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# Efficiency and safety of microscopic cluster ligation of the internal spermatic veins: A prospective matched case-control study

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**Introduction** The aim of this study was to evaluate the surgical efficacy and safety of microscopic cluster ligation of the spermatic vein (MCLSV), and to compare the similarities and differences between MCLSV and microscopic traditional branch ligation of the spermatic vein (MTBLSV).

**Material and methods** A prospective matched case-control study of 91 patients with bilateral varicocele was conducted. Participants underwent microscopic bilateral spermatic vein ligation and were randomly assigned by computer to undergo MCLSV on one side and MTBLSV on the other. The operative outcomes of the two techniques were compared.

**Results** The operative time of MCLSV was significantly lower than that of MTBLSV ($p < 0.001$). Postoperative day 1 VAS scores at the operative site in MCLSV were significantly lower than MTBLSV ($p < 0.05$). There was no significant difference between the two groups in the number of spermatic vein ligations, the number of internal spermatic arteries and lymphatics, complications, occurrence of foreign body sensation of wire knots, improvement of scrotal pain and distant recurrence ($p > 0.05$).

**Conclusions** Compared with MTBLSV, MCLSV can significantly shorten surgical time, improve surgical efficiency, and alleviate postoperative perineal pain and discomfort in patients while ensuring surgical safety and effectiveness.

Key Words: varicocele ‹› cluster ligation ‹› microsurgery ‹› matched case-control study

## INTRODUCTION

Compared with other surgical methods for treating varicocele (VC), microscopic spermatic vein ligation was characterized by a low recurrence rate, fewer complications, and more effective improvement of semen quality [1–3]. Therefore, microscopic spermatic vein ligation was considered the gold standard for the treatment VC, which had led more and more doctors prefer to choose microscopic spermatic vein ligation [4, 5]. However, due to the fact that each patient had an average of 13 spermatic veins in the unilateral spermatic cord, ligating the gradual branches of these veins under the microscope not only takes a lot of time, but also was prone to damage the internal spermatic artery, which raising the potential for complications [2, 6, 7]. In a recent study, it was found that the application of microscopic spermatic vein ligation was significantly hindered by the complexity of the procedure [8]. To reduce the complexity and improve the efficiency of the operation while retaining the benefits of microscopic spermatic vein ligation, we propose a modified surgical approach of microscopic spermatic vein cluster ligation. We found that the intraoperative use of cluster ligation significantly reduced the difficulty of the procedure and improved the efficiency of microscopic spermatic vein ligation,

and with complications not significantly higher. However, to date, little research has been conducted to compare the efficiency and safety of microscopic cluster ligation of the spermatic vein (MCLSV) and microscopic traditional branch ligation of the spermatic vein (MTBLSV). Therefore, in this study, we prospectively evaluated the surgical efficiency and safety of this modified approach and assessed the differences between the two surgical modalities by comparing them with the means of paired case-control study. This suggested an effective improvement method to enhance the efficiency of microscopic spermatic vein ligation.

## MATERIAL AND METHODS

This prospective comparative study was conducted at Xuzhou Central Hospital in China. A detailed explanation of the entire research process was provided to the patients, and written informed consent forms were obtained from each patient. A total of 91 men, aged between 18 and 60 years, who underwent bilateral microscopic spermatic vein ligation for bilateral VC were included.

The study was conducted using a randomized, double-blind, controlled design. Different surgical methods were applied to the left and right sides of each patient, i.e. MCLSV and MTBLSV. The left side was randomly assigned using a computerized randomization method and the right side was assigned using another surgical method. The MCLSV and MTBLSV formed a paired comparison between the right and left sides of each patient.

Surgical parameters included bilateral operative time, VAS scores at 1 day and 5 days postoperatively, complications (such as epididymitis, hydrocele, testicular atrophy, and scrotal edema), improvement in scrotal pain, occurrence of foreign body sensation of wire knots (OFBSWK), recurrence and semen quality of patients with astheno-spermia and oligozoospermia (AO). All postoperative data were collected by two independent surgeons. (Operative time was calculated from skin incision to skin closure. OFBSWK: significant threads of nodular foreign body sensation felt around the patient's surgical area.)

### Operative technique

#### *MCLSV*

The patient was anesthetized in the supine position. A transverse incision, 2–3 cm in length, was made just below the external inguinal ring, through the skin and underlying tissues, until the spermatic cord was exposed. The spermatic cord was mobilized and gently pulled out of the incision using tissue forceps, and was pulled with a small pulling hook instead, The outer and inner fascia of the spermatic cord were carefully opened under microscopic magnification (10×) During branch-by-branch isolation of the spermatic veins, the vascular surface was infiltrated with 1% lidocaine solution to identify the testicular arteries, and the lymphatics, vas deferens, and their arteries were separated and freed for protection. All the genera of the internal spermatic veins were located (Figure 1A) and marked with 4-0 silk thread interspersed (Figure 1B), and their ends were ligated in clusters (Figure 1C). After clipping the cluster ligated spermatic veins, the integrity of the preserved arteries and lymphatics was examined (Figure 1D). The served end was connected to increase the stability of the operated spermatic cord. After checking for missed veins and bleeding spots visible to the naked eye, the cremaster and the external fascia of the spermatic cord were sutured. Found the spermatic index band vein to be ligated, returned the spermatic cord, sutured the incision layer by layer.

#### *MTBLSV*

The steps of procedure were the same to MCLSV. The only difference was that during the branch-by-branch isolation of the spermatic veins, and sequentially identify and characterize the genera of the internal spermatic veins and ligate them one by one singly. After clipping, the severed ends are ligated with 4-0 silk thread.

### Statistical analysis

SPSS 23.0 software was applied for statistical analysis. The count data were expressed as n (%), and the comparison was made by $\chi^2$ test or Fisher's exact probability method. The measurement data were expressed by ($\bar{x} \pm s$), and the comparisons between groups were made by t test or rank sum test. Differences were considered statistically significant at $p < 0.05$.

### Bioethical standards

The study protocol was approved by the Ethics Committee of Xuzhou Central Hospital (approval number: XZXY-LK-20230427-063).

## RESULTS

The demographic characteristics of the two groups were the same, as each patient underwent both

surgical methods. A total of 91 men were included in the study, with a mean age of 29.5 ±7.8 years, from July 2020 to October 2023..

The operative time in the MCLSV group was significantly lower than that in the MTBLSV group ($p < 0.001$). There was no significant difference in the number of ligated spermatic veins, the number of preserved internal spermatic arteries and lymphatic vessels between the two groups ($p > 0.05$). VAS scores of the MCLSV group were significantly lower than that in the MTBLSV group at 1d postoperatively ($p < 0.05$), and the difference at 5d postoperatively was not significant ($p > 0.05$). At 3 months after operation, there was no significant difference in total complication rates between the two groups ($p > 0.05$). OFBSWK was significantly lower in the MCLSV group than that in the MTBLSV group ($p < 0.05$). At 6 months postoperatively, there was no recurrence in either group, and there was no difference between the two groups ($p > 0.05$). The difference on the improvement of unilateral scrotal pain was not significant between two groups ($p > 0.05$) (Table 1).

MCLSV microscopic cluster ligation of the spermatic vein, MTBLSV microscopic traditional branch ligation of the spermatic vein, OFBSWK occurrence of foreign body sensation of wire knots

In this study, 26 patients were found to have preoperative combine AO. An analysis was conducted on their total sperm motility and sperm concentration one year after surgery, and there was a significant improvement in the patients' semen parameters ($p < 0.05$) (Table 2).

## DISCUSSION

Each patient was different, so their body mass index (BMI), anatomy, and pain sensitivity can vary.

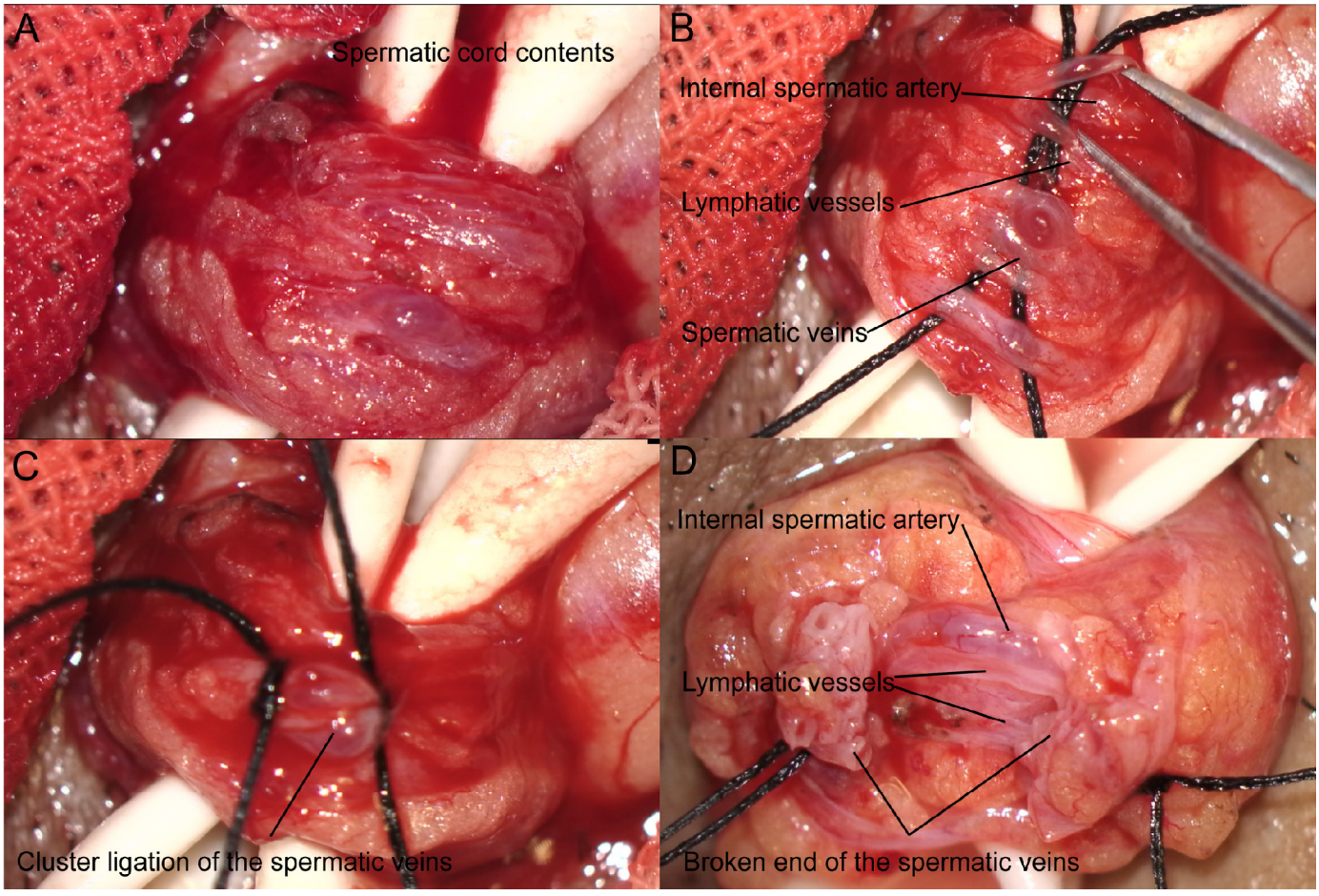


**Figure 1.** *Demonstration of surgical details of microscopic cluster ligation of the spermatic vein.* **A)** *Opening the cremaster and Internal spermatic fascia to expose the blood vessels, lymph, and other tissues in the spermatic cord.* **B)** *Free all blood vessels and lymphatics and pass a 4-0 silk thread below the spermatic veins that need to be ligated.* **C)** *All spermatic veins labeled with silk threads were cluster ligated using two threads.* **D)** *Cut the spermatic vein and preserve arteries and lymphatic vessels intact.*

The number of veins in the spermatic cord, postoperative VAS scores, and complications can be influenced by these individual differences , which may significantly impact the experimental results. Therefore, in this study, two different surgical methods were used to treat both spermatic cords of the same patient. This approach minimized confounding effects and reduces experimental error.

The results of the study indicated that our proposed MCLSV can significantly improve surgical efficiency, and reduce patients' postoperative pain and perineal discomfort while ensuring both safety and effectiveness. Surprisingly, the VAS scores of the surgical area on the MCLSV side was significantly lower than that on the MTBLSV side on the first postoperative day, and MCLSV effectively reduced the patient's pain on the first postoperative day. This may be attributed to the significantly shorter duration of surgery, reduced tissue irritation in the surgical area, and less postoperative tissue edema [9]. During the postoperative follow-up, some patients in the MTBLSV group reported noticeable OFBSWK and mild discomfort in the surgical area, while patients in the MCLSV group had fewer such complaints. Since no previous clinical studies have been published on OFBSWK in patients, the researchers analyzed potential causes based on patient reports. Since most patients with VC have a low BMI, resulting in less fat in the groin area [10, 11]. And MTBLSV produces more nodules, whereas MCLSV was effective in reducing the incidence of OFBSWK in the surgical area.

Approximately about 2–10% of VC patients who do not have fertility requirements but seek treatment for scrotal pain. Their surgical expectation were that the scrotal pain will be safely cured. The success of surgery in this group of patients has been assessed based on the degree of relief of pain symptoms and complications after surgery [12, 13]. Studies had shown that surgery was an effective treatment for painful VC and microsurgical techniques have gained popularity due to their minimal complication rates and satisfactory outcomes [14, 15]. In the study, there were 63 patients with pain on the left side and 25 patients with pain on the right side, with the number of patients experiencing left-sided pain significantly higher than those with right-sided pain [12,16]. As the patients were randomly assigned by computer to each side of the spermatic vein, left-right variability was controlled. The improvement in pain on the left side was compared with the right side and stratified by treatment groups: MCLSV and MTBLSV.. The results of the study indicated that there was no significant difference in scrotal pain relief between MCLSV and MTBLSV.

Regarding whether MCLSV retained the advantages of MTBLSV for effective improvement of semen parameters, we were unable to assess it in this study. However, in this study, 26 patients were found to have a combination of AO preoperatively. We analyzed their semen quality at 1 year postoperatively, and the semen parameters of the patients were significantly improved, which was consistent with the findings of previous studies [17–19]. A direct comparison of the two surgical approaches within the same patient has not yet been conducted, preventing an accurate assessment of their specific effects. The differences between MTBLSV and MCLSV in terms of semen quality enhancement will be further explored in subsequent studies.

In addition, some special descriptions were needed regarding the details of the surgery. During surgery, it was observed that the internal spermatic artery was embedded within the spermatic vein and tightly adhered to it, making separation difficult. In such cases, the internal spermatic artery should first be carefully identified using a lidocaine solution, and then separated from the vein with microsurgical in-

**Table 1.** *Operative outcomes in MCLSV and MTBLSV groups*

| Parameter | MCLSV (n = 91) | MTBLSV (n = 91) | p-value |
|---|---|---|---|
| Operative time (min) | 32.09 ±6.37 | 52.67 ±8.63 | <0.001 |
| Number of ligated spermatic veins | 9.89 ±1.91 | 9.95 ±2.35 | 0.86 |
| Number of preserved arteries | 1.45 ±0.50 | 1.52 ±0.75 | 0.41 |
| Number of preserved lymphatic vessels | 2.01 ±0.66 | 1.91 ±0.97 | 0.42 |
| VAS scores at 1 d postoperatively | 3.52 ±0.74 | 3.89 ±0.77 | 0.01 |
| VAS scores at 5 d postoperatively | 0.84 ±0.36 | 0.87 ±0.34 | 0.67 |
| Total complication rate, n (%) | 9/91 (9.9) | 7/91 (7.7) | 0.60 |
| OFBSWK, n (%) | 3/91 (3.3) | 15/91 (16.5) | 0.003 |
| Improvement in left scrotal pain, n (%) | 26/32 (81.3) | 27/31 (87.1) | 0.77 |
| Improvement in right scrotal pain, n (%) | 9/14 (64.3) | 5/11 (45.5) | 0.93 |
| Recurrence, n (%) | 0 | 0 | n/a |

OFBSWK – occurrence of foreign body sensation of wire knots; VAS – Visual Analogue Scale

**Table 2.** *Comparison of preoperative and 1-year postoperative changes in semen parameters*

| Parameter | Preoperative (n = 26) | 1 year postoperatively (n = 26) | p-value |
|---|---|---|---|
| Sperm motility (%) | 27.82 ±5.86 | 46.67 ±8.74 | <0.001 |
| Sperm concentration (106/ml) | 13.14 ±2.69 | 27.32 ±3.91 | <0.001 |

struments. Cluster ligation should not be attempted at this point; instead, the tightly adhered spermatic veins should be ligated individually. Two, three spermatic veins were tightly adhered and should not be forcibly separated. After confirming that they do not contain the internal spermatic artery or lymphatics, cluster ligation can be performed directly. In cases where the internal spermatic artery and vein were closely adherent during the surgery, following the aforementioned surgical technique, statistical analysis revealed no significant difference between the MCLSV and MTBLSV groups in terms of the number of spermatic veins ligated on both sides, as well as the number of arteries and lymphatic vessels preserved. These results suggest that MCLSV demonstrates the same efficacy as MTBLSV in the precise preservation of the internal spermatic artery and lymphatic vessels.

Although the sample size of this study was small, the paired test method effectively reduced the sample size requirement [20]. Overall, MCLSV has demonstrated good safety, efficacy, and patient comfort as a surgical approach for the treatment of varicocele, making it a promising option for further promotion and clinical application.

## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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## ETHICS APPROVAL STATEMENT

The study protocol was approved by the Ethics Committee of Xuzhou Central Hospital (approval number: XZXY-LK-20230427-063).

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