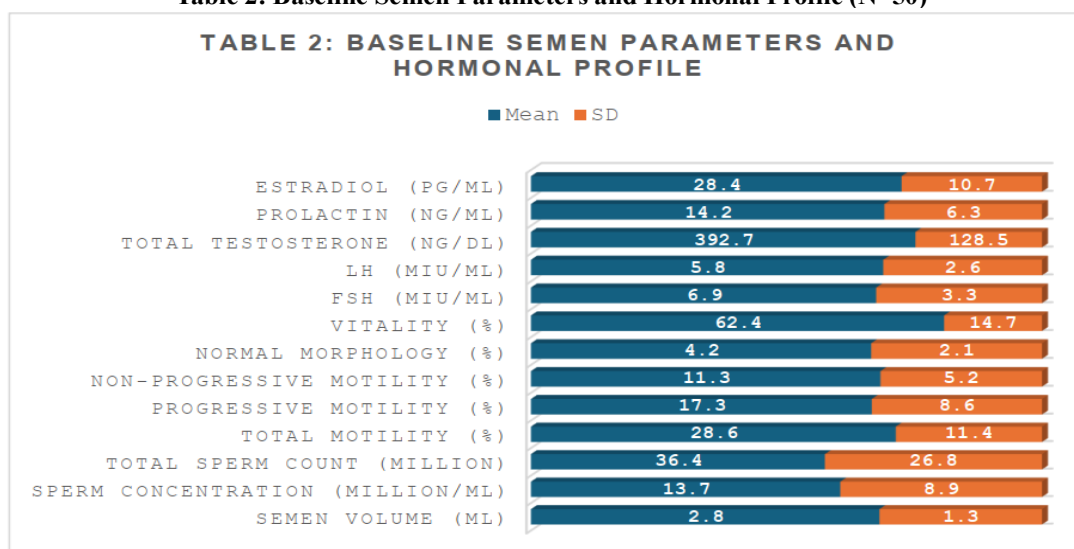


Table 2: Baseline Semen Parameters and Hormonal Profile (N=50)



Parameter	Mean ± SD
Semen volume (mL)	2.8 ± 1.3
Sperm concentration (million/mL)	13.7 ± 8.9

Total sperm count (million)	36.4 ± 26.8
Total motility (%)	28.6 ± 11.4
Progressive motility (%)	17.3 ± 8.6
Non-progressive motility (%)	11.3 ± 5.2
Normal morphology (%)	4.2 ± 2.1
Vitality (%)	62.4 ± 14.7
FSH (mIU/mL)	6.9 ± 3.3
LH (mIU/mL)	5.8 ± 2.6
Total Testosterone (ng/dL)	392.7 ± 128.5
Prolactin (ng/mL)	14.2 ± 6.3
Estradiol (pg/mL)	28.4 ± 10.7

Table 3: Comparison of Semen Parameters Before and After Varicocele Ligation (N=48)

Parameter	Pre-operative Mean ± SD	Post-operative Mean ± SD	Percentage Change	p-value
Sperm concentration (million/mL)	14.1 ± 9.0	19.6 ± 12.8	+39.0%	0.002
Total sperm count (million)	37.8 ± 27.3	54.9 ± 35.2	+45.2%	0.004
Total motility (%)	29.1 ± 11.6	38.9 ± 13.7	+33.7%	<0.001

Parameter	Pre-operative Mean ± SD	Post-operative Mean ± SD	Percentage Change	p-value
Progressive motility (%)	17.8 ± 8.8	26.4 ± 11.9	+48.3%	<0.001
Normal morphology (%)	4.3 ± 2.2	5.6 ± 2.9	+30.2%	0.019
Semen volume (mL)	2.9 ± 1.4	3.1 ± 1.5	+6.9%	0.187
Vitality (%)	63.1 ± 14.9	67.8 ± 15.3	+7.4%	0.042
Testosterone (ng/dL)	395.4 ± 129.8	431.9 ± 142.6	—	0.018

TABLE 3: COMPARISON OF SEMEN PARAMETERS BEFORE AND AFTER VARICOCELE LIGATION (N=48)

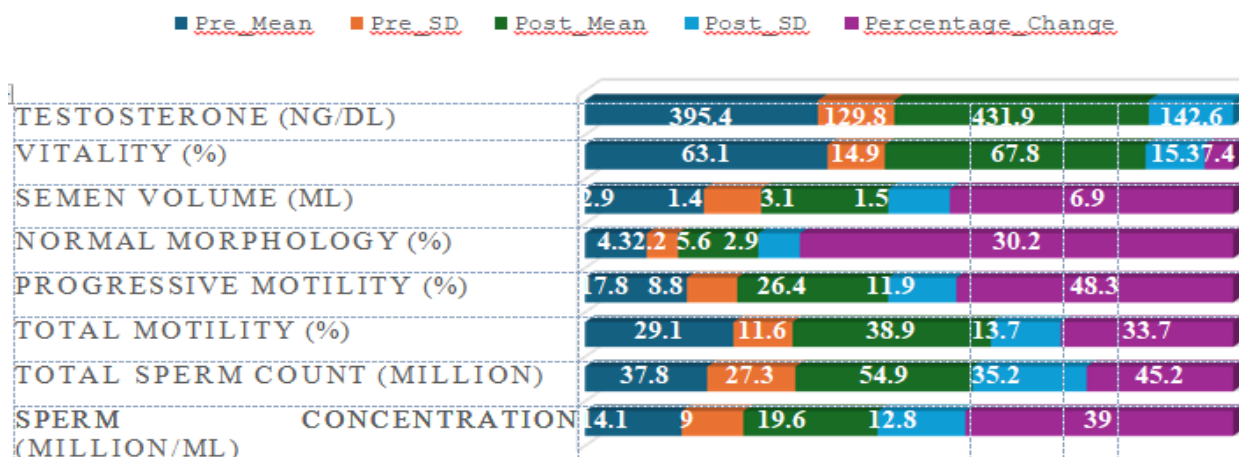
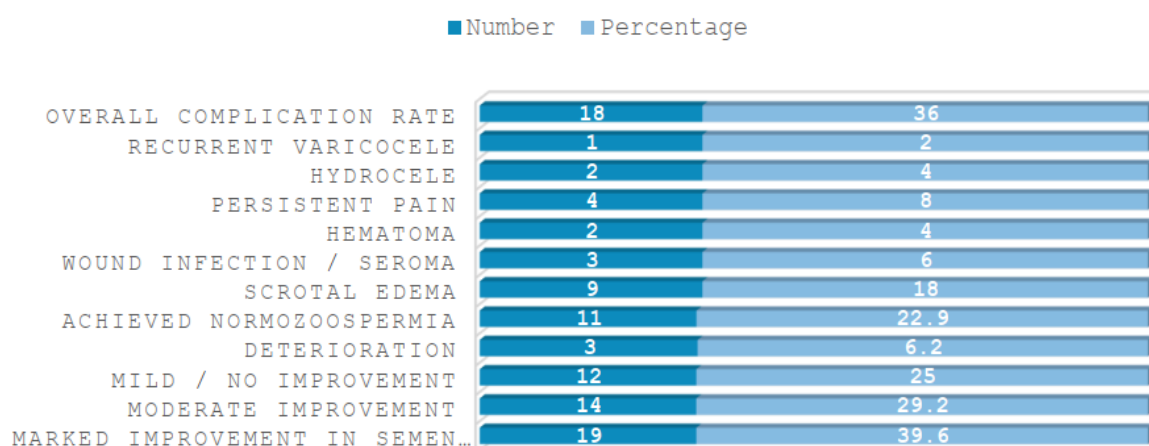


Table 4: Surgical Outcome and Complications (N=50)

Parameter	n (%)
Marked improvement in semen parameters	19 (39.6%)
Moderate improvement	14 (29.2%)
Mild / No improvement	12 (25.0%)
Deterioration	3 (6.2%)
Achieved normozoospermia	11 (22.9%)
Scrotal edema	9 (18.0%)
Wound infection / seroma	3 (6.0%)
Hematoma	2 (4.0%)
Persistent pain	4 (8.0%)
Hydrocele	2 (4.0%)

Recurrent varicocele	1 (2.0%)
Overall complication rate	18 (36.0%)

**TABLE 4: SURGICAL OUTCOME AND COMPLICATIONS
(N=50)**



Overall, the majority of patients were young adults with primary infertility. Baseline semen analysis showed reduced sperm concentration, motility, and morphology in most patients. Following varicocele ligation, statistically significant improvement was observed in key semen parameters and testosterone levels. More than two-thirds of patients demonstrated marked or moderate improvement. Complications were infrequent and predominantly minor.

DISCUSSION

The present study demonstrates that varicocele ligation leads to significant improvement in semen parameters and hormonal profile in infertile men with clinically palpable varicocele. These findings support the concept that varicocele is an important, potentially reversible cause of impaired spermatogenesis.

Dubin and Amelar were among the earliest investigators to demonstrate a relationship between varicocele size and postoperative improvement in semen quality, reporting better outcomes in men with higher-grade varicoceles. Gorelick and Goldstein highlighted the progressive nature of testicular damage in untreated varicocele and emphasized the association between varicocele and loss of fertility. The baseline abnormalities in sperm concentration, motility, and morphology observed in our study are consistent with these observations.

Several mechanisms have been proposed to explain improvement after varicocele repair. Zorgniotti and Macleod demonstrated that increased scrotal temperature adversely affects spermatogenesis, and reduction of hyperthermia following ligation may restore normal germ cell function. Agarwal and colleagues emphasized the role of oxidative stress in varicocele-associated infertility and showed that surgical correction reduces reactive oxygen species and improves sperm function.

In the present study, sperm concentration and total sperm count improved by approximately 39% and 45%, respectively. Similar magnitudes of improvement have been reported by Al Bakri et al., who observed that semen parameters typically begin to improve within three months following surgery. Cannarella and co-workers, in meta-analyses of before-and-after data, demonstrated significant postoperative increases in sperm concentration, motility, and morphology, supporting the effectiveness of varicocele repair.

Progressive motility showed the most pronounced improvement in our study, increasing by nearly 48%. This finding is clinically relevant, as progressive motility is a key determinant of fertilizing potential. Agarwal et al. reported that improvements in motility after repair are closely linked to reductions in oxidative stress and mitochondrial dysfunction.

Normal morphology also improved significantly in our cohort. Although the absolute increase was modest, even small improvements in morphology may translate into improved fertility potential. Similar findings have been reported by Cannarella et al. and Shah et al., who observed consistent but moderate improvements in morphology after repair.

Serum testosterone increased significantly after surgery in our study. Tanrikut et al. demonstrated that varicocele is a risk factor for androgen deficiency and that repair can improve testosterone levels, particularly in men with low baseline values. Improvement in testosterone may further enhance spermatogenesis and overall testicular function.

Regarding safety, the overall complication rate in our study was 36%, with most complications being minor and self-limiting. Scrotal edema was the most common complication, while serious complications such as testicular atrophy or spermatic artery injury were not observed. These findings are comparable to those reported by Goldstein et al., who emphasized that meticulous surgical technique minimizes complications.

The main strengths of the present study include its prospective design, standardized evaluation, and paired comparison of preoperative and postoperative parameters. Limitations include relatively small sample size and short follow-up duration, which may not capture long-term fertility outcomes such as spontaneous pregnancy rates.

CONCLUSION

Varicocele ligation results in significant improvement in semen parameters and testosterone levels in a majority of patients with clinically palpable varicocele. Surgical correction is a safe and effective treatment option for selected infertile men and can contribute to restoration of spermatogenesis.

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