Review Article

A comparison between the efficacy and complication of laparoscopic and microsurgical varicocelectomy: Systematic review and meta-analysis

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Abstract

Varicocele is the dilatation of the scrotal veins and may affect sperm count and infertility. It is caused by congenital vein insufficiency or absence of venous valve. The main treatment is by surgery, and currently, there are two minimally invasive choices: laparoscopic and microsurgical varicocelectomy. This systematic review aimed to record randomized clinical trials from various sources using all qualified studies up to June 2022. The assessed outcomes were operation time, hydrocele, hospital stay, change in semen parameter, recurrence rate, and pregnancy rate. The essential data extracted were Jadad score, publication year, age, and sample size. This systematic review consisted of 509 and 512 patients in the laparoscopic and microsurgery group, respectively, taken from 12 out of 281 studies. The result of this systematic review was significant difference in operation time between patients from two groups (weighted mean difference [WMD] −21.40, 95% confidence interval [CI]: −28.90–−13.89); length of hospitalization (WMD: 0.38, 95% CI: 0.02–0.74); laparoscopic could significantly increase the risk of hydrocele by 3.30-fold (risk ratio [RR]: 3.30, 95% CI: 1.07–10.12); laparoscopic could significantly increase the recurrence rate by 6.98-fold (RR: 6.98, 95% CI: 3.46–14.08); no significant difference in spontaneous pregnancy between patients in both groups (RR: 0.81, 95% CI: 0.57–1.16); and laparoscopic surgery decreased the occurrence of sperm parameter changes by 40% (RR = 0.40, 95% CI: 0.25–0.62).

Keywords: Laparoscopic varicocelectomy, microsurgical varicocelectomy, varicocele

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INTRODUCTION

Varicocele is the dilatation of the scrotal veins. It contributed to 30%–40% of male infertility.[1] The incidence increases by age due to the disruption in blood flow to the testis and likely to cause of infertility in males.[2-4] Surgery is currently considered the gold standard for varicocele therapy and offers a better prognosis when compared with other treatments.[5] A study by Baazeem *et al.* showed that surgery improves testicular and sperm function.[6,7] Our study aimed to compare these two

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techniques on their efficacy and safety to provide better surgical treatment.

METHODS

Literature search

The search was done in four databases, PubMed, EMBASE, Scopus, and Google Scholar, for all qualified studies up to June 2022 on microsurgery and laparoscopic varicocelectomy for varicocele repair. Following keywords were used for this systematic review "Laparoscopic varicocelectomy" AND ("Microsurgery Varicocelectomy" OR "Microvaricocelectomy" OR "Microsurgical Varicocelectomy") AND Outcome. Two reviewers were responsible for literature search, whereas the third reviewer was used in case of disagreement between two reviewers.

Study selection

The study selection criteria included in this study were randomized controlled trials (RCTs); patients with varicocele were treated with either microsurgery or laparoscopic varicocelectomy. The assessed outcomes were operation time, hydrocele, hospital stay, change in semen parameter, rate of recurrence, and pregnancy rate. Duplicate publication, nonrandomized clinical trial, and irrelevant outcome were excluded from this meta-analysis. Two reviewers were responsible to search and screen studies that fulfilled the criteria. The third reviewer will be used in case of disagreement.

Data extraction and eligibility

Extraction of studies consists of information and outcome. Data which include Jadad score, publication year, age, and sample size were collected as essential information. Extracted outcomes were duration of operation, hydrocele, duration of hospitalization, change in semen parameter, recurrence rate, and pregnancy rate. The RCT will be assessed with five items: randomization statement, acceptability of generating a randomized sequence, details on withdrawals, use of double-blinding method and its description, and dropouts. Score below 3 represented low-quality studies with high risk of bias, whereas score of more than three were considered high-quality studies. It was performed by two studies separately, and the differences were discussed.

Statistical analysis

Data collected were analyzed using Revman version 5.3 (Cochrane, 11-13 Cavendish Square, London, W1G 0AN, United Kingdom) for quantitative analysis, whereas describing method was used for qualitative analysis to analyze the baseline differences and stringency of research methods between studies. Qualitative analysis was conducted initially, followed by quantitative analysis. Data were first extracted for heterogeneity test. Random-effect model was used if heterogeneity presence, and fixed-effect model was used if it did not exist. Results were reported in risk ratio (RR), odds ratio, 95% confidence intervals (95% CI), and *P* values. $P < 0.05$ considered statistically significant results.

RESULTS

Studies characteristics

The indexed words gave a total of 281 articles. The initial screening eliminated 250 records, leaving 31 articles for further assessment. We performed a full-text searching and screening of 31 publications obtained during abstract screening; nine were excluded due to the outcome not being assessed in the current study; variables such as pain in painful varicocele were excluded. Out of the 22 studies, two were excluded due to full-text unavailability, and two were excluded for being duplicated. At last, 17 studies were assessed with 913 patients with laparoscopic varicocelectomy and 1037 patients with microsurgical varicocelectomy included in this review. Search process is outlined in Figure 1, with a Jadad score of 2.8, indicating a low quality in most of the studies, and the primary age in all studies was between 20 and 34 years. Table 1 shows the study characteristics.

Operation time

Eleven trials with 481 and 478 patients in the microsurgery and laparoscopic group, respectively, showed the data to assess surgery time. We chose a random-effect model to

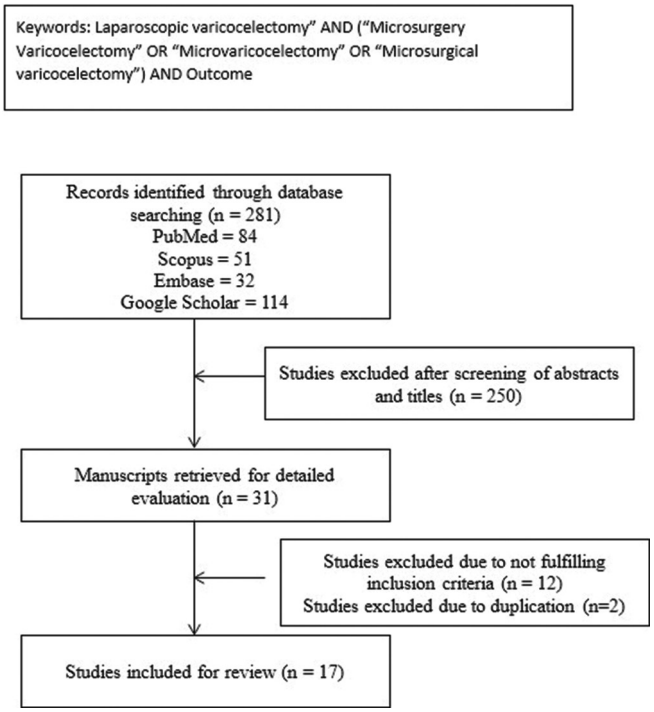

Figure 1: Literature search

investigate surgery duration based on the Chi-square test *P* value ($P \leq 0.00001$) and I^2 tests-value ($I^2 = 98\%$). The results showed a significant difference in surgical duration between both groups, with a mean difference of 21.40 min shorter in laparoscopic varicocelectomy compared with microsurgical varicocelectomy (mean difference: −21.40, 95% CI: −28.90–−13.89). Figure 2 shows these results.[12]

Hospital stay

Seven trials with 276 patients in laparoscopic and 294 patients in microsurgery group showed the data for postoperative length of stay. We analyzed the hospital stay by choosing a random-effect model based on I^2 tests-value ($I^2 = 94\%$) and Chi-square test *P* value ($P < 0.0001$). The pooled tests indicated a significant difference in the length of stay between patients from two groups (weighted mean difference [WMD]: 0.38, 95% CI: 0.02–0.74), as shown in Figure 3.

Table 1: Study characteristics

Study	Jadad score	Patient number		Average age (years)	
		L	M	L	M
Al-Kandari *et al*.[8]	4	40	40	33.5	33.1
Al-Said *et al*.[9]	4	112	94	15	14.5
Bryniarski *et al*.[10]	3	42	42	31.6	33.6
Li *et al*.[11]	3	35	29	30.2	28.6
Liu *et al*.[13]	3	49	48	25.65	25.55
Feng *et al*.[15]	3	31	31	31.5	30.2
Salem *et al*.[16]	3	25	25	19–44	19–44
Song *et al*.[17]	3	36	36	30.84	31.2
Sun *et al*.[18]	3	58	55	25.65	25.55
Söylemez *et al*.[19]	3	20	20	25.1	24.2
VanderBrink *et al*.[20]	3	28	31	15	14.5
Watanabe *et al*.[21]	3	33	61	33.5	33.1

Postoperative hydrocele

Eleven trials with 478 patients in laparoscopic and 481 patients in the microsurgery group provided the data for postoperative hydrocele occurrence. I^2 tests-value ($I^2 = 50\%$) and Chi-square test *P* value ($P = 19.91$) led us to choose a random-effect model to determine the hydrocele occurrence in postsurgery patients. The pooled results demonstrated that the laparoscopic group could significantly increase the risk of hydrocele by 3.30-fold compared to microsurgery group [RR: 3.30, 95% CI: 1.07–10.12, Figure 4].

Recurrence rate

Nine trials with 407 and 416 patients in the laparoscopic and microsurgery group, respectively, provided the rate of recurrence in all patients. Based on the I^2 tests-value of <50% ($I^2 = 0\%$) and Chi-square test *P* value ($P = 0.99$), we chose a fixed–effect model to analyze the recurrence rate. Our results showed that there was an increase of recurrence rate in the laparoscopic group significantly by 6.98-fold compared with the microsurgery group (RR: 6.98, 95% CI: 3.46–14.08), as shown in Figure 5.

Pregnancy rate

Four trials with 125 patients in laparoscopic and 153 patients in the microsurgery group provided the data for spontaneous pregnancy 12 months postsurgery. We selected a fixed-effect model to assess postsurgery spontaneous pregnancy based on the I^2 test value ($I^2 = 47\%$) and Chi-square test *P* value ($P = 0.13$). The pooled results showed no significant difference in spontaneous pregnancy between patients from both groups (RR: 0.81, 95% CI: 0.57–1.16), as shown in Figure 6.

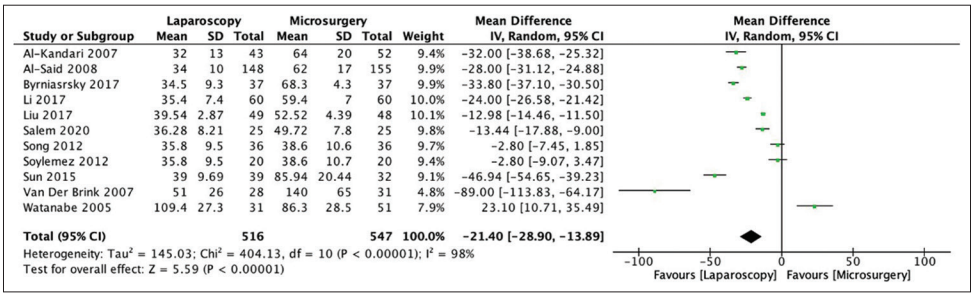

Figure 2: Forest plot of operation time between laparoscopic and microsurgical varicocelectomy

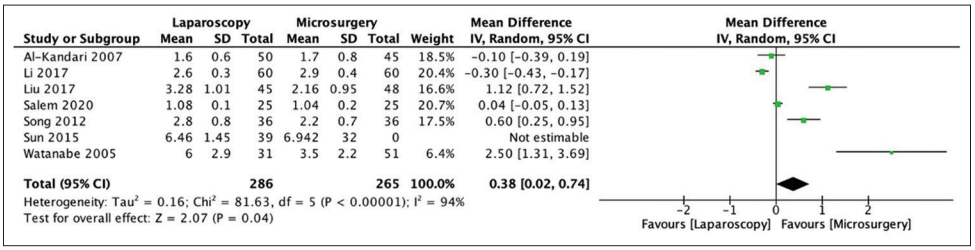

Figure 3: Forest plot of hospital stay between laparoscopic and microsurgical varicocelectomy. CI: Confidence interval, SD: Standard deviation, IV: Intravenous

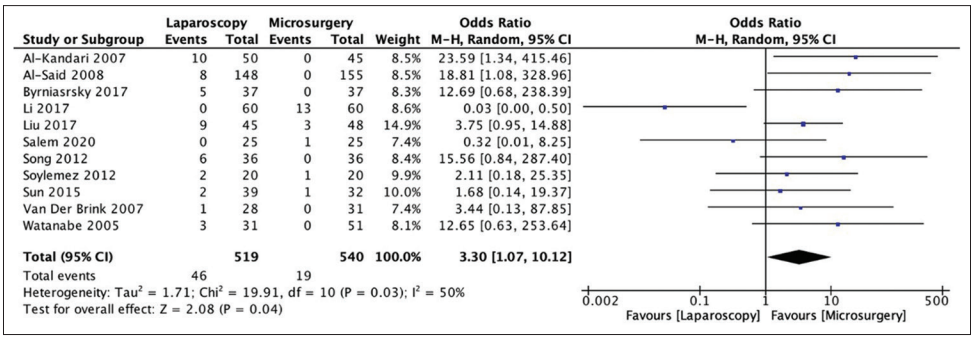

Figure 4: Forest plot of postoperative hydrocele between laparoscopic and microsurgical varicocelectomy. CI: Confidence interval, SD: Standard deviation, IV: Intravenous

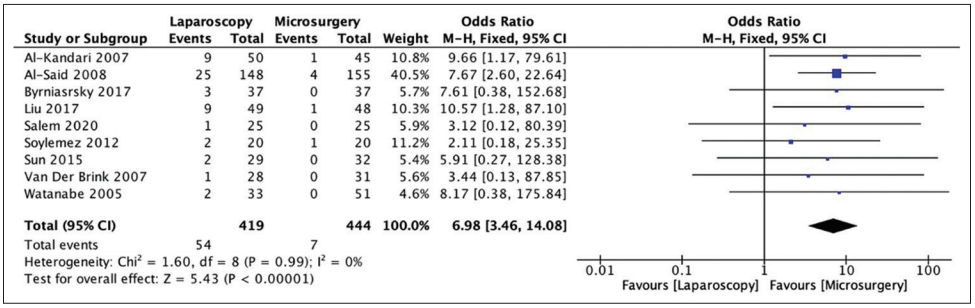

Figure 5: Forest plot of recurrence rate between laparoscopic and microsurgical varicocelectomy. CI: Confidence interval

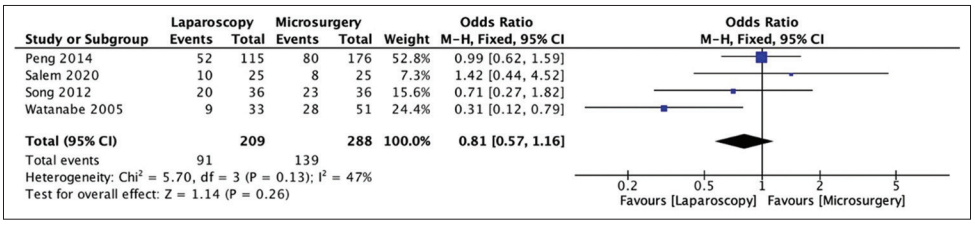

Figure 6: Forest plot of pregnancy rate between laparoscopic and microsurgical varicocelectomy. CI: Confidence interval

Semen parameter improvement

Three trials with 122 patients in laparoscopic and 121 patients in the microsurgery group provided the data for sperm parameter improvement 12 months postsurgery. Based on the I^2 tests-value of <50% ($I^2 = 0\%$) and Chi-square test P value ($P = 0.98$), we used a fixed-effect model to evaluate postsurgery sperm parameter improvement. The pooled results showed a significant difference in sperm parameters postsurgery between the two groups. It was found that laparoscopy decreases the occurrence of sperm parameter changes when compared to the microsurgery group by 40% (RR = 0.40, CI 95% =0.25–0.62), as shown in Figure 7.

DISCUSSION

Varicocele is a dilatation or tortuosity of the pampiniform plexus scrotal veins. This condition is commonly found unilateral, specifically on the left side. However, there are different types of bilateral varicoceles, ranging from 30% to 80%.[24] Isolated varicocele on the right side is very rare and should be evaluated further for retroperitoneal mass. The left internal testicular vein drains into the left renal vein, and the right testicular vein drains into the vena cava. This primary finding has two branches that contribute to the predisposition to the left. First, the pathway of the left allows an increase of about 8–10 cm in length compared to the right. This increase in hydrostatic pressure, which occurs due to an upright posture, impacts the function of valves in the veins, leading to dilation and twisting of the veins. Second, the insertion of the left internal spermatic vein perpendicularly into the left renal vein may increase pressure elevations in the left spermatic vein. In contrast, the right internal spermatic vein is protected from elevated pressures in the vena cava by the oblique insertion into the vein.[25-27]

Some conditions such as palpable varicocele, documented infertility, female partner having a normal or potential correctable fertility problem, while the male having

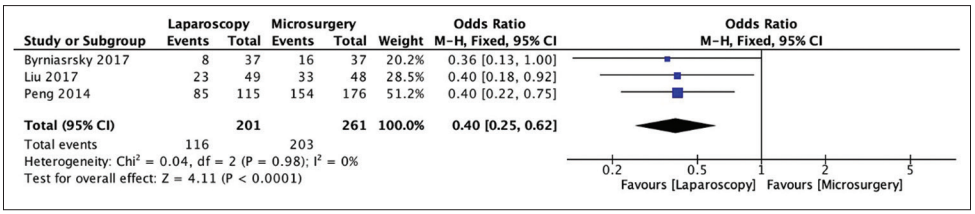

Figure 7: Forest plot of semen parameter improvement between laparoscopic and microsurgical varicocelectomy. CI: Confidence interval

abnormal semen parameter or sperm function test are some indicators that showed varicocelectomy may be necessary. Furthermore, varicocelectomy may be required to prevent or reverse adolescent testicular atrophy, painful varicocele, high DNA fragmentation, and testicular function improvement in hypogonadal men with varicocele.[5] Several techniques, such as open, laparoscopic, and microsurgery, are available to correct varicoceles.[22]

Open varicocelectomy is performed using the variety of incisions to uncover spermatic vessels at diverse levels. Palomo technique or high retroperitoneal ligation, for example, is conducted by incising horizontally at the medioinferior to the anterior superior iliac spine and extending medially. Then, the incision of the external oblique fascial and retraction of the internal oblique muscle were done to uncover the internal vein. Other techniques such as the Ivanissevich technique use the inguinal approach through the incision of the groin superolateral to the ipsilateral pubic tubercle. The incisions are extending along the skin line of the inferior abdominal wall laterally. Then, incision is made in the external oblique fascia to the exposed spermatic cord, which is covered with cremasteric fiber, to access the vascular structure.[24] Vas deferens should be identified and preserved along with their artery and lymphatic vessels. Vein structure should be identified and prepared for ligation concomitantly. Although open varicocelectomy is commonly done, complications occur at a rate of up to 30%, including inadvertent arterial ligation, hydroceles, injury to the vas deferens, testicular atrophy, hematoma, epididymitis, and wound infection. Moreover, open varicocelectomy has a 10%–45% recurrence rate, significantly higher than other treatment options.[28]

On the other hand, minimally invasive surgeries such as laparoscopic and microsurgical varicocelectomy have better outcomes than open techniques regarding postoperative complications, hospital stay, and recurrence. In this study, we tried to assess which of the following minimally invasive choices between laparoscopic and microsurgery is more superior in treating varicocelectomy patients.[14]

Our study compared the outcome, safety, and recurrence of the two minimally invasive techniques: laparoscopy and microsurgery. With the currently available evidence, we assess surgery time, hospital stay, hydrocele occurrence, varicocele recurrence, and fertility outcomes such as pregnancy rate and semen parameter changes.[23]

In our meta-analysis, it was found that the surgery duration is shorter in laparoscopy. It is possibly due to a steeper learning curve in microsurgical varicocelectomy than in laparoscopic varicocelectomy. In contrast, the latter learning curve only requires 13–14 surgeries for novice surgeons to be proficient.[29] This can be mitigated through various modification methods for microsurgery to overcome the difficulty of the procedure, for example, using microsurgical intermediate subinguinal varicocelectomy where the modification is done to facilitate microdissection of the spermatic cord. The cord below the external oblique aponeurosis was cut thoroughly using a peanut dissector. A small, 1-cm external ring incision was made along the suitable angle clamp, and thus allowing additional cut on the upper part of the cord. Another significant silastic drain was used between the internal and external fascia and the surroundings. While retracting the small silastic drain caudally, the cord was elevated on the drain, which allows an examination of the cord on microscope. Eventually, we could observe the upper part of the cord at approximately 2 cm compared with the common level without incision on the external inguinal ring, and the cord was more redundant without arterial choking by the external spermatic ring. It was stated in the study by Kang *et al.* that such modification is noninferior when compared with a standard microsurgical subinguinal varicocelectomy (MSV) in terms of complication rate and efficacy.[30]

Complications, including hydrocele occurrence in our study, are significantly higher in laparoscopic than in the microsurgery group. We found that laparoscopic surgery increases the risk of hydrocele by 2.55-fold compared with the microsurgery group, which corresponds the study by Wu *et al.* that found microsurgical varicocelectomy lowers the possibility of hydrocele (WMD = 0.05 [95% CI = 0.01–0.27] $P = 0.0005$, $Z = 3.49$).[31] In theory, risk of hydrocele formation is higher in laparoscopic surgery than in lower ligation due to lymphatic obstruction along the spermatic cord. In high *en bloc* ligation, commonly

performed in laparoscopic surgery, there is disruption of lymphatic and blood vessels, leading to an imbalance characterized by decreased absorption and secretion of tunica vaginalis. Hydrocele complication should not be underrated as it might initiate formal hydrocelectomy. Varicocelectomy followed by hydrocelectomy poses a risk if internal testicular artery injury is present because the remaining collateral blood supply to the testis, the vascular artery, could be compromised. Varicocele repair followed by hydrocele formation could lead to the development of a fluid-insulating layer around the testis that was supposed to be fixed since varicocele repair restores the standard counter-current cooling mechanism to the testis. It remains unclear whether this layer contributes to additional impairment of spermatogenesis, ultimately resulting in delayed catch-up growth of the testis.[32]

Efficacy wise, our study found that laparoscopic varicocelectomy has a higher recurrence level than microsurgical varicocelectomy by 5.84 fold, concurrent with a prior meta-analysis study in 2017 that found microsurgery is superior in terms of recurrence.[31] This is possibly due to the finding in the study by Moon KH *et al.* in 2021, which showed that the likely culprit of higher recurrent rate in laparoscopic surgery was mostly due to the remnant collateral vein of the internal or external spermatic vein that merges with the *in situ* vitrification (ISV) at the higher level that is unidentifiable using venography. Microsurgical subinguinal varicocelectomy is superior to laparoscopic surgery as it can expose the spermatic cord without dividing any abdominal muscles or fascia and identify varicoceles and small veins collateral to minimize persistent or recurrent varicocele. Furthermore, it can identify smaller arteries to avoid accidental ligation. Other than remnants of ISV at subinguinal level, other small venous collateral such as periarterial venous plexus, cremasteric veins, and extraspermatic and gubernacular collaterals that, if missed, could dilate postoperatively and cause the recurrence of varicocele.[33]

Our meta-analysis was in line with prior studies, such as by Wu *et al*., which found that sperm concentration parameters increased significantly in microsurgery than in laparoscopic surgery.[31] This finding can be explained by Pajovic *et al.* which stated that although laparoscopic surgery could spare both the spermatic artery and lymphatic channel, identification and preservation of both was better and more reliable on the microsurgical approach in their studies.[33,34] As the study shows, out of 70 patients, 100% from the microsurgery group established a testicular artery preservation compared with 95.1% in laparoscopic surgery. Artery preservation in microsurgical ligation was higher due to microscopic magnification of 10–25 times, which allow the artery to be identified quickly and avoided from being accidentally ligated. Thus, although the testis receives additional blood supply from vassal and cremasteric arteries, the testicular artery is still the main supply and ought to be protected at all costs to be able to function at its best.[34]

The rate of pregnancy did not differ significantly between microsurgery and laparoscopy varicocelectomy as a result of the multifactorial nature of pregnancy, in which both partners have equal contributions toward the conception rate.

There were several limitations in this study. First, trials were not blinded, as it involved surgical procedures. Second, there were potential sources of heterogeneity between studies that may have influenced the outcomes, including the duration of follow-up, grade of varicocele, and surgical technique. Last, the three studies included in our study did not provide female partner's medical history, which may have confounded our results in describing spontaneous pregnancy rates. Therefore, we suggest a more high-quality extensive trials to better evaluate the effects of microsurgery and laparoscopic varicocelectomy to treat varicocele.

CONCLUSION

Laparoscopic varicocelectomy is inferior to microsurgical varicocelectomy in terms of efficacy and safety, although a higher learning curve was observed in the microsurgery group, which caused a longer duration of surgery.

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Conflicts of interest
There are no conflicts of interest.

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