

CONTEMPORARY APPROACHES IN THE MANAGEMENT OF VARICOCELE: SURGICAL AND MINIMALLY INVASIVE TECHNIQUES

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Abstract

Varicocele is one of the most common and correctable causes of male infertility, as well as an important source of chronic testicular discomfort. Contemporary management encompasses open surgical techniques, laparoscopic varicocelectomy, microsurgical approaches, and minimally invasive radiological procedures such as percutaneous embolization. The present retrospective study evaluates the outcomes of patients treated for varicocele at Tetovo Clinical Hospital over a three-year period. Fifteen patients aged 16–48 years were included. Ten of them underwent laparoscopic varicocelectomy, while five were treated with open surgery. The parameters analyzed included age distribution, length of hospital stay, postoperative pain, and early postoperative complications. The laparoscopic approach resulted in a shorter hospital stay, reduced pain, and faster recovery compared with open surgery. Patients treated with open techniques more frequently experienced postoperative discomfort and prolonged convalescence. Current literature data support minimally invasive techniques as safe and effective alternatives, associated with lower morbidity and improved clinical outcomes. This study confirms that laparoscopic varicocelectomy represents an effective treatment modality with favorable clinical results in carefully selected patients.

Keywords: varicocele, laparoscopic varicocelectomy, open surgery, minimally invasive surgery, male infertility, postoperative pain.

Introduction

Varicocele is defined as the abnormal dilation and tortuosity of the pampiniform venous plexus within the spermatic cord and is recognized as one of the most prevalent disorders of the male reproductive system (Agarwal et al., 2016). Its prevalence in the general male population is estimated at approximately 15%, while in men with primary infertility the figures rise to 35–40%, and up to 75–81% in those with secondary infertility (Alsaikhan et al., 2016; Gorelick & Goldstein, 1993). The anatomical predominance of varicocele on the left side is related to the right-angle venous drainage of the left spermatic vein into the renal vein, the greater length of this vein, and the absence or insufficiency of competent venous valves (Sharlip et al., 2002; Wishahi, 1991). Bilateral involvement, although less frequent, is documented in a considerable number of cases when high-sensitivity Doppler scanning is employed (Gat et al., 2004).

The pathophysiology of varicocele is complex and multifactorial. The principal mechanisms of testicular damage include increased scrotal temperature, oxidative stress, hypoxia induced by venous stasis, reflux of renal and adrenal metabolites, and disruption of the hypothalamic–pituitary–gonadal axis (Cho et al., 2016; Hassanin et al., 2018). These processes lead to sperm DNA fragmentation, injury to Leydig cells, and progressive reduction of testicular volume, particularly in adolescents with high-grade varicocele (Diamond et al., 2007). The accumulation of reactive oxygen species (ROS) is considered one of the chief molecular causes of varicocele-associated infertility, as it reduces sperm motility and compromises membrane integrity (Agarwal et al., 2014).

Clinically, patients may present with a variety of complaints: a sensation of heaviness in the scrotum, chronic pain that worsens after prolonged standing or physical exertion, testicular atrophy, or, more commonly, infertility identified during evaluation of the couple (Baazeem et al., 2011; Owen et al., 2017). Diagnosis is usually established through physical examination in the standing and supine positions, with and without the Valsalva maneuver, and is confirmed

by color Doppler ultrasonography, which is regarded as the principal imaging modality for determining the grade and the presence of venous reflux (Pauroso et al., 2011).

Over the last decades, therapeutic approaches have evolved markedly. Classical open techniques, such as the Palomo procedure (high retroperitoneal ligation) and the Ivanissevich procedure (inguinal ligation), have been complemented and frequently replaced by subinguinal microsurgical methods and minimally invasive techniques such as laparoscopy and radiological percutaneous embolization (Çayan et al., 2009; Goldstein et al., 1992; Marmar & Kim, 1994). Laparoscopic varicocelectomy and embolization currently represent preferred options in many centers because of reduced postoperative pain, improved visualization of anatomical structures, shorter hospital stay, and faster return to daily activities (Kim et al., 2013; Iaccarino & Venetucci, 2012).

Despite the wide adoption of minimally invasive approaches, scientific debate remains open regarding the optimal technique. Comparative studies have reported variable results in terms of recurrence rates, postoperative hydrocele formation, improvement in semen parameters, and achieved pregnancy rates (Practice Committee of the American Society for Reproductive Medicine, 2014; Çayan et al., 2009). For this reason, ongoing evaluation of surgical outcomes within the local context remains essential for optimizing patient management.

The present paper presents the experience of the Department of Urology at Tetovo Clinical Hospital in the management of varicocele through laparoscopic and open techniques over a three-year period and discusses the results in the light of contemporary literature.

Aim of the study

The primary aim of this study was to assess current surgical approaches in the management of varicocele and to compare postoperative outcomes between laparoscopic and open varicocelectomy.

The specific objectives were:

To assess postoperative pain in both groups;

To compare the length of hospital stay;

To evaluate early postoperative recovery;

To analyze perioperative and early postoperative complications;

To compare clinical outcomes between the minimally invasive and the open approach;

To place the clinical findings within the context of current international literature.

Materials and methods

This is an observational, retrospective study based on a cohort of 15 patients diagnosed with varicocele and treated surgically at the Department of Urology of Tetovo Clinical Hospital during the period 2023–2026. Data were collected from operative protocols, admission records, ultrasonography reports, and postoperative follow-up visits.

3.1 Study population: The study population comprised male patients aged 16–48 years. All patients underwent a standard clinical assessment, including history-taking, physical examination of the scrotum in the standing and supine positions with the Valsalva maneuver, and color Doppler ultrasonography. Surgical indications included symptomatic varicocele, the presence of chronic scrotal pain refractory to conservative treatment, infertility associated with abnormalities in semen analysis parameters, or a progressive reduction in testicular volume relative to the contralateral side (according to a criterion of >20% volume difference). Clinical classification was performed according to the Dubin–Amelar system (Dubin & Amelar, 1971),

with the inclusion of patients with grade II and grade III varicocele. Patients with subclinical varicocele were excluded from the study.

3.2 Surgical techniques: Of the 15 patients included in the study:

10 patients (66.7%) underwent laparoscopic varicocelectomy;

5 patients (33.3%) were treated with open surgery.

3.3 Laparoscopic technique: The laparoscopic procedure was performed under general anesthesia, with the patient placed in a slight Trendelenburg position. A standard transperitoneal three-port approach was used: a 10-mm umbilical port for the camera and two auxiliary 5-mm ports in the lower abdominal quadrant. After inspection of the operative field, the internal spermatic vein was identified above the level of the internal inguinal ring. The peritoneum was incised, and the veins were carefully dissected, isolated, and ligated with metallic clips or with intracorporeal suture, with an attempt to preserve the testicular artery and lymphatic vessels whenever this was technically feasible (Donovan & Winfield, 1992). This modality afforded magnified visualization of anatomical structures and minimal trauma to the surrounding tissues.

3.4 Open surgical technique: Open operations were performed through an inguinal or subinguinal incision according to the Ivanissevich modification. After opening the external oblique fascia, the spermatic cord was identified, the dilated veins of the pampiniform plexus were exposed, and ligations were performed with non-absorbable suture. The vas deferens and the testicular artery were preserved with care (Ivanissevich, 1960). The wound was closed in anatomical layers using standard technique.

3.5 Parameters evaluated: The following variables were analyzed systematically:

Patient age and distribution by age group;

Type of surgical procedure and operative duration;

Intensity of postoperative pain assessed using the Numerical Rating Scale (NRS 0–10);

Length of hospital stay (in days);

Early postoperative complications (bleeding, wound infection, hydrocele, recurrence);

Time to return to usual activities (in days).

3.6 Statistical analysis: Data were processed using descriptive statistical analysis. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between the two groups were carried out at a descriptive level, given the small sample size. The data were processed using Microsoft Excel and the SPSS statistical package, version 25.0.

Results

During the study period, a total of 15 patients with a diagnosis of varicocele were operated on. The mean age of the patients was 29.4 years (range 16–48 years). Most patients ($n = 11$; 73.3%) were within the 20–35 year age group, which corresponds to the age range most frequently affected by varicocele-related reproductive problems (Hassanin et al., 2018). All fifteen patients had left-sided varicocele, while bilateral involvement was documented in two cases — a finding consistent with the literature, which reports a clear left-sided predominance (Sharlip et al., 2002).

4.1 Distribution by surgical technique: The distribution of patients by surgical treatment modality was as follows: laparoscopic varicocelectomy — 10 patients (66.7%); open surgery — 5 patients (33.3%). Table 1 presents the baseline characteristics of the two groups.

Table 1. Baseline characteristics of the study groups.

Characteristic	Laparoscopic group (n=10)	Open group (n=5)
Mean age (years)	28.6 ± 7.2	31.0 ± 9.4
Left-sided varicocele (n)	9	4
Bilateral varicocele (n)	1	1
Grade II (Dubin–Amelar)	4	2
Grade III (Dubin–Amelar)	6	3
Indication: infertility (n)	6	2
Indication: scrotal pain (n)	4	3

4.2 Length of hospital stay: Patients treated by the laparoscopic approach had a markedly shorter hospital stay. The majority were discharged within the first 24 postoperative hours, while patients operated on with the open technique required more prolonged clinical observation. The mean length of stay was approximately 1 day in the laparoscopic group and 2–3 days in the open surgery group. These results are in line with data reported in other comparative studies that have shown clear benefits of minimally invasive approaches with respect to length of stay (Tan et al., 1995; Watanabe et al., 2005).

4.3 Postoperative pain: Postoperative pain was more pronounced and more frequent in patients treated with open surgery. Patients in the laparoscopic group reported mild and transient discomfort, with earlier mobilization and a reduced need for opioid analgesics. Mean NRS values during the first 24 hours were 2.4 in the laparoscopic group, compared with 5.2 in the open surgery group. These results corroborate the findings of Kim et al. (2013) and Al-Said et al. (2008), who likewise reported reduced pain following minimally invasive approaches.

4.4 Recovery and complications: Patients treated with the laparoscopic technique resumed their usual activities earlier than those in the open surgery group (an average of 7 days versus 14 days). No serious intraoperative complications were observed in either group. Mild postoperative edema and transient discomfort were documented in a small number of patients, mainly in the group operated on with the open technique. No significant wound infections or hydrocele formation were recorded during the early follow-up period (1–3 months postoperatively). No patient presented clinical recurrence of varicocele during early follow-up.

Table 2. Comparison of postoperative outcomes between the two groups.

Parameter	Laparoscopic (n=10)	Open (n=5)
Hospital stay (days, mean)	1.0	2.6
Pain NRS at 24 h (mean)	2.4	5.2
Return to activity (days)	7	14
Major complications (n)	0	0
Edema / minor complications (n)	1	2

Parameter	Laparoscopic (n=10)	Open (n=5)
Early recurrence (n)	0	0

Discussion

Varicocele continues to be one of the most important causes of correctable male infertility and a meaningful source of chronic scrotal symptoms (World Health Organization, 1992). Technological advances in minimally invasive surgery have profoundly transformed therapeutic approaches, modifying the postoperative morbidity profile and enhancing the patient experience (Agarwal et al., 2016).

The findings of the present study indicate clear advantages of laparoscopic varicocelectomy compared with open surgery, particularly with respect to postoperative recovery and patient comfort. The reduction of postoperative pain and the shortening of hospital stay were the most evident benefits in the laparoscopic group. These findings are consistent with previous studies reporting reduced morbidity and accelerated recovery following minimally invasive approaches (Çayan et al., 2009; Kim et al., 2013).

Laparoscopic varicocelectomy provides excellent visualization of the spermatic vessels at the retroperitoneal level, facilitating precise ligation while minimizing trauma to the surrounding tissues (Donovan & Winfield, 1992). The magnified operative field afforded by laparoscopic optics contributes to reducing postoperative discomfort and allows earlier patient mobilization. Similar advantages have been highlighted in comparative analyses by Al-Said et al. (2008) and Tan et al. (1995), who demonstrated faster postoperative recovery following minimally invasive approaches. In bilateral cases in particular, the laparoscopic approach provides the possibility of simultaneous treatment of both sides through the same ports, obviating the need for two separate open incisions (Watanabe et al., 2005).

Open surgical techniques, although older, remain effective and continue to be widely used, especially in centers where laparoscopic resources or specialized expertise may be limited. Nevertheless, open surgery is generally associated with greater postoperative pain, longer convalescence, and a higher risk of wound-related complications (Baazeem et al., 2011). In our study, patients treated with the open technique experienced more pronounced postoperative discomfort and a longer hospital stay than those treated laparoscopically, confirming the trends reported in the literature.

Subinguinal microsurgical varicocelectomy, introduced and popularized by Goldstein et al. (1992) and Marmar and Kim (1994), is often regarded as the gold standard of surgical treatment because of its very low rates of recurrence (1–2%) and of postoperative hydrocele formation (<1%) (Hopps et al., 2003). The use of the operating microscope allows the systematic identification and preservation of the testicular artery, lymphatic vessels, and vas deferens, thereby minimizing long-term complications. However, this technique requires a long learning curve, specialized equipment, and a longer operative time. The laparoscopic approach, by contrast, remains an attractive alternative because of its relative technical simplicity, the possibility of bilateral treatment, and favorable cosmetic outcomes (Ficarra et al., 2006).

Percutaneous radiological embolization constitutes another minimally invasive modality, performed by interventional radiologists under fluoroscopy, with a technical success rate of 85–95% and clear benefits in terms of recovery time (Iaccarino & Venetucci, 2012). However, this technique may not be available in all centers and has limitations in cases of complex venous anatomy.

With regard to improvement in semen parameters and pregnancy rates, the meta-analysis by Marmar et al. (2007) reported that surgical correction of clinical varicocele in men with oligospermia increases the chances of spontaneous pregnancy compared with conservative

management. Esteves et al. (2016) likewise showed that varicocelectomy can increase success rates among couples undergoing assisted reproductive techniques, including intracytoplasmic sperm injection (ICSI). Although our study did not systematically assess these long-term outcomes, the symptomatic improvement and the safety profile observed support surgical treatment in carefully selected patients.

The present study has several limitations that should be acknowledged. First, the small sample size ($n = 15$) and the retrospective nature of the design limit the generalizability of the results. Second, postoperative semen analysis parameters and long-term reproductive outcomes were not systematically evaluated. Third, the absence of a microsurgical treatment group did not allow a direct comparison with the current gold standard. Despite these limitations, the study reflects a real clinical experience in a regional urological center and supports the global trend toward minimally invasive management of varicocele.

Future studies with larger patient samples, prospective designs, and long-term follow-up of reproductive parameters are needed in order to refine optimal treatment strategies and to tailor the choice of technique to each patient's clinical profile.

Conclusions

Contemporary approaches in the management of varicocele are increasingly oriented toward minimally invasive techniques, owing to the reduced postoperative morbidity and the faster recovery they offer.

In this study, laparoscopic varicocelectomy demonstrated several clear advantages over open surgery, including:

Shorter length of hospital stay;

Reduced postoperative pain;

Faster postoperative recovery;

Greater patient comfort;

Absence of major intraoperative complications.

Open surgical repair remains an effective and safe therapeutic option, particularly in settings with limited technological resources; however, postoperative discomfort was more frequent and more pronounced in this group of patients.

The results support laparoscopic varicocelectomy as a safe and effective approach to the surgical management of varicocele. Careful patient selection, adequate surgical expertise, and appropriate equipment are essential for achieving optimal clinical outcomes. Placing the findings in the context of contemporary literature confirms that the global trend toward minimally invasive approaches is also reflected in our regional practice, providing tangible benefits for male patients with varicocele.

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