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ORIGINAL ARTICLES

Optimizing Varicocele Treatment: A Comparative Review of Surgical and Minimally Invasive Approaches

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ABSTRACT

Background. Varicocele is the most common surgically correctable cause of male infertility, yet the choice of surgical technique remains a matter of ongoing debate. Open (Ivanissevich-type), laparoscopic, and microsurgical subinguinal approaches each carry distinct profiles of recurrence, hydrocele formation, postoperative pain, and recovery. We report a small, single-centre comparative experience and place it within the contemporary evidence base.

Methods. Between January 2024 and January 2026, 16 male patients (aged 18–46 years) undergoing varicocele repair at the Clinical Hospital of Tetovo were studied. Eight were treated with a laparoscopic technique and eight with a conventional open technique. Outcomes recorded were intra- and postoperative complications, postoperative pain, hydrocele formation, time to full recovery, and varicocele recurrence.

Results. No complications were recorded in the laparoscopic group; one patient in the open group developed a postoperative haematoma. Postoperative pain was clearly lower after laparoscopy, and full recovery was shorter than after open surgery. No hydrocele was observed in either group. A mild recurrence occurred in one laparoscopic patient and in one open patient, the latter being more pronounced.

Conclusions. In this limited series, laparoscopic repair was associated with less pain and faster recovery than open repair, with comparable short-term safety. These observations are consistent with the broader literature, in which microsurgical subinguinal varicocelectomy currently shows the lowest recurrence and hydrocele rates and is regarded by many andrology centres as the surgical reference standard. The small sample size precludes firm conclusions, and larger comparative work is needed.

Keywords: varicocele; varicocelectomy; laparoscopy; microsurgery; male infertility;

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INTRODUCTION

A varicocele is an abnormal dilatation of the veins of the pampiniform plexus within the spermatic cord. It is one of the most frequently encountered conditions in andrological practice and remains the most common surgically correctable cause of male subfertility (1,2).

Reported figures place varicocele in roughly 10–20% of the general male population, in about 35–40% of men with primary infertility, and in a still higher proportion of men with secondary infertility (2,3).

These estimates are themselves imperfect, because prevalence depends heavily on how the diagnosis is made and on the experience of the examiner, and varicocele is thought to be underdiagnosed in some infertility settings (4,5). The condition is overwhelmingly left-sided. This laterality is usually attributed to anatomical factors: the left gonadal vein drains into the left renal vein at close to a right angle and over a longer vertical course, whereas the right gonadal vein enters the inferior vena cava more obliquely (2).

Varicocele typically becomes apparent during puberty, with prevalence rising from under 1% in prepubertal boys to around 10–14% in adolescents (2).

The mechanisms by which a varicocele impairs testicular function are not completely settled, but several converging pathways are consistently described: an increase in scrotal and testicular temperature, relative hypoxia from venous stasis, reflux of metabolites from the renal and adrenal circulation, and oxidative stress driven by excess reactive oxygen species (2).

These processes can translate into measurable falls in sperm concentration, motility, and morphology, and in some men into reduced testosterone production.

Not every varicocele warrants intervention. Current guidance from the American Urological Association and the American Society for Reproductive Medicine recommends that surgical varicocelectomy be considered in men who are attempting to conceive, who have a palpable (clinical) varicocele, infertility, and abnormal semen parameters, with the explicit exception of azoospermic men (6).

Both the AUA/ASRM and the European Association of Urology advise against repair of subclinical varicoceles detected by imaging alone (2,6).

The same bodies note that, when the female partner is 35 years or older, the time cost of surgery has to be weighed against proceeding directly to assisted reproduction (7).

The role of repair in men with non-obstructive azoospermia is more contentious; pooled data suggest that a minority may regain sperm in the ejaculate after repair, but the evidence is limited and the decision is made case by case (8).

Once the decision to operate has been made, the surgeon must choose among several established techniques. The principal options are conventional open ligation through an inguinal or subinguinal incision, laparoscopic (retroperitoneal) ligation, microsurgical subinguinal or inguinal varicocelectomy performed under an operating microscope, and radiological percutaneous embolisation.

The persistent question is not whether varicocele can be treated, but which method best balances durable correction against the avoidance of complications such as hydrocele, recurrence, and arterial or lymphatic injury.

This paper has two aims. First, we report a small comparative experience from the Clinical Hospital of Tetovo, in which laparoscopic and open repairs performed over a two-year period are compared on practical clinical endpoints. Second, we set those observations against the contemporary literature so that the local findings can be interpreted honestly, including their limitations.

The clinical importance of getting this choice right is hard to overstate. Infertility affects a substantial share of couples, and a male factor contributes in roughly half of cases; varicocele is the single most common cause that can actually be corrected (2).

Unlike many causes of male subfertility, a varicocele can be treated with a procedure that has the potential to reverse an ongoing pathological process rather than merely bypass it through assisted reproduction (6). That potential, however, is realised only when the right patient is selected and the right technique is applied; a poorly chosen operation can leave a patient with a persistent varicocele, a new hydrocele, or an injured testicular artery, none of which advances the original goal. The comparative question this paper examines is therefore not academic but directly tied to whether men are helped or harmed.

Anatomical and Technical Background

Understanding why the techniques differ in outcome requires a brief look at the venous anatomy of the spermatic cord. Venous drainage of the testis and epididymis is shared among three groups of veins: the internal spermatic (testicular) veins, the deferential veins, and the external spermatic or cremasteric veins; these communicate at the lower pole of the testis and connect, through gubernacular veins, with the posterior scrotal veins (9).

Because several venous routes exist, a technique that interrupts only the most obvious channels may leave collateral pathways intact, and it is these residual collaterals that are thought to underlie many recurrences.

The level at which the cord is approached changes the operative picture.

A retroperitoneal or high laparoscopic approach addresses the internal spermatic veins where they are few in number, but may miss cremasteric and gubernacular collaterals.

A subinguinal approach encounters a larger number of veins but allows the surgeon, particularly under

magnification, to identify and preserve the testicular artery and lymphatics while ligating the relevant veins (9).

Preservation of lymphatics is the key to avoiding postoperative hydrocele, and preservation of the artery is essential to avoid testicular compromise.

The microsurgical subinguinal technique was introduced by Marmar and colleagues in 1985 and modified by Goldstein and colleagues in 1992; operating under the microscope brings recurrence and postoperative hydrocele rates down toward very low single-digit figures (9).

Laparoscopy, by contrast, offers a minimally invasive route with small incisions and the ability to treat bilateral disease through the same access, but it works at a level where collateral veins may escape ligation.

How a varicocele harms the testis

The link between dilated cord veins and impaired spermatogenesis is best understood as a convergence of several insults rather than a single lesion. Venous stasis raises the local temperature of the testis above the few degrees below core temperature that normal spermatogenesis requires; the same stasis produces relative hypoxia; and reflux carries metabolites from the renal and adrenal circulation back toward the testis (2).

Layered onto these is oxidative stress, widely regarded as the central mediator of varicocele-related sperm damage: an excess of reactive oxygen species that overwhelms seminal antioxidant capacity and damages sperm membranes and DNA (2,7).

Because these mechanisms accumulate over time, the rationale for repair is partly to halt an ongoing process before the damage becomes fixed — which is also why outcomes are less predictable in long-standing or higher-grade disease, and why the question of who benefits most remains an active area of study.

This mechanistic picture explains two features of clinical practice.

First, it is clinical (palpable) varicoceles, which produce the largest haemodynamic disturbance, that are associated with measurable harm and with benefit from repair, whereas subclinical varicoceles are not (6).

Second, the choice of surgical technique matters precisely because the goal is to interrupt the abnormal venous drainage completely while leaving arterial inflow and lymphatic outflow intact; a technique that achieves the former but injures the latter trades one problem for another.

Diagnosis and Grading

Diagnosis rests first on physical examination. The patient is examined standing, in a warm room, and the cord is palpated at rest and during a Valsalva manoeuvre. The grading scheme in routine use was introduced by Dubin and Amelar in 1970 (10): grade 1 denotes a varicocele palpable only with Valsalva; grade 2 is palpable at rest without Valsalva; and grade 3 is visible through the scrotal skin (11).

A varicocele that is impalpable but detectable only on imaging is termed subclinical.

Physical examination is, by its nature, subjective and depends heavily on the examiner's experience; agreement between examiners improves with seniority (11).

Colour Doppler ultrasonography can confirm a clinically suspected varicocele and assess venous diameter and reflux, but guidance differs by region: European practice tends to use ultrasound for confirmation, whereas the AUA and EAU advise against routine imaging to detect non-palpable varicoceles, and against treating varicoceles found by imaging alone (2,6)

The practical consequence is that clinical, palpable disease, not an incidental ultrasound finding, is what should drive the decision to operate.

Alongside grading, the andrological work-up includes at least two semen analyses and an assessment of testicular volume and consistency, since a small or soft testis on the affected side may itself be an indication to intervene in adolescents. These baseline measures also provide the reference against which the success of any repair is later judged.

Overview of Treatment Options

Several distinct approaches are available, and each carries its own balance of advantages and drawbacks. A clear understanding of these is what makes a comparative discussion meaningful.

Open (conventional) varicocelectomy

Open repair through an inguinal or subinguinal incision is the longest-established surgical option. The internal spermatic veins are identified and ligated. Performed without magnification, this technique is widely available and technically straightforward, but it carries the highest reported recurrence among the surgical options — figures of roughly 10–45% have been cited for non-microsurgical open repair (12) and a measurable rate of hydrocele, because lymphatic channels are difficult to spare without magnification.

Laparoscopic varicocelectomy

Laparoscopy ligates the internal spermatic veins at a high, retroperitoneal level through small abdominal ports. Its strengths are those of minimally invasive surgery generally: small incisions, less postoperative pain, and a quicker return to activity, together with the ability to treat bilateral varicoceles through a single access. Its principal weakness is that, by working above the inguinal canal, it may leave cremasteric and gubernacular collaterals untreated, which is the leading explanation for its comparatively higher recurrence (12).

Microsurgical varicocelectomy

The microsurgical subinguinal (or inguinal) technique uses an operating microscope to identify and preserve the testicular artery and lymphatics while ligating the relevant veins. Pooled data place its recurrence and hydrocele rates at very low single-digit figures — on the order of 1–2% recurrence and 0–1% hydrocele in experienced hands, and a meta-analysis has identified the inguinal and subinguinal micro-surgical routes as the optimal surgical management of varicocele (9,13,14). Its costs are a longer operating time and a steeper learning curve, since it demands microsurgical skill and equipment (15).

Percutaneous embolization

Radiological embolization occludes the internal spermatic vein from within, via a percutaneous catheter, without an incision. A prospective comparison with microsurgery found no significant difference in sperm quality, pregnancy rate, or overall satisfaction, while embolization offered faster recovery and less pain (16). However, embolization has a non-trivial technical failure rate and is not always feasible anatomically, so it is generally positioned as an alternative rather than a default.

Aim and Objectives

The aim of this study was to compare laparoscopic and conventional open varicocelectomy in patients treated at the Clinical Hospital of Tetovo between January 2024 and January 2026, in order to inform the choice of surgical technique in routine practice and to situate that comparison within the contemporary evidence on varicocele treatment.

To address this aim, the study set the following specific objectives:

- to describe and compare the rate of intra- and postoperative complications between the laparoscopic and open groups;
- to compare postoperative pain and the time to full recovery between the two techniques;
- to record the occurrence of postoperative hydrocele in each group;
- to assess varicocele recurrence and its severity on follow-up;
- to interpret these local findings against published comparative data, including the role of microsurgical varicocelectomy as the reference standard, so that evidence-based recommendations can be drawn for the department.

We did not set out to test a formal statistical hypothesis. Given the modest number of patients available over the study period, the study was framed as a descriptive comparison whose purpose is to generate locally relevant observations and to define the design of a larger, more rigorous study, rather than to establish the superiority of one technique with statistical certainty (6).

PATIENTS AND METHODS

Setting and design

This was a single-centre comparative observational study conducted in the Department of Urology of the Clinical Hospital of Tetovo. Patients treated for varicocele between January 2024 and January 2026 were included. The study compared two operative techniques used during this period: a laparoscopic approach and a conventional open approach.

Participants

Sixteen male patients aged between 18 and 46 years were studied. Eight patients were treated with the laparoscopic technique and eight with the open technique. Allocation reflected routine clinical practice and surgeon judgement rather than randomisation.

Operative techniques

In the laparoscopic group, the spermatic vessels were approached through a standard transperitoneal laparoscopic route, with identification and ligation of the dilated internal spermatic veins at the retroperitoneal level. In the open group, repair was carried out through an inguinal/subinguinal incision with identification and ligation of the internal spermatic veins under direct vision. Both techniques followed the department's established routine, and the same perioperative care pathway — analgesia protocol, mobilisation, and discharge criteria — was applied to all patients so that the comparison of pain and recovery reflected the procedure rather than differences in aftercare.

Follow-up

Patients were reviewed clinically after surgery for wound healing, pain, and the appearance of any swelling suggestive of hydrocele, and were examined for evidence of varicocele recurrence. Recurrence was judged on clinical examination, consistent with the grading approach described above, and any residual or returning varicocele was noted together with its severity relative to the pre-operative state.

Outcomes assessed

The following clinical endpoints were recorded for every patient:

- intraoperative and early postoperative complications (including haematoma);
- postoperative pain;
- postoperative hydrocele formation;
- time to full recovery and return to normal activity;
- varicocele recurrence on follow-up.

Analysis

Given the small number of patients in each arm, outcomes are reported descriptively. No formal statistical hypothesis testing was performed, because the sample size is too small to support meaningful inferential statistics; reporting raw counts avoids overstating certainty. This decision is itself a deliberate limitation rather than an oversight, and is discussed further below.

RESULTS

The two groups were comparable in age range (18–46 years). The principal findings are summarised in Table 1 and described below.

Table 1. Outcomes by surgical technique (n = 16).

Outcome	Laparoscopic (n = 8)	Open (n = 8)
Postoperative complications	None recorded	1 haematoma
Postoperative pain	Clearly lower	Higher
Hydrocele formation	None	None
Time to full recovery	Shorter	Longer
Recurrence	1 (mild)	1 (more pronounced)

Complications

No intraoperative or early postoperative complications were recorded in any of the eight patients treated laparoscopically. In the open group, one patient developed a postoperative haematoma at the operative site. No other complications were noted in the open arm.

Postoperative pain and recovery

Postoperative pain was clearly lower in the laparoscopic group than in the open group. Consistent with this, the time to full recovery and return to normal activity was shorter after laparoscopic repair than after open repair.

Hydrocele

No hydrocele was recorded in either group during the follow-up period.

Recurrence

A mild recurrence of the varicocele was observed in one patient in the laparoscopic group and in one patient in the open group. The recurrence in the patient who had undergone open varicocelectomy was more pronounced than that seen after laparoscopy.

DISCUSSION

Our small series points in the same direction as the larger literature on two practical endpoints: minimally invasive repair produced less postoperative pain and a faster recovery than open surgery. A focused comparison of laparoscopic and microscopic subinguinal repair likewise found markedly lower pain scores and a shorter return to normal activity after the minimally invasive route (Shiraishi et al., 2012) (17).

The single haematoma in our open arm, against no recorded complications laparoscopically, is consistent with the general observation that minimally invasive approaches tend to reduce wound-related morbidity, although a single event in eight patients cannot carry statistical weight.

The recurrence pattern we observed also fits the published evidence. Across randomised and pooled data, laparoscopic ligation carries a higher recurrence rate than microsurgery. A 2024 systematic review and meta-analysis reported that recurrence was roughly seven-fold higher after laparoscopic than after microsurgical varicocelectomy (Mawong et al., 2024) (12).

A separate meta-analysis similarly found significantly lower hydrocele and recurrence rates after microsurgery than after laparoscopy, at the cost of a longer operating time (Yuan et al., 2017) (18).

In a three-arm randomised trial comparing open inguinal, laparoscopic, and microscopic subinguinal repair, no patient in the microsurgical group developed a hydrocele, whereas hydrocele occurred in 2.8% of open and 5.4% of laparoscopic patients, and recurrence was lowest after microsurgery (Al-Kandari et al., 2007) (19).

A meta-analysis of randomised trials comparing open non-microsurgical, laparoscopic, and open microsurgical repair reached the same conclusion, with microsurgery showing the lowest recurrence and hydrocele (Ding et al., 2012) (20).

That our single more pronounced recurrence followed an open procedure should be read cautiously given the numbers involved, but it does not contradict the wider picture.

This brings the discussion to the central point of controversy. Over the past decade, varicocele surgery has shifted toward microsurgical technique, which shows the lowest complication rates, including hydrocele (Lim et al., 2014) (15).

The reason many urologists now treat laparoscopic varicocelectomy as debatable is not that the method is unsafe or ineffective; it is that microsurgical subinguinal varicocelectomy has demonstrated a consistent set of advantages:

- lower recurrence;
- less hydrocele;
- better preservation of the testicular artery and lymphatics;

- fertility outcomes that are at least equal to, and often better than, the alternatives.

For these reasons, in many andrology and male-infertility centres the microsurgical subinguinal varicocelectomy is currently regarded as the surgical reference standard for varicocele (Mirilas & Mentessidou, 2012; Diao et al., 2018; Lim et al., 2014) (9,13,15)

The advantage rests on the level and magnification of the dissection: under the microscope the surgeon can ligate the relevant veins while sparing the artery and lymphatics, which is what drives the low hydrocele rate, and can address collaterals that a higher laparoscopic ligation may leave behind, which is what drives the low recurrence rate (Diao et al., 2018) (13).

None of this makes laparoscopy obsolete. It remains a reasonable option, particularly for bilateral disease treated through a single access, and our own laparoscopic patients did well on pain and recovery. The honest summary is that laparoscopy competes well on perioperative comfort but trails microsurgery on the two endpoints that matter most for a definitive cure: recurrence and hydrocele.

Fertility and semen outcomes

Beyond the perioperative comparison, the ultimate purpose of repair in subfertile men is improvement in semen quality and the chance of conception. Across the literature, varicocele repair in men with clinical disease and abnormal semen has been reported to improve semen parameters in roughly 60–80% of cases and to raise spontaneous pregnancy rates into the region of about 26–37% (Lee et al., 2025) (2).

A meta-analysis of randomised trials concluded that surgical repair significantly increases the pregnancy rate compared with observation and recommended it as first-line treatment for clinical varicocele in subfertile men, with subgroup analysis favouring the microsurgical subinguinal technique (Kim et al., 2013) (21).

Comparative work between microsurgery and embolization found similar improvements in sperm quality and similar pregnancy rates, with embolization offering somewhat lower perioperative morbidity (Bechara et al., 2017) (16).

In our small series, semen and fertility endpoints were not the primary focus and the numbers are too few to comment on conception, which is a further reason to treat the present data as preliminary.

Comparative summary of the evidence

Table 2 draws together the comparative profile of the main techniques as reported in the cited literature. The figures are indicative ranges from published series and meta-analyses rather than results from the present study, and are intended to frame, not replace, individual clinical judgement.

Limitations

The most important limitation of this study is its size. With eight patients in each arm, the findings are descriptive and hypothesis-generating only; they cannot support claims of statistical superiority of one technique over another. Allocation was not randomised, so selection effects cannot be excluded. Follow-up duration was not standardised across all patients, which is relevant because both recurrence and hydrocele can appear late.

Pain and recovery were assessed clinically rather than with a validated instrument such as a visual analogue scale, so the comparison, while clear in direction, is not quantified. Finally, the study did not include a microsurgical arm, which is precisely the technique the wider literature identifies as the reference standard; our data therefore speak to the laparoscopic-versus-open question rather than to the question of which technique is optimal overall.

A further limitation is that semen and pregnancy outcomes, the endpoints that matter most for the infertile population in whom repair is usually indicated, were not analysed here. Short-term surgical endpoints such as pain, haematoma, and early recurrence are easier to capture but are not the whole story; a varicocele repair that is comfortable and incision-light yet fails to improve fertility has not achieved its purpose. Any reading of the present results should therefore be confined to the perioperative domain.

These limitations map directly onto a future-work agenda. A larger, prospective, ideally randomised comparison conducted at our centre should: include a microsurgical arm alongside laparoscopic and open repair; use a validated pain instrument and a fixed

Table 2. Indicative comparative profile of varicocele treatment approaches (from cited literature).

Approach	Recurrence	Hydrocele	Pain / recovery	Key trade-off
Open (non-microsurgical)	High (≈10–45%)	Higher	More pain	Simple, widely available
Laparoscopic	Higher than micro	Low–moderate	Less pain, fast recovery	Bilateral via one access
Microsurgical subinguinal	Lowest (≈1–2%)	Lowest (≈0–1%)	Low pain	Longer time, needs skill
Percutaneous embolization	Variable	Very low	Least morbidity	Technical failure possible

follow-up schedule; confirm recurrence and hydrocele with colour Doppler ultrasonography read by an assessor blinded to the operative technique; and report semen parameters and spontaneous pregnancy with adequate follow-up. Such a design would allow the local data to contribute meaningfully rather than merely to echo the existing literature.

Clinical Implications for Our Centre

Read together, our local experience and the wider evidence point to a few practical positions for a department such as ours. None of these is a rigid rule; each is a reasonable default that an individual case may override.

First, patient selection should remain anchored to clinical examination. A palpable varicocele in a man with infertility and abnormal semen parameters is the well-supported indication for repair; an incidental ultrasound finding in an asymptomatic man with normal semen is not (Lee et al., 2025; Brannigan et al., 2021) (2,6). Holding this line avoids operating on men who cannot benefit.

Second, where the principal goal is the most durable possible correction with the lowest complication burden, particularly in men being treated for infertility, the literature favours the microsurgical subinguinal technique as the reference standard (Mirilas & Mentessidou, 2012; Wang et al., 2015; Kim et al., 2013). (9,14,21).

Our series did not include a microsurgical arm, so a sensible next step for the department would be to develop or formally evaluate this capability and to audit its outcomes against our existing laparoscopic and open results.

Third, laparoscopy retains a defined role. Its perioperative profile in our patients was favourable, and it is well suited to bilateral disease through a single access. Where it is used, counselling should be honest about the comparatively higher recurrence relative to microsurgery (Mawong et al., 2024) (12).

Fourth, for patients who wish to avoid an incision or who decline surgery, percutaneous embolization is a legitimate alternative with comparable fertility outcomes and low morbidity, provided the limitations of technical failure and anatomical feasibility are explained (Bechara et al., 2017) (16).

Finally, every patient should have standardised pre- and post-operative documentation — graded examination, at least two semen analyses, and a defined follow-up interval — so that future audits rest on consistent data rather than impressions.

CONCLUSION

In this small single-centre comparison, laparoscopic varicocele repair offered less postoperative pain and faster recovery than open repair, with comparable short-term safety and no hydrocele in either group. A mild recurrence occurred in one patient per group, more pronounced after open surgery. These observations align with a literature in which minimally invasive techniques reduce perioperative morbidity, and in which microsurgical subinguinal varicocelectomy currently delivers the lowest recurrence and hydrocele rates and is treated by many centres as the surgical reference standard. The limited sample size means our results should be regarded as a local audit rather than definitive evidence. Larger, ideally randomised, comparisons that include a microsurgical arm and standardised follow-up are needed to refine practice at our institution.

Editorial Statements

Ethics Approval and Consent to Participate

This study involved the analysis of data from human participants. The research protocol was reviewed and approved by the Institutional Ethics Committee and was conducted in accordance with institutional regulations, the principles of the Declaration of Helsinki, and internationally accepted standards for biomedical research ethics.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions (CRediT): Conceptualization & Methodology: EE, AA; Data Curation, Investigation and Writing – Original Draft: FD: Formal Analysis: FD, VE: Writing – Review & Editing: EE, VE: Supervision: EE. All authors have read and approved the final version of the manuscript.

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The authors used a generative artificial intelligence tool solely for language editing and grammar improvement. All scientific content, data analysis, interpretation, and conclusions were independently developed, verified, and approved by the authors.

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REFERENCES

1. Jensen, C. F. S., Østergren, P., Dupree, J. M., Ohl, D. A., Sønksen, J., & Fode, M. (2017). Varicocele and male infertility. *Nature Reviews Urology, 14*(9), 523–533. https://doi.org/10.1038/nrurol.2017.98
2. Lee, S. W., Kim, J. H., & Park, H. J. (2025). Recent guidelines and perspectives for varicocele: A clinical consensus and recommendations from the Korean Society for Sexual Medicine and Andrology. *The World Journal of Men's Health, 43*(4), 712–730. https://doi.org/10.5534/wjmh.240290
3. Alsaikhan, B., Alrabeeah, K., Delouya, G., & Zini, A. (2016). Epidemiology of varicocele. *Asian Journal of Andrology, 18*(2), 179–181. https://doi.org/10.4103/1008-682X.172640
4. Clavijo, R. I., Carrasquillo, R., & Ramasamy, R. (2017). Varicoceles: Prevalence and pathogenesis in adult men. *Fertility and Sterility, 108*(3), 364–369. https://doi.org/10.1016/j.fertnstert.2017.06.036
5. Jarow, J. P., Coburn, M., & Sigman, M. (1996). Incidence of varicoceles in men with primary and secondary infertility. *Urology, 47*(1), 73–76. https://doi.org/10.1016/S0090-4295(99)80385-9
6. Brannigan, R. E., Hermanson, L., Kaczmarek, J., Kim, S. K., Kirkby, E., & Tanrikut, C. (2021). Diagnosis and treatment of infertility in men: AUA/ASRM guideline part II. *Fertility and Sterility, 115*(1), 62–69. https://doi.org/10.1016/j.fertnstert.2020.11.016
7. Agarwal, A., Cannarella, R., Saleh, R., Boitrelle, F., Gül, M., Toprak, T., … & Shah, R. (2026). Global Andrology Forum (GAF) clinical guidelines on the management of infertile men with varicocele. The World Journal of Men's Health, 44(1), 1–25. https://doi.org/10.5534/wjmh.250004
8. Esteves, S. C., Miyaoka, R., Roque, M., & Agarwal, A. (2016). Outcome of varicocele repair in men with non-obstructive azoospermia: Systematic review and meta-analysis. *Asian Journal of Andrology, 18*(2), 246–253. https://doi.org/10.4103/1008-682X.169562
9. Mirilas, P., & Mentessidou, A. (2012). Microsurgical subinguinal varicocelectomy in children, adolescents, and adults: Surgical anatomy and anatomically justified technique. *Journal of Andrology, 33*(3), 338–349. https://doi.org/10.2164/jandrol.111.013052
10. Dubin, L., & Amelar, R. D. (1970). Varicocele size and results of varicocelectomy in selected subfertile men with varicocele. *Fertility and Sterility, 21*(8), 606–609. https://doi.org/10.1016/S0015-0282(16)37684-1
11. Cocuzza, M., Alvarenga, C., & Pagani, R. (2020). Diagnostic accuracy of physical examination compared with color Doppler ultrasound in the determination of varicocele diagnosis and grading: Impact of urologists' experience. *Andrology, 8*(5), 1160–1166. https://doi.org/10.1111/andr.12797
12. Mawong, S., Tantiwong, A., & Leenanupunth, C. (2024). A comparison between the efficacy and complication of laparoscopic and microsurgical varicocelectomy: Systematic review and meta-analysis. *Urology Annals, 16*(2), 1–9. https://doi.org/10.4103/ua.ua_85_23
13. Diao, B., Sun, X., Zhang, Z., & Wang, J. (2018). Microscopic subinguinal varicocelectomy in 100 consecutive cases: Spermatic cord vascular anatomy, recurrence and hydrocele outcome analysis. *Arab Journal of Urology, 16*(2), 188–194. https://doi.org/10.1016/j.aju.2018.01.001
14. Wang, J., Xia, S.-J., Liu, Z.-H., Tao, L., Ge, J.-F., Xu, C.-M., & Qiu, J.-X. (2015). Inguinal and subinguinal micro-varicocelectomy, the optimal surgical management of varicocele: A meta-analysis. *Asian Journal of Andrology, 17*(1), 74–80. https://doi.org/10.4103/1008-682X.136443
15. Lim, S. K., Kim, H. J., & Park, S. Y. (2014). Microsurgical intermediate subinguinal varicocelectomy. *Korean Journal of Urology, 55*(7), 451–456. https://doi.org/10.4111/kju.2014.55.7.451
16. Bechara, C. F., Weakley, S. M., Kougias, P., Athamneh, H., Duffy, P., Khera, M., … & Lin, P. H. (2017). Subinguinal microsurgical varicocelectomy versus percutaneous embolization in infertile men: Prospective comparison of reproductive and functional outcomes. *Basic and Clinical Andrology, 27*(1), 11. https://doi.org/10.1186/s12610-017-0055-x
17. Shiraishi, K., Oka, S., & Matsuyama, H. (2012). Comparison of laparoscopic and microscopic subinguinal varicocelectomy in terms of postoperative scrotal pain. *JSLS: Journal of the Society of Laparoendoscopic Surgeons, 16*(1), 67–72. https://doi.org/10.4293/108680812X13291597716221
18. Yuan, R., Zhuo, H., Cao, D., & Wei, Q. (2017). Therapeutic efficacy and safety of laparoscopic surgery versus microsurgery for varicocele of adult males: A meta-analysis. *Medicine, 96*(33), e7677. https://doi.org/10.1097/MD.0000000000007677
19. Al-Kandari, A. M., Shabaan, H., Ibrahim, H. M., Elshebiny, Y. H., & Shokeir, A. A. (2007). Comparison of outcomes of different varicocelectomy techniques: Open inguinal, laparoscopic, and subinguinal microscopic varicocelectomy: A randomized clinical trial. *Urology, 69*(3), 417–420. https://doi.org/10.1016/j.urology.2007.01.057
20. Ding, H., Tian, J., Du, W., Zhang, L., Wang, H., & Wang, Z. (2012). Open non-microsurgical, laparoscopic or open microsurgical varicocelectomy for male infertility: A meta-analysis of randomised controlled trials. *BJU International, 110*(10), 1536–1542. https://doi.org/10.1111/j.1464-410X.2012.11093.x
21. Kim, K. H., Lee, J. Y., Kang, D. H., Lee, H., Seo, J. T., & Cho, K. S. (2013). Impact of surgical varicocele repair on pregnancy rate in subfertile men with clinical varicocele and impaired semen quality: A meta-analysis of randomized clinical trials. *Korean Journal of Urology, 54*(10), 703–709. https://doi.org/10.4111/kju.2013.54.10.703