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Comparison of the pulling technique versus the standard technique in microsurgical subinguinal varicocelectomy: a randomized controlled trial

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Abstract

Background We compare the outcome of microsurgical subinguinal varicocelectomy (MSV) using the pulling technique (P-MSV) compared to the standard technique (S-MSV).

Methods A total of 60 patients were diagnosed with varicocele compounded with infertility and/or scrotal pain not responding to medical treatment. Twenty-nine patients were randomized to the P-MSV, while 31 were randomized to S-MSV. The number of ligated veins was counted intraoperative and compared. Follow-up was done at 1 and 3 months including clinical examination, scrotal duplex ultrasound scan, and semen analysis.

Results A total of 85 sides were operated upon, 43 (50.5%) were done by the P-MSV technique while 42 (49.5%) were done by the S-MSV technique. The median gained cord length after using the P-MSV was [3 cm; IQR 2–5 cm]. For the P-MSV technique, the mean number of detected internal spermatic veins after cord pulling was (4 ± 1.3 SD) compared to (6 ± 1.4 SD) before pulling (*P* value < 0.01) and for the S-MSV was 3 (2.75–5). There was no statistical or clinically significant difference in the perioperative outcomes between both groups. The overall conception rate was 47.1%. Ninety-two percent of patients complaining of preoperative scrotal pain had resolution of the pain on follow-up with no statistical difference between both techniques (*P* values 0.53, 0.3 respectively). There was no statistical difference in the recurrence rate between both groups (*P* = 0.11). The number of ligated veins decreased significantly using the P-MSV technique leading to an improvement in the surgical feasibility of MSV.

Conclusion There is a significant benefit for the new pulling technique in decreasing the number of internal spermatic veins which leads to improving the surgical feasibility of microsurgical varicocelectomy.

Keywords Varicocele, Pulling technique, Microsurgical, Subinguinal, Fertility, Semen analysis, Scrotal pain

1 Background

Among various techniques of treating varicocele, microsurgical varicocelectomy is considered the gold standard technique in both adults and adolescents, due to relatively lower postoperative recurrence and complication rates [1]. It was also found that microsurgical varicocelectomy was associated with higher postoperative rates of spontaneous pregnancy rate (39%) in infertile men with clinically palpable varicoceles [2, 3].

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Microsurgical varicocele repair can be performed by either an inguinal or subinguinal approach but differences exist. In the inguinal approach, it is necessary to open the external oblique aponeurosis, which is associated with fewer veins however, in the subinguinal approach, the need for opening the external oblique aponeurosis is omitted; thus, theoretically, this approach is associated with a faster and less painful recovery, but with more veins to ligate. Because both methods have their risks and benefits, we questioned whether we could combine both methods' benefits while avoiding their risks. We thus tried a "pulling technique" to perform a new approach to microscopic subinguinal varicocelectomy which was initially described by Wu et al. [4]. In this study, we prospectively evaluated the safety and efficacy of the new method, compared with conventional microscopic subinguinal varicocelectomy (MSV) by a prospective randomized controlled trial.

2 Methods

This was a prospective randomized controlled trial conducted in the Department of Urology at Cairo University hospitals. A total of 60 male patients with varicocele presented between December 2018 and March 2020 were included as shown in the CONSORT flow diagram (Fig. 1). Inclusion criteria were adults with clinically palpable varicocele complaining of infertility with impaired semen quality [oligospermia < 15 million/mL or asthenospermia with progressive count < 32% or teratozoospermia > 96%] [5] or pain not responding to medical treatment (medical treatment included scrotal support, venotonics and analgesics) or adolescents with varicocele, while adults with subclinical varicocele, paediatric age group, acute urogenital infection, and concomitant inguinal hernia were excluded.

Randomization was performed by the closed envelope method with a single-blind arm. A total of sixty patients were included in the study. Twenty-nine patients were randomized to the microsurgical subinguinal varicocelectomy with pulling technique (P-MSV) and another 31

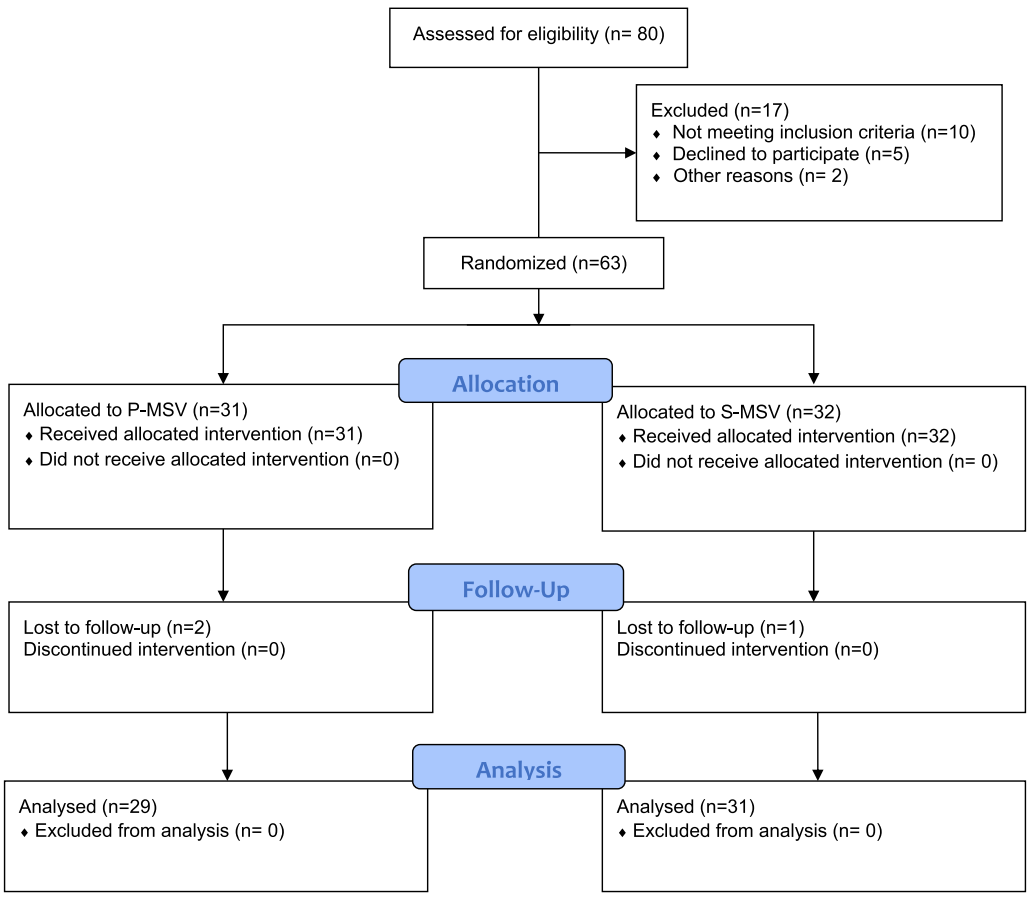

Fig. 1 CONSORT flow diagram

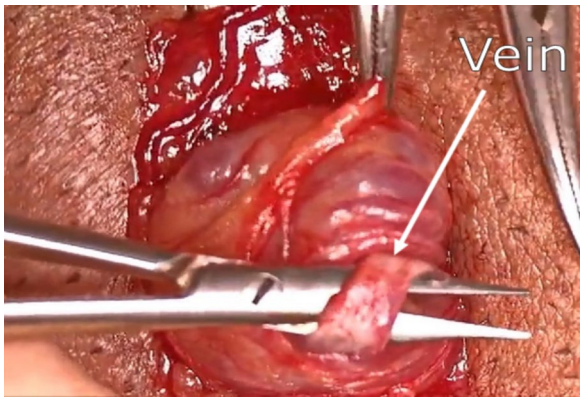

Fig. 2 Internal spermatic vein under operating microscope

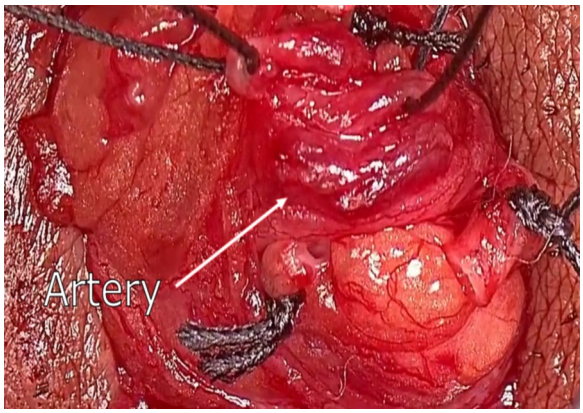

Fig. 3 Testicular artery under operating microscope

patients were randomized to the standard microsurgical subinguinal varicocelectomy (S-MSV).

All patients had preoperative semen analysis and scrotal duplex ultrasound scans. The criteria for diagnosis included a diameter of the internal spermatic vein of 2 mm or more and the presence of venous reflux.

The S-MSV was performed by identifying the location of the external inguinal ring. A 1.5–2 cm skin incision was made at this level. Camper's and Scarpa's fasciae were opened using electrocautery, and the external ring and spermatic cord were clearly visualised. The spermatic cord was identified and delivered out of the incision. Inspection of the spermatic cord for the presence of external spermatic veins was done. External spermatic veins were noted and were ligated using 5–0 or 6–0 prolene ties and divided. The operating microscope (Leica® M690 Heerbrugg, Switzerland) was used in all cases with 8× to 12× magnification power. The vas deferens and associated vasculature were then identified and preserved with a vessel loop. The internal spermatic veins were then individually mobilized and stripped of surrounding adventitia and lymphatics. All veins within the spermatic cord except the vasal veins were ligated with 6–0 prolene ties and divided (Fig. 2). The arteries were identified by pulsation, serpentine shape, and bright red colour (Fig. 3). Papaverine 1% irrigation was used to dilate the arteries in cases with difficult identification. During the dissection, the number of internal spermatic veins ligated was recorded. The lymphatic ducts were preserved. Finally, the spermatic cord was returned to the subinguinal level. Scarpa's fascia was closed with an interrupted 4–0 absorbable sutures, and the skin was reapproximated with a running sub-cuticular 4–0 absorbable suture.

The P-MSV was performed as described above, however, after spermatic cord delivery through the incision, 10% Betadine lotion was used to mark the spermatic cord at the conventional surgical site in the S-MSV technique (mark A). Pulling of the spermatic cord was performed after dissection from the external ring by separating the external spermatic and cremasteric fasciae from the internal spermatic fascia. The newly exposed part of the cord after pulling out of the external ring was then marked just below the external ring (mark B) and the distance between the two marks is measured to estimate the gained length then varicocelectomy was performed. The S-MSV technique is illustrated in Fig. 4a, b while the P-SMV technique is illustrated in Fig. 5a–c.

The primary outcome was defined as the number of veins ligated. Secondary outcomes were preserving at least one artery and one lymphatic duct, and operative time for microsurgery (calculated from opening to closing of the external spermatic fascia). Functional success after the treatment of primary varicocele by MSV was defined as the increase in total motile sperm count or return of sperm to ejaculate in non-obstructive azoospermia patients, improvement of pain, absence of clinically palpable varicocele or retrograde flow by scrotal duplex ultrasound scan on follow-up and finally spontaneous conception rate.

Baseline perioperative data were analysed. All patients were followed up at 1 and 3 months. Follow-up included clinical examination, scrotal duplex ultrasound scan for clinically palpable varicoceles at 3 months and semen analysis at 3 months for patients with impaired semen parameters. The MedCalc version 19.5.1 (MedCalc Software Ltd, Ostend, Belgium) software for Windows was used for statistical analysis.

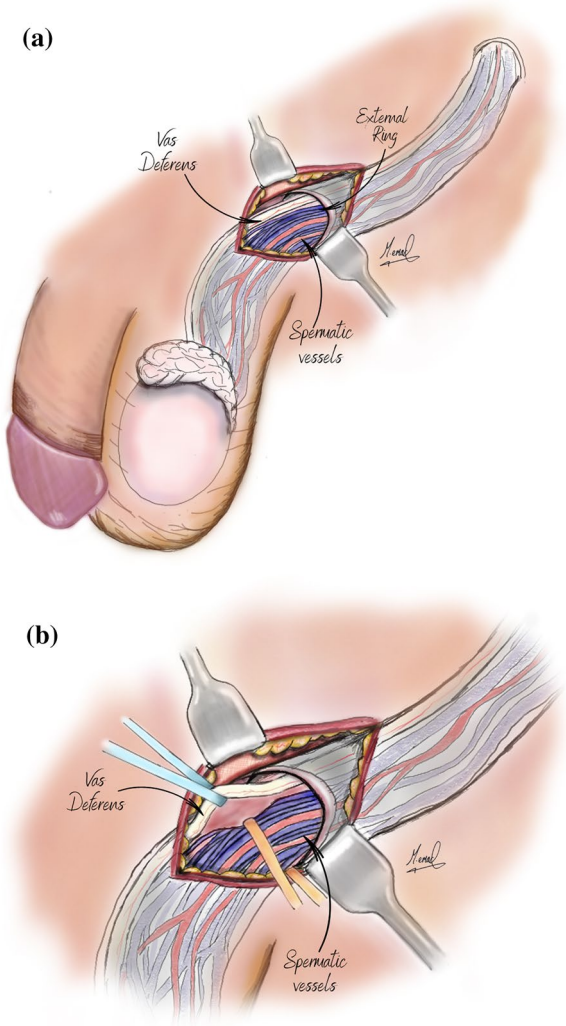

Fig. 4 **a, b** S-MSV technique

3 Results

There was no clinical or statistical significance in the preoperative data including number of cases, age, BMI, side, and indication for varicocelectomy (Table 1).

Based on the semen analysis parameters, patients were divided into three groups: oligospermia (semen count < 15 million/ml) in 35 patients (17 in P-MSV, and 18 in S-MSV), asthenospermia in 7 patients (4 in P-MSV, and 3 in S-MSV), and non-obstructive azoospermia (NOA) in 3 patients (1 in P-MSV, and 2 in S-MSV) (Fig. 6).

The median gained cord length after using the P-MSV was 3 cm (IQR 2–5 cm). The median number of arteries, veins and lymphatics was insignificant between both groups (*P* value 0.07, 0.16 and 0.27 respectively) (Table 2).

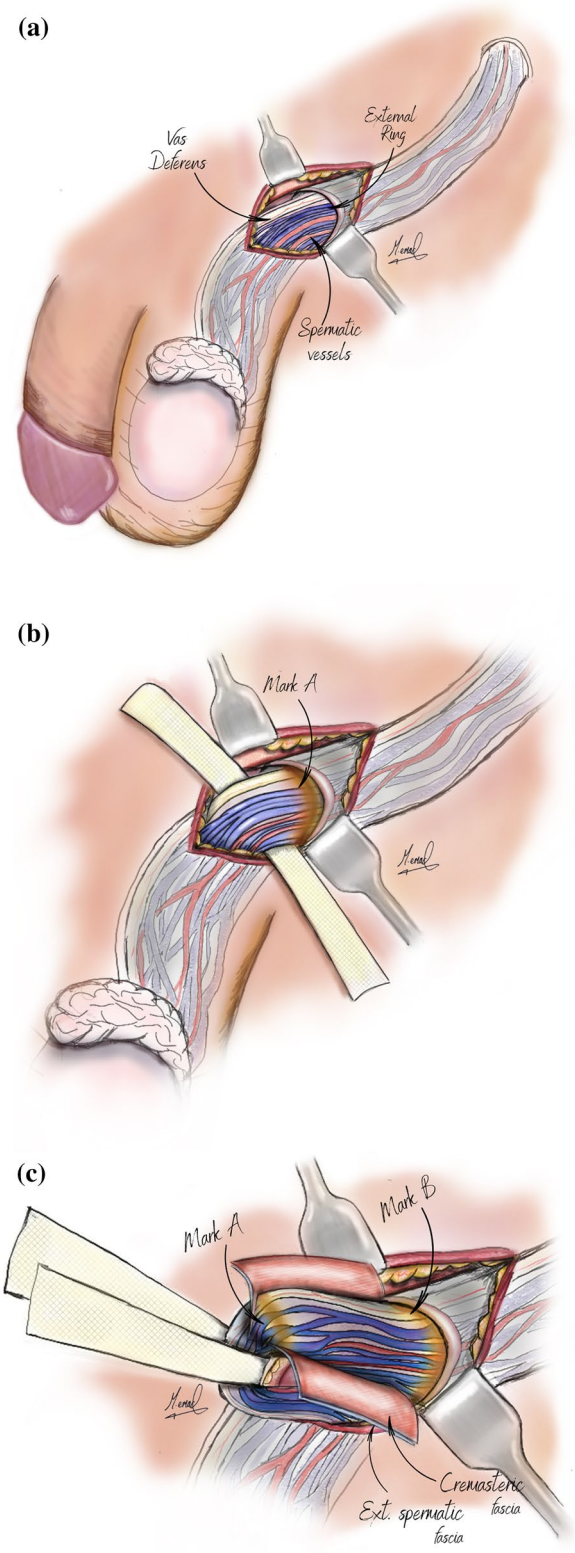

Fig. 5 **a–c** P-MSV technique

Table 1 Patient demographics

	S-MSV		P-MSV		*P* value
Number of cases, no (%)	31 (51.6%)		29 (48.3%)		–
Age, years median (IQR)	27 (22–30)		28 (22–30)		0.85
BMI, kg/m^2 median (IQR)	22 (18–28)		23 (20–30)		0.8
Side, no (%)	Bilateral	11 (18.3%)	Bilateral	14 (23.4%)	0.9
	Left	20 (33.3%)	Left	15 (25%)	
	Total	42 (49.5%)	Total	43 (50.5%)	
Scrotal pain, no (%)	15 (48.4%)		10 (34.5%)		0.3
Infertility, yes (%)	16 (51.6%)		10 (34.5%)		0.3

For the P-MSV technique a sub-study was done for P-MSV group patients which demonstrated a decrease in the number of detected internal spermatic veins after cord pulling (mean 4 ± 1.3 SD) when compared to before pulling (mean 6 ± 1.4 SD) with a *P* value < 0.01.

There was no statistical or clinical difference between both groups regarding operative time and intraoperative arterial injury (*P* value 0.29 and 1 respectively) (Table 2). Postoperative follow-up showed similar pain control (*P* value 0.5), recurrence rate (*P* value 0.11), and conception rate (*P* value 0.46) between both groups (Table 3).

Forty-two patients performed postoperative semen analysis, 33 patients among the infertility subgroup and 9 among the scrotal pain subgroups. In the infertility subgroup, only one patient did not perform semen analysis because he achieved successful conception, while in the scrotal pain subgroup, 16 patients did not perform semen analysis: due to pain improvement with normal preoperative semen analysis (11 patients), adolescents who could not perform the test pre- or postoperatively (2 patients) and patients who missed follow-up (3 patients). The median time to achieve conception was 4 months after surgery in the P-MSV arm and 4.5 months after surgery in the S-MSV arm (*P* value 0.67) (Figs. 7, 8).

4 Discussion

Microsurgical varicocelectomy is the gold standard technique with the lowest postoperative rates of hydrocele formation and varicocele recurrence based on several studies including meta-analyses and randomized controlled trials comparing different varicocelectomy approaches. Prospective randomized studies by Al-Kandari et al. [7], Al-Said et al. [8], and meta-analyses done by Çayan et al. [9] and Ding et al. [2] reported that in the microscopic group, the incidence of hydrocele and varicocele recurrence ranged from 0–0.5% and 1–2.5%, respectively, which is significantly lower than that in the open and laparoscopic groups.

Table 2 Intraoperative data

	S-MSV	P-MSV	*P* value
Number of arteries, median (IQR)	1 (1–2)	1 (1–1)	0.07
Number of veins median (IQR)	3 (2.75–5)	4 (3–6)	0.16
Number of lymphatic vessels median (IQR)	2 (2–3)	2.5 (2–3)	0.27
Operative time, minutes median (IQR)	50 (45–60)	52.5 (50–60)	0.29
Arterial injury, no (%)	2/31(6.5%)	2/29 (6.9%)	1

Table 3 Postoperative data

	S-MSV	P-MSV	*P* value
Pain improvement, no (%)	13/15 (86.7%)	10/10 (100%)	0.5
Conception, no (%)	6/15 (40%)	10/19 (52.6%)	0.46
Recurrence, no (%)	4/31 (12.9%)	0/29 (0%)	0.11
Wound infection, no (%)	0/31 (0%)	1/29 (3.5%)	0.9

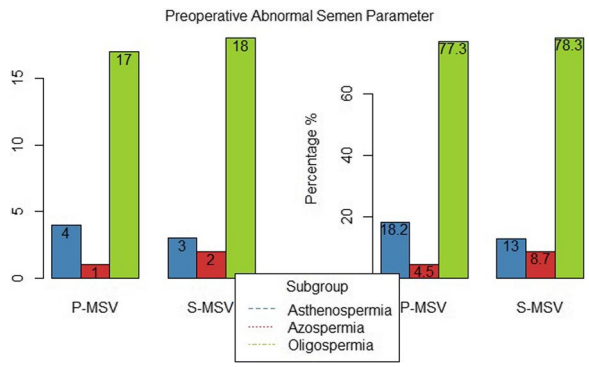

Fig. 6 Preoperative semen parameter (number of patients and percentage)

Microsurgical varicocelectomy can be performed by either an inguinal or subinguinal approach providing access to the external spermatic and gubernacular veins,

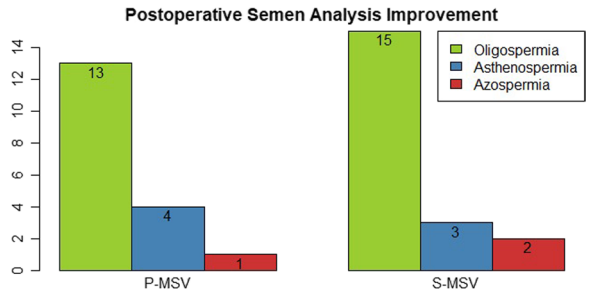

Fig. 7 Postoperative semen analysis improvement (number of patients)

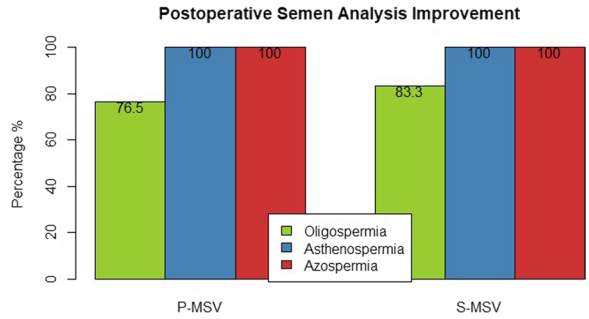

Fig. 8 Postoperative semen analysis improvement (%)

but differences exist. In the inguinal approach, it is necessary to open the external oblique aponeurosis which is associated with fewer veins. In the subinguinal approach, the need for opening the external oblique aponeurosis is omitted; thus, theoretically, this approach is associated with a faster and less painful recovery, but with more veins to ligate [1].

Our study was among the first two studies to compare the different microsurgical techniques and showed a benefit for the pulling technique over the standard technique. Our study is the first randomized controlled trial to our knowledge that compares two techniques of MSV, namely P-MSV and S-MSV.

We found that MSV with the P-MSV was not associated with increased microsurgical operative time, with no difference in the number of detected arteries, veins or lymphatic vessels when compared with the S-MSV with a gained cord length of 2–5 cm which can theoretically gain benefits of inguinal varicocelectomy. In patients who underwent P-MSV, there was a significant decrease in the number of detected internal spermatic veins in a sub-study comparing the number of veins after cord pulling which signifies the added benefit of doing the pulling technique in subinguinal approach, however, this decrease in the number of veins did not show as a statistically significant difference when compared to the S-MSV (*P* value 0.16) which can be attributed to the great individual variability in the number of internal spermatic veins with no increase in microsurgical operative time (*P* value 0.29) despite the extra steps done for P-MSV which may be explained by the fewer number of veins ligated.

A similar study done by Wu et al. in 2017 showed significantly fewer internal spermatic veins encountered and ligated after cord pulling when compared to the standard approach (*P* value = 0.01), operative time was significantly shorter (*P* value = 0.01). The study also found that the number of testicular arteries was less but with no statistical significance [4].

In our opinion, there were many limitations in the study done by Wu et al.: Firstly, this was a non-randomized study including a smaller number of patients. The study did not compare the pregnancy rate between the 2 groups and the follow-up duration was short. Also, all patients included in the study had normal preoperative semen count so the effect of varicocelectomy on semen parameters could not be assessed. Lastly, the study did not explain the pulling strategy and whether cord pulling was done before or after opening the external spermatic fascia and cremaster muscle which should have been mentioned due to the anatomical fact of attachment of the external spermatic fascia to the external inguinal ring and attachment of cremaster muscle to the internal oblique & transversus abdominis muscles.

Beck et al. reported the intraoperative anatomy of 83 infertile men who underwent MSV at the inguinal level and identified 1 artery in 69% of dissections, 2 arteries in 27% of dissections, and 3 or more arteries in 4% of spermatic cords [6]. Chan et al. found that the incidence of accidental testicular artery ligation in MSV was approximately 1% & testicular atrophy developed in 5%. It is possible that the smaller testes usually associated with azoospermia may have smaller testicular arteries, thus posing a greater risk of accidental ligation [10]. Güdeloğlu et al. suggested the use of micro-Doppler ultrasonography in microsurgical varicocelectomy as it seems to be an effective and safe method that facilitates the identification of testicular vessels [11]. In our study, there were no high-grade complications in either P-MSV or S-MSV groups, however, 6.7% had an intraoperative testicular arterial injury which occurred early at the beginning of the study during the period of gaining the surgical experience.

Wu et al. also found that sperm motility was significantly increased at 3 months after surgery in both groups with no significant difference between the 2 groups. However, sperm count did not significantly improve in either group after surgery. That was because both groups in this study had normal sperm counts preoperatively which is a drawback in the study and therefore

postoperative counts did not differ significantly [4]. A comparative study between different varicocelectomy approaches by Al-Said et al. also shows that MSV resulted in significant improvement in semen parameters in terms of increased sperm concentration and motility as well as improved sperm morphology. These improvements were observed as early as 3 months postoperatively and they were durable at 6 to 12 months with an overall improvement in semen parameters in 182 of 298 patients (61%) who underwent varicocelectomy [8]. Our study showed 76.5% & 83.3% improvement in sperm count in patients with preoperative oligospermia in P-MSV and S-MSV, respectively, with counts improving to > 15 million/ml. While all patients with preoperative asthenospermia showed improved sperm motility postoperatively.

A meta-analysis done by Weedin et al. aimed to identify factors that might predict success following varicocelectomy in men with non-obstructive azoospermia and included 233 patients. Motile sperms were found in postoperative semen analyses in 91 men (39.1%) resulting in 14 (6%) spontaneous pregnancies and 10 pregnancies following IVF/ICSI. The study found that patients diagnosed with hypospermatogenesis and maturation arrest had the best outcomes, with motile sperm found in 55% and 42%, respectively [12].

Lipshultz et al. addressed the important role of MSV in the setting of required IVF/ICSI in NOA patients, since MSV may be able to improve outcomes in those NOA patients who must still utilize assisted reproductive techniques [13]. Our study included 3 patients with preoperative NOA, all of them had improved semen counts postoperatively but remained less than 15 million/ml with one of them (33.3%) having successful postoperative conception.

Regarding spontaneous pregnancy rates following MSV, meta-analyses have done by Ding et al. [2], Cayan et al. [9] & Mohamed et al. [5] showed improved spontaneous pregnancy rates. In our study, the conception rate among infertility patients who underwent microsurgical varicocelectomy was 47.1% (16 patients out of 34 infertile patients), time to conception was 4 months in most patients, this percentage can even increase with longer follow-up.

Several studies reported scrotal pain improvement following MSV, Armağan et al. reported that the complete success for scrotal pain control after varicocelectomy was 73–86% and found no association between varicocele grade and pain resolution after surgery [14]. Kim et al. found that 76.5% of patients experienced a marked or complete resolution of pain after MSV among 81 patients while 19.7% of patients experienced partial resolution and 8.6% of men reported no change [15]. In our study, 25 patients had scrotal pain, 92% had resolution of the pain and 8% had persistent scrotal pain after S-MSV. Despite the clinical significance, this was not statistically significant.

The limitations of our study include: follow-up was limited to three months, although the sample size was calculated to prove the statistical difference, a larger sample size may yield better outcomes and there was no objective tool to assess the scrotal pain pre-and postoperative. Further studies may examine the needed length after cord pulling for optimum outcomes, finally, the clear benefit of P-MSV in decreasing the number of ligated veins needed a sub-study comparing the number of internal spermatic veins before and after cord pulling in every patient to show the statistically significant difference which did not show when comparing P-MSV to S-MSV. Different study populations (infertility and scrotal pain) and laterality were included which may confound the results.

5 Conclusion

Microsurgical subinguinal varicocelectomy with the pulling technique was not associated with increased perioperative morbidity. There is a significant benefit for the new pulling technique in decreasing the number of internal spermatic veins improving the surgical feasibility of microsurgical technique without an increase in the intraoperative time despite the extra steps taken. From this, we conclude that the pulling technique is superior to the standard technique in microsurgical subinguinal varicocelectomy.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12301-023-00393-z.

Additional file 1. Figure S1: Internal spermatic vein under operating microscope. **Figure S2:** Testicular artery under operating microscope.

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Author contributions
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Availability of data and materials
The datasets used and/or analysed during the current studies are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Research Ethics Committee of the Faculty of Medicine, Cairo University in Egypt. Ethics committee reference numbers is not available. All patients included in this study gave written informed consent to participate in this research.

Consent for publication
All patients included in this research gave written informed consent to publish the data contained within this study.

Competing interests
The authors declare that they have no competing interests.

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