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COMPARATIVE OUTCOMES OF MICROSCOPIC VERSUS NON MICROSCOPIC OPEN SUBINGUINAL VARICOCELECTOMY ON SPERM PARAMETERS: A QUASI EXPERIMENTAL STUDY FROM PESHAWAR

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ABSTRACT

BACKGROUND: Varicocele, common cause of male infertility, negatively affects semen parameters like sperm count and motility. Surgical intervention, specifically varicocelectomy, remains a key treatment strategy, with laparoscopic, open and microscopic sub-inguinal techniques widely practiced. However, comparative data specific to open techniques, traditional and microscopic to the Peshawar region remains limited.

OBJECTIVE: This study aimed to compare the impact of microscopic versus non microscopic open sub-inguinal varicocelectomy on sperm parameters, evaluating postoperative improvements and complication rates among patients in a tertiary care setting.

METHODOLOGY: :A quasi-experimental study was conducted at Northwest General Hospital, Peshawar, enrolling 220 male patients with clinically diagnosed varicocele. Patients were divided into two groups: Group A underwent microscopic sub-inguinal varicocelectomy (n=110), and Group B received the non-microscopic open subinguinal varicocelectomy technique (n=110). Pre- and postoperative semen analyses were performed, and data were statistically analyzed using SPSS v22.

RESULTS: Group A showed significantly greater improvements in sperm count (from 14 ± 0.68 to 39 ± 7.4 million/mL) and motility (from 23 ± 3.75% to 58 ± 12.32%) compared to Group B (count: 12 ± 2.28 to 30 ± 5.7 million/mL; motility: 21 ± 5.34% to 53 ± 8.73%). ≥50% improvement in semen parameters was achieved in 53.63% of Group A, versus 39.09% in Group B (p = 0.0426). Although statistically non-significant, postoperative complications were fewer in the microscopic group.

CONCLUSION; Microscopic varicocelectomy provided superior improvement in semen parameters and fewer complications than the non-microscopic open subinguinal varicocelectomy technique. The findings support broader adoption of microsurgical approaches in fertility management, particularly in resource-limited settings.

KEYWORDS Varicocelectomy, Microscopic Surgery, Sperm Parameters, Male Infertility, Sub-Inguinal Approach

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INTRODUCTION

Varicocele is the pathological dilatation of veins of pampiniform plexus of the spermatic cord, responsible for draining blood from the testes. [1] Varicocele has very significant effect on all semen parameters such as sperm morphology, count, and motility, as well as testicular size. In recent years, various research studies have yielded reliable evidence that marks the association between varicocele and male infertility as well as assessing different treatment options and their outcomes. [2] Along the way, infertility emerges as a major medical and social concern, affecting not only reproductive health but also the psychological health of families and couples. The etiology of infertility among couples can be attributed to a variety of causes, some of which are specific to males such as abnormal semen parameters, abnormal ejaculation, or the presence of varicocele. [3] Although the specific etiology would differ, its cause remains elusive in most cases. Idiopathic varicoceles are usually explained by the perpendicular crossing between the left spermatic and left renal vein. Different treatment modalities such as surgical and non-surgical alternatives (e.g. varicocele embolization) have been suggested for the repair of varicocele. Surgical alternatives aim at correcting the fundamental venous dilatation and thus enhancing the fertility outcomes. [4] Varicocelectomy is a surgical procedure to treat varicocele by ligating affected veins, redirecting blood flow to healthier ones, and improving testicular function. It can be performed via open surgery, laparoscopy, or microsurgical methods, with microsurgery offering higher precision and fewer complications. [5] In parallel with surgical advancements, artificial intelligence (AI) is revolutionizing the approach to diagnosing and managing male infertility, including varicocele. For varicocele, AI holds potential in improving diagnostic accuracy through imaging techniques and enhancing decision-making in selecting surgical or non-surgical treatment modalities. [6] Furthermore, translational research in the context of varicocele has advanced significantly in recent years, aiming to bridge the gap between laboratory discoveries and clinical applications. [7] However, limited access to advanced diagnostic technologies, insufficient funding, and a lack of interdisciplinary collaboration hinder progress. [8] Comparative clinical trials have reported that

microscopic varicocelectomy yields significantly greater improvements in total motile sperm count and morphology compared to the open technique, especially in men with grade II or III varicocele. [9] However, microscopic versus non-microscopic open varicocelectomy may be determined on the basis of available surgical experience, institutional facilities, and patient factors such as prior surgery or grade of varicocele. [10]

Varicocele is a prevalent reason for male infertility; however, the ideal surgical repair for its correction remains a topic of immense debate. Particularly, there is an imperative need for regional data to inform clinical practice. Though both non-microscopic open sub-inguinal varicocelectomy technique and microscopic sub-inguinal varicocelectomy are frequently used, their relative effects on sperm parameters important markers of male fertility are scantily reported in the population of Peshawar, Pakistan. The current study seeks to bridge this lacuna by comparing and evaluating the results of these two surgical techniques in a tertiary care center.

METHODOLOGY:

This research was conducted on a population sample and was conducted in the Department of General Surgery and Urology, Northwest General Hospital and Research Center, Peshawar, Pakistan from 1st June 2024 to 31st May 2025. The research was approved by the Ethical Review Board of Northwest General Hospital and Research Center. All participants provided consent to participate in the research before it was conducted. The participants were informed about why the research was being conducted, what would be done to them in the process of conducting the research, and what risks or benefits to them.

A total of 220 male patients diagnosed clinically for varicocele were enrolled and allocated non-randomly into two groups according to the chosen surgical technique by the operating surgeon and patient preference: Group A (microscopic sub-inguinal varicocelectomy) and Group B (non-microscopic open sub-inguinal varicocelectomy), each group containing 110 patients.

According to a prior study in the literature [(11),] anticipated outcome rates for the determination of ≥50% improvement in semen parameters were 48% in Group A (microsurgical varicocelectomy) and 28% in Group B (non-microscopic open sub-inguinal varicocelectomy). From these numbers and considering a significance level of 0.05 (two-tailed) and a power of 80%, the minimum sample size was computed using OpenEpi to be 102 patients per group. To accommodate potential loss to follow-up or incomplete data, sample size was increased to 110 patients per group, resulting in a total of 220 participants.

Inclusion criteria: Men with primary varicocele between 18 and 50 years, indication of surgical intervention were symptomatic (scrotal pain, dragging sensation, primary infertility). A patient was considered for varicocelectomy with a stable sexual relationship and actively seeking fertility treatment. Patients were eligible if they had a clinical diagnosis of varicocele, confirmed by color Doppler ultrasound showing a reflux on Valsalva maneuver and a spermatic vein diameter exceeding 3 mm. Patients were also required to have at least two abnormal semen analyses (performed 4–6 weeks apart) showing oligospermia (sperm count <15 million/mL) and/or asthenozoospermia (progressive motility <40%), in accordance with WHO 2010 criteria.

Exclusion criteria: Patient age < 18 years and > 50 years, secondary varicocele, bilateral varicocele, recurrence varicocele after operation, scrotal or inguinal pathology unrelated to varicocele (e.g., hernia, hydrocele, spermatocele), patients with history of infertility due to other causes such as hormonal or genetic abnormalities, patients with scrotal surgery within the last 12 months, genital tract infections, clinically significant leukocytospermia, or systemic conditions known to impair fertility (e.g., thyroid dysfunction or uncontrolled diabetes) were also excluded. In addition, individuals using medications known to affect spermatogenesis (e.g., testosterone therapy, anabolic steroids), and those with incompletely filled preoperative or follow-up records, were excluded. Patient not suitable for general anesthesia and Patients with subclinical varicocele, i.e., scrotal venous reflux with no palpable distention of the pampiniform plexus,[12] were also not included in study.

Preoperative assessment: Preoperative evaluation involved a thorough review of the Patient's history, thorough physical exam, and routine preoperative investigations. at least 2 semen analyses and baseline scrotal grayscale ultrasonography with Doppler support. We established varicocele on ultrasonography as a spermatic venous diameter of more than 3.7 mm with augmentation of diameter on Valsalva maneuver and venous reflux on Doppler detection. [12] Before the procedure, all patients in both groups were administered intravenous antibiotics.

Non-Microscopic Open Varicocelectomy: In non-microscopic open varicocelectomy, every patient underwent spinal/ general anesthesia for the surgery. The examiner detected the outside border of the inguinal canal's perimeter by touching it along the spermatic cord the patient was lying on their back. A transverse incision measuring 2-3 cm in length was performed directly above the cord, positioned at a level about two finger-widths underneath the external inguinal ring. The Camper's and Scarpa's fascia were separated by electrocoagulation. The cut was made deeper, revealing the spermatic cord. The object was secured using an Alis or Babcock instrument, dissected using a blunt technique, and raised using the index finger. The protective coating of the cord was incised, the outer layer of the spermatic cord was carefully separated, the internal spermatic fascia and cremastric muscles were opened, spermatic cord (vas deferens) and testicular artery were identified and separately preserved and the enlarged veins of the pampiniform plexus were dissected and securely tied with a 2-0 vicryl suture. In subinguinal cases, the

number of veins ligated varied between two and seven individually. Carefully dissecting and ligating dilated veins can preserve the arteries and lymphatics. The dermis and outer connective tissue layer were sutured together sequentially.

Microscopic varicocelectomy: The external inguinal ring's position is determined. At this level, a 2-3 cm skin incision was done following Langer's guidelines. Using electrocautery, fascias of Camper and Scarpa are opened, allowing for a clear visualization of the spermatic cord and external ring. After inserting two retractors into the incision, cephalad and caudally retracting, the cord of sperm was located, ringed with a Babcock clamp, raised out of the incision, and covered with either a piece of gauze or a non-toothed forceps, then went on to investigate the spermatic cord regarding the existence of extrinsic spermatic veins that pierced the inguinal canal's floor rather than accompanying the cord vessels. After noting the external spermatic veins, 5/0 or 6/0 proline ties were doubly ligated and split. It was noted how many external spermatic veins there were. The operative field had an operating microscope. The process's microscopic phase uses an 8-12 power magnification. Following the identification of the cremasteric artery, the exterior and internal spermatic fasciae and the cremaster are opened, revealing the internal spermatic arteries. After that, the vas deferens and related arteries are located and protected using a rubber sheet. The adjoining adventitia and lymphatics are removed from each internal spermatic vein after being separately mobilized. Except for the vassal veins, every vein in the spermatic cord was split and doubly ligated using 6/0 proline ties. The number of external (cremasteric) and interior (spermatic) veins ligated during the dissection was noted. The lymph ducts were kept intact. The arteries' color, shape, and pulse can be used to identify them. While 1% papaverine irrigation is employed to widen the arteries maximally and aid in their identification, suspected arteries may also be evaluated. Additionally, the quantity of external (cremasteric) and internal spermatic arteries found was counted and classified according to location. The internal spermatic artery was categorized as either independent (no dissection was required to separate the artery from the veins) or found among a complex of veins (artery adherent to two or more minor or medium veins). The skin and superficial fascia are closed in layers when the process is finished.

Postoperative Follow up: Every Patient had either an non-microscopic open or microscopic varicocelectomy, and our results include the outcomes of the postoperative improvement test, as well as a follow-up scrotal ultrasound to check for reoccurrence of varicocele, and semen analysis performed four months later. Baseline and 6-month postoperative semen analyses were conducted in a standardized hospital laboratory. All semen samples were collected following 3–5 days of abstinence and analyzed within one hour of collection, using the WHO 2010 laboratory manual criteria. The primary outcome was defined as a ≥50% improvement in semen parameters (sperm count and motility) between baseline and postoperative assessments.

Data Analysis: Data were analyzed with SPSS version 22. Continuous variables were reported as mean ± SD, and categorical variables as frequencies and percentages. Chi-square test assessed residence, marital status, overall improvement in sperm parameters, independent t-test compared age, BMI, sperm count, and motility, while Fisher's Exact Test evaluated postoperative complications. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 220 patients were enrolled in the study, with 110 undergoing microscopic varicocelectomy and 110 undergoing non-microscopic open sub-inguinal varicocelectomy. Table 1 presents the baseline characteristics of the two groups: Group A (Microscopic Varicocelectomy) and Group B (non-microscopic open varicocelectomy). The mean age was slightly higher in Group A (32 ± 8.52 years) compared to Group B (31 ± 10.77 years), with the difference being statistically significant ($t = 2.47$, $p = 0.0142$). Most participants were married, comprising 77.28% (85 individuals) in Group A and 80.00% (88 individuals) in Group B, with no significant difference between the groups ($\chi^2 = 0.11$, $p = 0.7422$). Regarding place of residence, a majority in both groups were from urban areas—61.82% (68 individuals) in Group A and 65.46% (72 individuals) in Group B—also with no statistically significant difference ($\chi^2 = 0.18$, $p = 0.6742$). The mean Body Mass Index (BMI) was 24.08 ± 5.94 in Group A and 24.95 ± 5.36 in Group B, with a statistically significant difference noted ($t = -2.58$, $p = 0.0105$).

Table 1: Demographics of the patient.

Variable	Group A (Microscopic Varicocelectomy)	Group B (Non-Microscopic Open Varicocelectomy)
Age (years) ± S.D	32 ± 8.52	31 ± 10.77
Marital Status		
Married	85 (77.28%)	88 (80.00%)
Unmarried	25 (22.72%)	22 (20.00%)
RESIDENCE		
Urban	68 (61.82%)	72 (65.46)
Rural	42 (38.18)	38 (34.54)
BODY MASS INDEX		
BMI ± S.D	24.08 ± 5.94	24.95 ± 5.36

SPERM COUNT (millions/ ml): The Microscopic Varicocelectomy group demonstrated a significantly greater improvement in sperm count compared to the Non-Microscopic Open Varicocelectomy group ($p < 0.05$). In the Microscopic group, the mean sperm count increased markedly from 14 ± 0.68 million/ml pre-operatively to 39 ± 7.4 million/ml post-operatively. The Non-Microscopic Open Varicocelectomy also showed improvement, though to a lesser extent, with mean sperm count rising from 12 ± 2.28 million/ml to 30 ± 5.7 million/ml. These results indicate a superior enhancement in sperm count following the microscopic approach.

Table 2: Comparison of pre-operative and post-operative sperm counts between the two surgical groups.

Procedure	Pre-Operative Sperm count (millions/ ml)	Post-Operative Sperm count (millions/ ml)	t-test value	p-value
Microscopic Varicocelectomy	14 ± 0.68	39 ± 7.4	5.19	0.0005
Non-Microscopic Open Varicocelectomy	12 ± 2.28	30 ± 5.7		

SPERM MOTILITY (%): Table 3 illustrates a notable improvement in sperm motility in both surgical groups, with a statistically significant advantage observed in the Microscopic Varicocelectomy group ($p < 0.05$). Patients in this group experienced an increase in motility from 23 ± 3.75% before surgery to 58 ± 12.32% after the procedure. Similarly, the Non-Microscopic Open Varicocelectomy group showed an improvement, with motility rising from 21 ± 5.34% pre-operatively to 53 ± 8.73% post-operatively. While both approaches proved effective, the microscopic technique was associated with a slightly greater enhancement in motility.

Table 3: Comparison of pre-operative and post-operative sperm motility between the two surgical groups.

Procedure	Pre-Operative Sperm motility (%)	Post-Operative Sperm motility (%)	t-test value	p-value
Microscopic Varicocelectomy	23 ± 3.75	58 ± 12.32	2.22	0.0271
Non-Microscopic Open Varicocelectomy	21 ± 5.34	53 ± 8.73		

POSTOPERATIVE COMPLICATIONS: Postoperative complications did not differ significantly between the surgical techniques, though some variation was noted. Persistence of varicocele occurred in one patient in the non-microscopic open varicocelectomy group, with recurrence equal in both groups (5 patients each). Wound infections were more common in the non-microscopic open varicocelectomy group (7 vs. 2 cases), while hydrocele, hematoma, and spinal headache were observed only in the non-microscopic open varicocelectomy group. Overall, the microscopic approach was linked to fewer complications.

Table 4: Comparison of post-operative complications between the two surgical groups.

Complications	Group A (Microscopic varicocelectomy)	Group B (Non-Microscopic Open Varicocelectomy)	p-value (Fisher's Exact Test)
Wound infection	2	7	0.1706
Hydrocele	0	2	0.4977
Persistence	0	1	1.0000
Haematoma	0	2	0.4977
Recurrence	5	5	1.0000
Spinal headache	0	3	0.2466

Comparison of Improvement Outcomes between Study Groups: A comparison of overall improvement in sperm parameters following surgery is presented in Table 5. A significantly greater proportion of patients in the Microscopic Varicocelectomy group achieved an improvement of ≥50% ($p < 0.05$). Specifically, 59 patients (53.63%) in Group A demonstrated this level of improvement, compared to only 43 patients (39.09%) in Group B (Non-Microscopic Open Varicocelectomy). In contrast, a higher percentage of patients in the non-microscopic open varicocelectomy group (60.91%; 67 individuals) showed less than 50% improvement, compared to 46.37% (51 individuals) in the microscopic group. These findings suggest that the microscopic approach was associated with more favorable postoperative outcomes.

DISCUSSION

This research sought to establish the difference in the effect of non-microscopic open varicocelectomy and microscopic sub-inguinal varicocelectomy on semen parameters in a Pakistani clinical population. The findings indicate that though significantly improved, sperm motility and count were better with microscopic sub-inguinal varicocelectomy. The improvement was quantitatively higher but also accompanied by a reduced complication rate, indicating the microscopic method's clinical utility and safety. The noteworthy postoperative semen parameter alterations reported in the present study concur with global evidence. Specifically, Agarwal et al. performed a high-volume meta-analysis that described improved total motile sperm count and morphology after microscopic varicocelectomy, especially in men with grade II and III varicocele. [9] This has been supported by our study where the microscopic group showed a mean increase in sperm counts of 14 to 39 million/mL versus 12 to 30 million/mL in the non-microscopic open varicocelectomy group. Sperm motility was also enhanced from 23% to 58% in the microscopic group and from 21% to 53% in the non-microscopic open varicocelectomy, which shows the effectiveness of the two methods with a tendency towards the microsurgical method in this aspect. The microscopic technique's benefit is largely attributed to the use of magnification, which enables better identification and preservation of testicular arteries and lymphatics .[13-15] This observation is seen in our research, as hydrocele and hematoma only appeared within the non-microscopic open varicocelectomy group. This is in line with the findings of Bajaniya and Jha, who had better postoperative outcomes and fewer complications among microscopic sub-inguinal varicocelectomy-treated patients.[10] Addar et al., in a study conducted locally, also experienced significant improvement in semen parameters of microscopic cases, which was quite comparable to our microscopic group's rate of improvement of 53.63%.[16] Both groups had comparable recurrence rates of around 4.5%. Most series report recurrence rates ranging from 2% to 10% with some discrepancy depending on technique and operator .[17-19] Although recurrence will be lower with microscopic methods, our findings might be explained by similar competence of surgery in both groups or by differences in innate anatomy not covered in this study. Complication rates were markedly higher in the non-microscopic open varicocelectomy group, including wound infections, spinal headaches, and hydroceles. The results are consistent with previous studies by Hariri et al., who showed a higher rate of postoperative complications following non-microscopic open varicocelectomy, especially in those with higher BMI or larger vein diameter.[2] The precision of the microsurgical method is one such explanation for the fewer cases of these complications in this study. New trends in diagnostic and therapeutic approaches of varicocele, such as the use of artificial intelligence, are beginning to transform male infertility treatment. Huang et al. referred to AI increasing diagnostic accuracy from imaging and making the decision-making process for treatment easier. [20] AI systems were not employed within this study, but they are a promising option for optimizing preoperative evaluation and surgical planning in future practice. Furthermore, Munoz-Lopez et al. highlighted how an evolving understanding of varicocele pathophysiology, enabled by multi-omics and translational research, is helping simplify treatment strategies. Mounting evidence indicates that varicocele affects not only conventional semen parameters but also sperm DNA integrity, oxidative stress, and testicular microenvironment.[4] While our study did not quantify these advanced biomarkers, future research incorporating such variables can give a more comprehensive account of varicocele's impact and true gain from intervention.A key strength of this study is its contribution to region-specific data from a Pakistani tertiary care center. As most comparative varicocelectomy studies originate from Western or East Asian populations, local anatomical, environmental, or genetic differences may affect treatment outcomes. Thus, our findings offer valuable insights for optimizing varicocele-related infertility management in South Asian populations. Nonetheless, several limitations should be acknowledged. The non-randomized design introduces potential selection bias, as treatment choice was determined by the patient or surgeon. Additionally, the follow-up period was limited to four months, which may be insufficient to assess long-term outcomes such as natural conception or pregnancy rates. Important confounding variables such as hormone levels, testicular size, and oxidative stress markers were also not evaluated.

CONCLUSION

Both techniques improved sperm parameters, but the microscopic approach yielded significantly greater enhancement in semen parameters. These findings align with global literature and provide valuable regional insight. Expanding access to microsurgical expertise may enhance fertility outcomes in resource-limited settings. Future research should focus on multicenter randomized trials with longer follow-up to evaluate fertility outcomes, cost-effectiveness, and patient-reported measures. Prioritizing training in microsurgery and determining the role of AI in diagnosis and monitoring are imperative. Adding bilateral and recurrent varicocele cases will increase clinical applicability.

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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved