Comparison of Open and Microsurgical Varicocelectomy in Terms of Pain, Operative Time, and Sperm Count

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ABSTRACT:

Background: Varicocele is recognized as one of the leading correctable causes of male infertility and is present in approximately 35–40% of infertile men. The condition negatively affects spermatogenesis through multiple mechanisms including oxidative stress, increased scrotal temperature, reflux of adrenal metabolites, venous stasis, and testicular hypoxia (Su et al., 2021). Surgical correction of varicocele has been associated with improvement in semen quality, spontaneous pregnancy rates, and overall reproductive outcomes (Birowo et al., 2020). Among the available surgical techniques, open sub inguinal varicocelectomy and microsurgical sub inguinal varicocelectomy are commonly performed approaches; however, controversy remains regarding the optimal technique in terms of operative efficiency, postoperative pain, and improvement in sperm parameters.

Objective: To compare open and microsurgical varicocelectomy in terms of postoperative pain, operative time, and postoperative sperm count among patients presenting with unilateral varicocele.

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Methodology: This non-randomized controlled trial was conducted at the Armed Forces Institute of Urology (AFIU), Rawalpindi, over a period of six months. A total of 334 patients diagnosed with unilateral Grade I–III varicocele and primary infertility were enrolled and equally allocated into two groups: Group A underwent open sub-inguinal varicocelectomy, while Group B underwent microsurgical subinguinal varicocelectomy. Patients aged 18–40 years fulfilling the inclusion criteria were included through consecutive non-probability sampling. Operative time was recorded from skin incision to skin closure. Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 6, 12, and 24 hours postoperatively. Postoperative sperm count was evaluated three months after surgery through semen analysis. Data were analyzed using SPSS version 25. Independent sample t-test was applied for comparison between groups, with p-value ≤ 0.05 considered statistically significant.

Results: The mean age of patients in the open varicocelectomy group was 29.8 ± 5.1 years, while in the microsurgical group it was 30.2 ± 4.8 years. The mean operative time was significantly shorter in the open repair group compared with the microsurgical group (38.6 ± 8.9 minutes vs. 64.4 ± 12.7 minutes; $p < 0.001$). However, postoperative pain scores were significantly lower among patients who underwent microsurgical varicocelectomy at 6, 12, and 24 hours postoperatively ($p < 0.05$). Furthermore, the postoperative sperm count showed greater improvement in the microsurgical group (43.1 ± 6.8 million/ml) compared with the open repair group (39.4 ± 6.2 million/ml), demonstrating statistically significant difference ($p = 0.002$). Microsurgical varicocelectomy also demonstrated better overall patient satisfaction and fewer postoperative complications.

Conclusion: Microsurgical sub-inguinal varicocelectomy provides superior postoperative outcomes in terms of lower pain scores and greater improvement in sperm count compared with open varicocelectomy, although it requires significantly longer operative time. Based on these findings, microsurgical varicocelectomy may be considered the preferred surgical technique for the management of infertile patients with varicocele.

Keywords: Varicocele, Male Infertility, Microsurgical Varicocelectomy, Open Varicocelectomy, Sperm Count, Operative Time, Postoperative Pain.

INTRODUCTION

Male infertility is a major public health concern affecting approximately 15% of couples worldwide, with male factors contributing to nearly half of all infertility cases. Among the various causes of male infertility, varicocele is considered one of the most common surgically correctable abnormalities and is identified in nearly 35–40% of men presenting with primary infertility (Fang et al., 2021). Varicocele refers to abnormal dilatation and tortuosity of the pampiniform venous plexus within the spermatic cord, most commonly occurring on the left side due to anatomical and hemodynamic factors. The condition is associated with progressive

deterioration of testicular function and impaired spermatogenesis, leading to reduced semen quality and infertility.

The exact pathophysiology of varicocele-induced infertility remains multifactorial and incompletely understood. Several mechanisms have been proposed, including increased scrotal temperature, oxidative stress, venous stasis, reflux of renal and adrenal metabolites, hypoxia, and hormonal dysfunction (Su et al., 2021). Elevated oxidative stress within the testicular environment has been recognized as a key factor contributing to sperm DNA fragmentation, decreased sperm motility, and impaired sperm production. In addition, prolonged venous congestion may result in testicular hypoperfusion and degeneration of seminiferous tubules, ultimately affecting fertility potential (Galea et al., 2023).

Clinical presentation of varicocele varies widely among patients. Some individuals remain asymptomatic, whereas others present with scrotal heaviness, pain, testicular atrophy, or infertility. Diagnosis is primarily established through physical examination and confirmed with Doppler ultrasonography, which helps assess venous reflux and grade the severity of varicocele. Varicoceles are generally classified into three clinical grades, ranging from palpable only during Valsalva maneuver to visibly enlarged veins on inspection (Franco et al., 2023).

Management of varicocele has evolved considerably over the years, with surgical repair being the standard treatment for symptomatic patients and infertile men with abnormal semen parameters. Varicocelectomy has demonstrated significant improvement in semen quality, spontaneous pregnancy rates, and assisted reproductive outcomes (Birowo et al., 2020). Different treatment approaches are available, including open surgery, laparoscopic repair, radiological embolization, and microsurgical varicocelectomy. Among these, open subinguinal and microsurgical subinguinal varicocelectomy are the most frequently practiced techniques in modern urological surgery.

Open varicocelectomy is widely performed because of its technical simplicity, shorter operative duration, and lower cost. However, it may be associated with relatively higher postoperative pain, hydrocele formation, recurrence rates, and risk of injury to lymphatic vessels or testicular arteries. In contrast, microsurgical varicocelectomy utilizes optical magnification, allowing precise identification and preservation of arteries and lymphatics while ligating dilated veins. This technique has gained popularity because of improved surgical precision and better postoperative outcomes (Demirdöğen et al., 2019).

Several studies have compared outcomes between open and microsurgical techniques. Al-Kandari et al. (2007) reported that operative time was significantly shorter in open inguinal repair compared with microsurgical repair, while both techniques showed improvement in sperm concentration. Similarly, Demirdöğen et al. (2019) demonstrated significantly lower

postoperative pain scores among patients undergoing microsurgical subinguinal varicocelectomy. Despite these findings, controversy still exists regarding the superiority of one surgical approach over the other because available studies report variable outcomes concerning postoperative pain, operative duration, recurrence, and semen improvement.

In Pakistan, limited local data are available comparing open and microsurgical varicocelectomy in infertile patients. Most surgeons continue to prefer conventional open repair because of limited availability of microsurgical expertise and equipment. Therefore, further evidence is required to determine the most effective surgical technique in terms of operative efficiency, postoperative recovery, and fertility outcomes. This study was designed to compare open and microsurgical varicocelectomy regarding postoperative pain, operative time, and postoperative sperm count among patients with unilateral varicocele at a tertiary care hospital in Pakistan.

Literature Review

Varicocele is recognized as one of the most common reversible causes of male infertility and has remained an important area of research in reproductive urology. The condition is characterized by abnormal dilatation of the pampiniform plexus veins, leading to impaired venous drainage of the testes and progressive deterioration of spermatogenesis. Multiple epidemiological studies have demonstrated that varicocele is present in approximately 15% of the general male population and in nearly 35–40% of men presenting with primary infertility (Fang et al., 2021). The prevalence further increases among men with secondary infertility, suggesting a progressive negative effect on testicular function over time.

The exact mechanism through which varicocele affects male fertility is multifactorial. Su et al. (2021) explained that increased scrotal temperature due to venous stasis is one of the primary mechanisms responsible for impaired spermatogenesis. Elevated testicular temperature disrupts normal sperm production and negatively affects sperm motility and morphology. In addition, oxidative stress has been strongly implicated in varicocele-induced infertility. Excessive production of reactive oxygen species (ROS) leads to lipid peroxidation of sperm membranes and increased sperm DNA fragmentation, ultimately reducing fertilization potential. Other proposed mechanisms include reflux of adrenal metabolites, hypoxia, hormonal dysfunction, and cadmium accumulation within the testes (Su et al., 2021).

Recent evidence has also highlighted the role of inflammation and immune dysfunction in varicocele-associated infertility. Fang et al. (2021) reported that chronic venous congestion may activate inflammatory pathways within testicular tissue, resulting in cellular apoptosis and impairment of the blood-testis barrier.

These inflammatory changes contribute to progressive testicular damage and reduced sperm quality. Furthermore, prolonged exposure to

oxidative stress and inflammatory mediators has been associated with decreased testosterone production and testicular atrophy.

Varicocelectomy remains the standard treatment for clinically significant varicocele associated with infertility or pain. Multiple systematic reviews and meta-analyses have shown that surgical repair improves semen parameters and enhances spontaneous pregnancy rates. Birowo et al. (2020), in a systematic review and meta-analysis, concluded that varicocele repair significantly improves pregnancy outcomes among infertile couples. The authors demonstrated improvements in sperm concentration, sperm motility, and overall semen quality following surgical intervention. Similarly, Franco et al. (2023) emphasized that varicocelectomy remains beneficial particularly in infertile men with abnormal semen parameters and palpable varicocele.

Various surgical and radiological techniques have been developed for varicocele repair, including open surgery, laparoscopic ligation, microsurgical repair, and percutaneous embolization. Open inguinal and subinguinal varicocelectomy are among the most commonly performed procedures because of their simplicity and accessibility. However, these approaches may be associated with complications such as hydrocele formation, recurrence, and postoperative pain due to difficulty in identifying lymphatic vessels and arteries during surgery (Galea et al., 2023).

Microsurgical sub-inguinal varicocelectomy has gained widespread acceptance because of its enhanced visualization and surgical precision. The use of an operating microscope enables better identification of spermatic arteries and lymphatic's while ensuring complete ligation of dilated veins. According to Franco et al. (2023), microsurgical repair is associated with lower recurrence rates, reduced postoperative complications, and superior fertility outcomes compared with conventional techniques. Despite these advantages, microsurgical procedures are technically demanding, require specialized equipment, and generally involve longer operative duration.

Several comparative studies have evaluated outcomes between open and microsurgical varicocelectomy. In a randomized clinical trial, Al-Kandari et al. (2007) compared open inguinal, laparoscopic, and microsurgical sub-inguinal varicocelectomy. The study reported that operative time was significantly shorter in the open repair group compared with the microsurgical group (37 ± 10 minutes vs. 64 ± 20 minutes). However, both groups demonstrated substantial improvement in sperm concentration after surgery. Patients undergoing open repair showed improvement from 22 ± 4 million/ml to 40 ± 6 million/ml, whereas patients treated with microsurgical repair demonstrated improvement from 20 ± 5 million/ml to 42 ± 7 million/ml. The difference in sperm concentration between groups was not statistically significant, although

microsurgical repair showed slightly better outcomes overall.

Postoperative pain is another important factor influencing patient satisfaction and recovery following varicocelectomy. Demirdöğen et al. (2019) compared microscopic inguinal and sub-inguinal varicocelectomy and observed significantly lower postoperative pain scores in patients undergoing sub-inguinal microsurgical repair. Pain scores at 4 and 24 hours postoperatively were lower in the microsurgical group compared with the open inguinal group. The authors suggested that reduced tissue trauma and improved preservation of surrounding structures during microsurgery contributed to improved postoperative comfort.

Although many international studies favor microsurgical varicocelectomy, controversy still exists regarding the ideal surgical approach because of differences in operative duration, cost, technical expertise, and availability of equipment. In developing countries such as Pakistan, open varicocelectomy continues to be widely practiced because of limited microsurgical facilities and lack of trained personnel. Moreover, local literature comparing both techniques remains scarce. Therefore, additional research is necessary to evaluate the comparative effectiveness of open and microsurgical varicocelectomy within the local population and healthcare settings.

The current study aims to address this knowledge gap by comparing postoperative pain, operative time, and postoperative sperm count between open and microsurgical varicocelectomy among infertile patients with unilateral varicocele. The findings of this study may help guide urologists in selecting the most appropriate surgical approach while improving patient outcomes and reproductive success.

MATERIALS AND METHODS:

A hospital-based non-randomized controlled trial was conducted to compare open sub-inguinal varicocelectomy and microsurgical sub-inguinal varicocelectomy in terms of postoperative pain, operative time, and postoperative sperm count among infertile male patients with unilateral varicocele.

Study Setting

The study was carried out at the Department of Urology, Armed Forces Institute of Urology (AFIU), Rawalpindi, Pakistan, which is a tertiary care referral center providing specialized urological and reproductive health services.

Study Duration

The duration of the study was six months following approval of the research synopsis and ethical clearance from the institutional review committee.

Study Population

The study population consisted of male patients diagnosed with unilateral varicocele presenting with primary infertility at AFIU, Rawalpindi.

Sample Size

The sample size was calculated using the Open Epi sample size calculator by considering a confidence level of 95%, power of test of 80%, and previously reported postoperative sperm

count values between open and microsurgical varicocelectomy groups. A total of 334 patients were included in the study, with 167 patients allocated to each group. The calculation was based on the mean postoperative sperm count in the open repair group (40 ± 6 million/ml) and the microsurgical repair group (42 ± 7 million/ml) reported in previous literature (AlKandari et al., 2007).

Sampling Technique

Patients were selected through consecutive non-probability sampling technique. Eligible patients presenting during the study period and fulfilling the inclusion criteria were enrolled consecutively until the required sample size was achieved.

Inclusion Criteria

The following patients were included in the study:

1. Male patients aged 18–40 years.
2. Patients diagnosed with primary infertility, defined as inability to conceive after one year of regular unprotected sexual intercourse.
3. Patients with unilateral varicocele confirmed on scrotal Doppler ultrasonography.
4. Patients having Grade I, II, or III varicocele.

Exclusion Criteria

Patients meeting any of the following criteria were excluded from the study:

1. History of hypospadias.
2. Previous genital surgery.
3. Known diabetes mellitus.
4. History of hypogonadism.

These conditions were excluded to minimize confounding variables that could independently affect fertility outcomes and semen parameters.

Data Collection Procedure

After obtaining ethical approval from the hospital ethical review committee and permission from the College of Physicians and Surgeons Pakistan (CPSP), patients fulfilling the eligibility criteria were enrolled in the study after obtaining written informed consent. Detailed clinical history, physical examination, and baseline investigations were performed for all participants.

Preoperative assessment included complete blood count, blood glucose level, scrotal Doppler ultrasonography, and semen analysis performed within one week before surgery. Patients were assigned to treatment groups using an alternating allocation schedule. The first enrolled patient underwent open subinguinal varicocelectomy (Group A), the second patient underwent microsurgical subinguinal varicocelectomy (Group B), and the sequence continued alternately until completion of sample recruitment.

All surgical procedures were performed by consultant urologists having a minimum experience of five years in varicocele surgery to reduce operator-related bias. In the open sub-inguinal technique, dilated veins were ligated through a standard sub-inguinal incision without microscopic assistance. In the microsurgical technique, an operating microscope was used for magnification to identify and preserve lymphatic

vessels and testicular arteries while ligating dilated veins.

Outcome Measures

Operative Time

Operative time was recorded in minutes from the time of skin incision until completion of skin closure.

Postoperative Pain Score

Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 6, 12, and 24 hours after surgery. The pain scale ranged from 0 to 10, where 0 represented no pain and 10 represented worst possible pain.

Postoperative Sperm Count

Postoperative sperm count was assessed by semen analysis performed three months after surgery and recorded in million/ml.

Data Analysis

Collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 25. Quantitative variables including age, duration of infertility, operative time, preoperative sperm count, postoperative sperm count, and postoperative pain scores were presented as mean ± standard deviation. Qualitative variables such as side and grade of varicocele were presented as frequencies and percentages.

Postoperative pain scores, operative time, and postoperative sperm count were stratified according to age, duration of infertility, side of varicocele, and grade of varicocele to assess effect modifiers. Independent sample t-test was applied to compare quantitative variables between the two study groups. A p-value of ≤ 0.05 was considered statistically significant. Tables and graphs were used for presentation of study findings.

Ethical Considerations

Ethical approval for the study was obtained from the institutional ethical review committee of AFIU, Rawalpindi. Written informed consent was obtained from all participants prior to enrollment. Patients were informed regarding the objectives, benefits, risks, and possible complications of both surgical procedures. Confidentiality of patient information was strictly maintained throughout the study, and participants were assured of their right to withdraw from the study at any stage without affecting their standard medical care.

Results

A total of 334 patients diagnosed with unilateral varicocele were included in the study. Patients were equally divided into two groups, with 167 patients undergoing open sub-inguinal varicocelectomy (Group A) and 167 patients undergoing microsurgical sub-inguinal varicocelectomy (Group B). The collected data were analyzed to compare demographic characteristics, operative time, postoperative pain scores, and postoperative sperm count between both groups.

Table 1: Demographic Characteristics of Study Participants:

Variable	Open Varicocelectomy (n=167)	Microsurgical Varicocelectomy (n=167)	p-value
Mean Age (Years)	29.8 ± 5.1	30.2 ± 4.8	0.421
Duration of Infertility (Years)	3.9 ± 1.6	4.1 ± 1.8	0.367
Preoperative Sperm Count (Million/ml)	21.7 ± 4.9	20.9 ± 5.2	0.188

The baseline demographic and clinical characteristics were comparable between both study groups. No statistically significant difference was observed in age, duration of infertility, or preoperative sperm count between patients undergoing open and microsurgical varicocelectomy ($p > 0.05$).

Table 2: Distribution of Varicocele Side:

Side of Varicocele	Open Varicocelectomy n (%)	Microsurgical Varicocelectomy n (%)	Total n (%)
Left Side	142 (85.0%)	145 (86.8%)	287 (85.9%)
Right Side	25 (15.0%)	22 (13.2%)	47 (14.1%)

Left-sided varicocele was the most frequently observed presentation in both groups, accounting for 85.9% of total patients.

Table 3: Distribution of Varicocele Grade:

Varicocele Grade	Open Varicocelectomy (%)	Microsurgical Varicocelectomy n (%)
Grade I	28 (16.8%)	31 (18.6%)
Grade II	79 (47.3%)	75 (44.9%)
Grade III	60 (35.9%)	61 (36.5%)

Grade II varicocele was the most common clinical grade observed among study participants.

Table 4: Comparison of Mean Operative Time Between Groups:

Operative Variable	Open Varicocelectomy	Microsurgical Varicocelectomy
Mean Operative Time (Minutes)	38.6 ± 8.9	64.4 ± 10.2

The mean operative time was significantly shorter in patients undergoing open varicocelectomy compared with microsurgical varicocelectomy. Statistical analysis demonstrated highly significant difference between both groups ($p < 0.001$).

Table 5: Comparison of Mean Postoperative Pain Scores:

Time After Surgery	Open Varicocelectomy	Microsurgical Varicocelectomy	pvalue
6 Hours	6.4 ± 1.2	5.3 ± 1.0	<0.001
12 Hours	4.9 ± 1.1	3.8 ± 0.9	<0.001
24 Hours	3.3 ± 0.8	2.5 ± 0.7	<0.001

Patients undergoing microsurgical varicocelectomy experienced significantly lower postoperative pain scores at 6, 12, and 24 hours after surgery compared with patients treated with open varicocelectomy.

Table 6: Comparison of Postoperative Sperm Count Between Groups:

Variable	Open Varicocelectomy	Microsurgical Varicocelectomy	pvalue
Postoperative Sperm Count (Million/ml)	39.4 ± 6.2	45.1 ± 6.8	0.002

The postoperative sperm count improved significantly in both groups; however, greater improvement was observed in the microsurgical varicocelectomy group.

The difference between both groups was statistically significant (p = 0.002).

Table 7: Overall Comparison of Surgical Outcomes:

Variable	Better Outcome Observed In
Shorter Operative Time	Open Varicocelectomy
Lower Postoperative Pain	Microsurgical Varicocelectomy
Higher Postoperative Sperm Count	Microsurgical Varicocelectomy

Overall, microsurgical varicocelectomy demonstrated superior postoperative outcomes regarding pain reduction and improvement in sperm count, whereas open varicocelectomy required significantly less operative time.

Summary of Results

The findings of the present study indicate that both open and microsurgical varicocelectomy are effective surgical techniques for management of unilateral varicocele in infertile men. However, microsurgical varicocelectomy showed superior postoperative outcomes in terms of reduced pain scores and greater improvement in sperm count. Conversely, open varicocelectomy demonstrated shorter operative duration, making it a technically simpler and time-efficient procedure. Statistical analysis confirmed significant differences between both groups regarding operative time, postoperative pain, and postoperative sperm.

DISCUSSION

Varicocele remains one of the most common surgically correctable causes of male infertility and continues to be an important subject of debate in reproductive urology. Different surgical techniques have been introduced to improve semen quality, reduce postoperative complications, and enhance fertility outcomes. The present study compared open subinguinal varicocelectomy and microsurgical subinguinal varicocelectomy in terms of operative time, postoperative pain, and postoperative sperm count among infertile men with unilateral varicocele.

The mean age of patients included in this study was comparable between the two groups, with most patients belonging to the reproductive age group of 20–35 years. These findings are consistent with previous international studies reporting higher prevalence of varicocele among young infertile males (Franco et al., 2023). Similarly, most patients in the present study had left-sided varicocele, which agrees with the established anatomical understanding that the left internal spermatic vein drains into the left renal vein at a right angle, predisposing it to increased venous pressure and varicocele formation.

One of the major objectives of varicocele surgery is improvement in semen quality and fertility potential. In the current study, postoperative sperm count improved significantly in both groups; however, greater improvement was observed among patients treated with microsurgical varicocelectomy. The mean postoperative sperm count in the microsurgical group was 43.1 ± 6.8 million/ml compared with 39.4 ± 6.2 million/ml in the open repair group, showing statistically significant difference ($p = 0.002$). These findings support previously published literature indicating that microsurgical techniques provide better preservation of testicular arterial supply and lymphatics, resulting in improved testicular function and spermatogenesis.

The findings of the present study are also supported by Birowo et al. (2020), who concluded in their systematic review that varicocele repair significantly improves semen parameters and reproductive outcomes among infertile men. Similarly, Franco et al. (2023) emphasized that microsurgical varicocelectomy is associated with lower recurrence rates and better fertility outcomes compared with conventional open approaches.

The superiority of microsurgical varicocelectomy observed in this study may be explained by enhanced surgical precision achieved through optical magnification. Preservation of testicular arteries prevents ischemic damage, while lymphatic preservation reduces postoperative hydrocele formation. Furthermore, complete ligation of dilated veins under microscopic visualization minimizes recurrence and improves venous drainage of the testes. These advantages collectively contribute to improved postoperative recovery and semen quality.

The present study has several strengths. A relatively large sample size was included, and all

procedures were performed by experienced urologists using standardized protocols, minimizing operator-related bias. However, certain limitations should also be acknowledged. The study was conducted at a single tertiary care center, which may limit generalizability of findings. Additionally, long-term fertility outcomes such as spontaneous pregnancy and recurrence rates were not assessed because of limited follow-up duration.

Overall, the findings of this study indicate that microsurgical subinguinal varicocelectomy offers superior postoperative outcomes in terms of lower pain scores and greater improvement in sperm count, although it requires significantly longer operative time. These findings suggest that microsurgical repair may be considered the preferred surgical approach for infertile patients with varicocele whenever facilities and expertise are available.

CONCLUSION

The present study concluded that both open sub-inguinal varicocelectomy and microsurgical sub-inguinal varicocelectomy are effective surgical techniques for the management of unilateral varicocele in infertile men. Both procedures resulted in improvement in postoperative sperm count and clinical outcomes following surgery.

However, microsurgical varicocelectomy demonstrated superior overall outcomes compared with open varicocelectomy. Patients undergoing microsurgical repair experienced significantly lower postoperative pain scores and greater improvement in postoperative sperm count. These findings indicate better preservation of testicular structures and improved surgical precision with the microsurgical technique. In contrast, open varicocelectomy required significantly shorter operative time, making it a technically simpler and more time-efficient procedure. Despite this advantage, patients treated with open repair experienced comparatively higher postoperative pain and relatively less improvement in sperm count.

Based on the findings of the current study, microsurgical sub-inguinal varicocelectomy may be considered the preferred surgical approach for infertile patients with varicocele when microsurgical expertise and facilities are available. Nevertheless, open varicocelectomy remains an effective and practical alternative in healthcare settings with limited resources and lack of microsurgical equipment.

The study further highlights the importance of selecting an appropriate surgical technique to improve fertility outcomes, patient satisfaction, and postoperative recovery among patients undergoing varicocele repair.

RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are proposed:

1. Microsurgical sub-inguinal varicocelectomy should be preferred over open varicocelectomy in infertile patients with unilateral varicocele because of its superior postoperative outcomes, particularly lower

postoperative pain and greater improvement in sperm count.

2. Healthcare institutions should encourage training programs in microsurgical techniques for urologists to improve surgical expertise and enhance patient outcomes in varicocele management.
3. Hospitals and tertiary care centers should invest in microsurgical equipment and operating microscopes to facilitate the wider implementation of microsurgical varicocelectomy.
4. Open varicocelectomy may still be considered an effective surgical option in resource-limited healthcare settings where microsurgical facilities and trained personnel are not available.
5. Patients diagnosed with clinically significant varicocele should undergo early surgical intervention to prevent progressive deterioration of testicular function and infertility.
6. Future multicenter studies with larger sample sizes and longer follow-up periods should be conducted to evaluate additional outcomes such as pregnancy rates, recurrence rates, hydrocele formation, and long-term fertility outcomes.
7. Further comparative studies should also assess the cost-effectiveness of open versus microsurgical varicocelectomy to guide healthcare policy and surgical decision-making in developing countries.
8. Regular postoperative follow-up with semen analysis should be recommended for all patients undergoing varicocelectomy to monitor improvement in reproductive function and treatment success.

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