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Research Article

Comparison between Microsurgical Varicocelectomy with and without Testicular Delivery for Treatment of Varicocele: An Updated Systematic Review and Meta-Analysis

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Dilated testicular gubernacular veins after varicocelectomy were reported to be the cause of varicocele recurrence. The gubernacular veins start at the tail of the testicular and merges into the posterior scrotal veins. The gubernacular veins could be ligated only after testicular delivery (TD) anatomically. TD and ligation of the gubernacular veins during microsurgical varicocelectomy might reduce the varicocele recurrence but this method is still under debate. Therefore, we performed this systematic review and meta-analysis and assessed varicocele recurrence, complications as well as clinical outcomes after microsurgical varicocelectomy with TD. Relevant researches were searched on the PubMed, Embase, Cochrane Library, Web of Science, and China National Knowledge Infrastructure databases to perform an updated meta-analysis. Standardized mean differences, relative risks (RRs), and their 95% confidence intervals (CIs) were applied to evaluate result indicators. This updated meta-analysis included 17 publications with 10 randomized controlled trials and 7 cohort studies. A total of 2,254 participants, including 1,024 subjects with TD and 1,230 without TD, were involved. The pooled results demonstrated that microsurgical varicocelectomy with TD might lead to higher incidences of postoperative scrotal edema (RR = 4.20, 95% CI = 2.60–6.81, $p < 0.001$), testicular hydrocele (RR = 6.58, 95% CI = 1.19–36.20, $p = 0.030$), and orchiepididymitis (RR = 6.33, 95% CI = 2.08–19.31, $p = 0.001$) than the group without TD. Similar findings were also found in subgroup analysis of varicocele grade II and III. By contrast, we failed to find significant differences between them in semen parameters, varicocele recurrence, serum testosterone, and natural pregnancy ($p > 0.05$). Sensitivity analysis revealed the pooled results were stable and no publication bias was detected. TD during microsurgical varicocelectomy may lead to more postoperative complications and may not be beneficial for semen parameters, recurrence of varicocele, and natural pregnancy. Therefore, varicocele patients may not benefit more from TD.

1. Introduction

As a common urological disorder, varicocele refers to dilated or tortuous veins of the pampiniform plexus, which is dominant on the left side [1, 2]. It is estimated that varicocele exists in about 15% of the general male population, 25.4% of men with abnormal semen, and 25%–35% of infertile men, with primary infertility at 35% and secondary infertility at 50%–81% [3, 4]. Many studies suggested that varicocele contributes to abnormal testicular spermatogenesis, reduced sperm quality, and testicular interstitial cell hypofunction [5, 6].

A surgical approach is effective in treating male infertility due to primary varicocele. Microsurgical varicocelectomy is gradually being considered as the procedure with the best clinical outcomes and least complications in the treatment of varicocele in patients of all ages [7]. Compared to nonmicrosurgical procedures, microsurgical varicocelectomy allows clinicians to better separate the spermatic veins, testicular arteries, and associated lymphatic system, thereby greatly reducing the problem of testicular artery injury while also decreasing postoperative complications and recurrence of varicocele [8, 9]. The cause of varicocele recurrence remains a challenge for urologists, and some researchers reported that the major contributor to the problem was the presence of gubernacular veins. Additional testicular delivery (TD) in microsurgery can be performed for the purpose of ligating the gubernacular veins, which may decrease the incidence of varicocele recurrence [10]. It has also been suggested that the recurrence rate of varicocele is not significantly increased even without intraoperative ligation of gubernacular veins and the penetrating branch of the external spermatic veins [11]. It is possible that dilatation of gubernacular veins is a result of compensation rather than a cause of recurrence [2].

Two meta-analyses comparing microsurgical varicocelectomy with or without TD have been performed in the past few years and found that TD was associated with higher complications [12, 13]. The earlier meta-analysis found a significant reduction in varicocele recurrence and serum testosterone levels after TD, with no significant difference in the operation time [12]. By contrast, the other concluded that TD did not reduce varicocele recurrence or serum testosterone, and it significantly prolonged the operation time [13]. Therefore, based on the results of the two meta-analyses, we found it was still under debate about the effects of TD on varicocele recurrence, serum testosterone levels, and operation time. In addition, the limited amount of eligible studies reduced the credibility of the final conclusions. Another nine articles [12, 14–21] were added to this research compared to the latest meta-analysis [13], which made the outcomes more convincing and credible. Gald conducted an additional stratified analysis utilizing the semen concentration of the patients [20]. Two studies highlighted the association between microsurgical varicocelectomy with TD and the higher occurrence of postoperative testicular hydrocele [16, 18]. Jin et al. [17] believed that microsurgical varicocelectomy without TD proved to be more effective in improving both sperm concentration and motility among patients with grade III varicocele. Hence, we performed an updated meta-analysis according to a systematic search and collection of existing researches to assess and examine the clinical outcomes and safety of TD in microsurgical varicocelectomy for varicocele.

2. Materials and Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses recommendations statement to report results [22].

2.1. Search Strategy. We adopted a systematic and extensive search on the PubMed, Embase, Cochrane Library, Web of Science, and China National Knowledge Infrastructure databases (until December 10, 2022) for researches on the influence of TD with microsurgical varicocelectomy. The keywords included "microsurgical varicocelectomy," " varicocelectomy," "gubernacular veins," and "testicular delivery." Detailed search strategies were presented in Tables S1–S5. Besides, we also adopted a reference search to determine additional researches through scanning the references of enrolled researches.

2.2. Inclusion and Exclusion Criteria. All researches enrolled in our study met the following criteria: (a) participants: varicocele males underwent microsurgical varicocelectomy; (b) interventions: microsurgical varicocelectomy with TD and gubernacular veins ligation; (c) comparisons: microsurgical varicocelectomy without TD; (d) outcomes: duration of surgery, length of hospital stay, testosterone, postoperative semen parameters, postoperative complications, and natural pregnancy. Sperm analyses in enrolled studies kept to the fifth World Health Organization evaluation criteria for patient sperm analysis; (e) study design: randomized controlled trials (RCTs) and cohort studies. The exclusion criteria were: (a) single-arm study without comparison and (b) duplication research.

2.3. Risk of Bias and Quality Assessment. We evaluated the rigor of the implementation process and the credibility of the results of all included cohort studies utilizing the Newcastle–Ottawa scale (NOS) [23]. This 9-point scale estimates the risk of bias of the enrolled studies from three perspectives, including selection of appropriate study participants, comparability between groups, and the adequacy and reliability of exposures and outcomes. Studies that score more than 7 on the NOS scale are considered to be of high quality. The Cochrane Risk of Bias tool (version 5.1.0) was adopted to assess the bias of eligible RCTs [24].

2.4. Studies Selection and Relevant Data Collection. Two independent researchers, Yulong Wang and Yuxuan Song, collected those enrolled articles and all available data for the eligible studies separately and then crosscheck them. When a disagreement occurred, a third reviewer (Caipeng Qin) would participate in the discussion and eventually reach a consensus. Available information for eligible researches was extracted from those included articles: first author, year of publication, study types, the age of subjects, sample size, microsurgical approach, postoperative follow-up time, and varicocele grade. When a study adopted median $\pm$ IQR to describe the continuous variables, we could convert it into mean $\pm$ SD through an already published method [25].

2.5. Statistical Analysis. We applied relative risks (RRs) to assess the combined impact of dichotomous variables. Standardized mean differences (SMDs) were adopted to evaluate the pooled impact of continuous variables. Final 95% confidence intervals (CIs) from all study data were used for overall comparisons. Random and fixed effects models were adopted to evaluate all RRs as well as SMDs obtained through the calculations [26, 27]. Heterogeneity among articles was measured and represented through a χ^2 test and I^2 value. When the P of the χ^2 test was less than 0.05 or I^2 was >50%, the heterogeneity was obvious and we took random-effect model into consideration; otherwise, the random-effect model was applied.

Moreover, sensitivity analysis was performed through deleting every single literature consecutively to identify the credibility of the pooled results. In addition, we applied Begger's tests and Egger's tests to detect possible publication bias [28]. When the p was <0.05, a significant bias was established. This research was conducted with Stata software

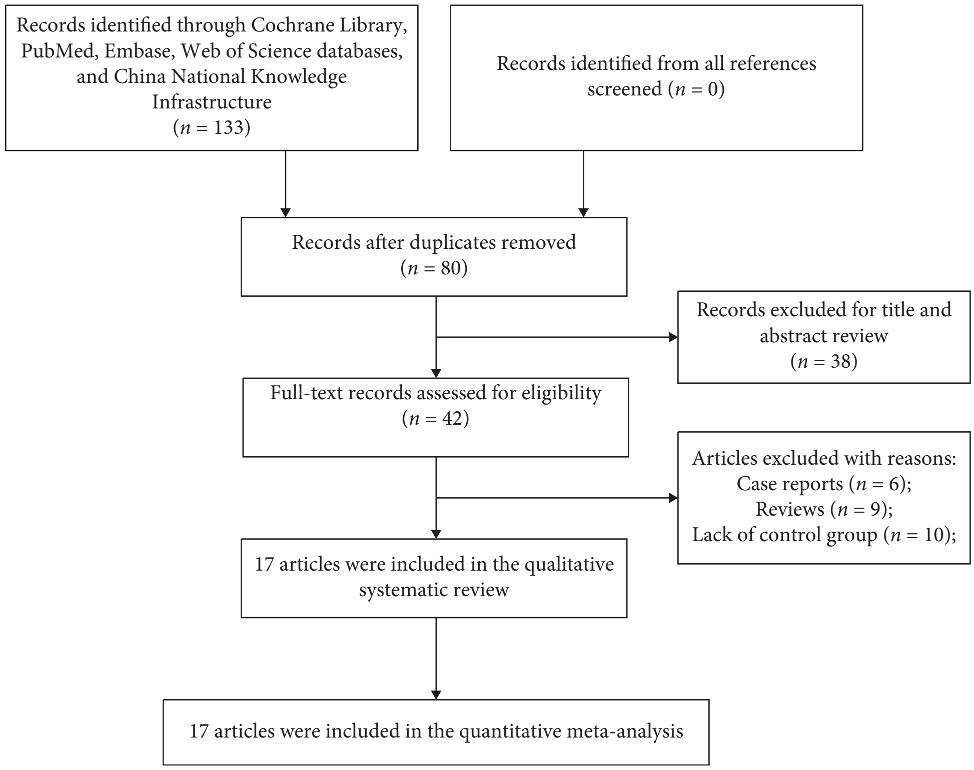


Figure 1: Flow chart of the identification and selection of the included studies.

(version 12.0) and Review Manager (version 5.3, Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014).

3. Results

3.1. Main Features of the Enrolled Studies. We obtained 133 potentially qualified articles based on the literature search strategy. Fifty-three studies were removed because of duplication. We retained 42 articles by screening the titles or abstracts of the possible studies. The rest of the studies were read in full. Ultimately, 25 researches were removed and 17 articles containing 10 RCTs [14–16, 18, 21, 29–33] and 7 cohort studies [17, 19, 20, 34–37] were included in the final systematic review and meta-analysis. The detailed study search and screening process is demonstrated in Figure 1. As a result, our study ultimately included 2,254 participants, of whom 1,024 underwent TD during operation as well as 1,230 subjects without TD. In these seventeen studies, all patients with TD underwent concomitant ligation of the gubernacular veins. The main features of the eligible researches are displayed in Table 1.

3.2. Risk of Bias and Quality Assessment. The results of the risk of bias and quality assessment of the enrolled RCTs were presented in Figure 2. No attrition bias was found in any of the 10 enrolled researches. Seven enrolled cohort researches had NOS quality scores of 7 or higher and were qualified.

3.3. Meta-Analysis Results

3.3.1. Duration of Surgery and Hospital Stay. Among these included articles, we identified nine studies comparing operative time and six reporting data on length of hospital stay. TD during microsurgical varicocelectomy significantly prolonged the duration of the procedure in comparison with the group without TD ($SMD = 1.49$, 95% CI = 0.99–1.98, $p < 0.001$) (Figure 3(a)). By contrast, we failed to find discernible diversity in length of hospital stay between them ($SMD = 0.38$, 95% CI = −0.26 to 1.01, $p = 0.244$) (Table 2).

3.3.2. Postoperative Complications. Major postoperative complications such as varicocele recurrence and testicular hydrocele were also analyzed to further investigate the impact of TD on the occurrence of complications. TD was not effective in reducing the complications of varicocele recurrence ($RR = 0.59$, 95% CI = 0.15–2.29, $p = 0.443$) and wound infection ($RR = 0.89$, 95% CI = 0.31–2.55, $p = 0.834$) when comparing patients with TD and without TD (Table 3). However, the pooled RRs demonstrated that TD during microsurgical varicocelectomy could be more likely to result in scrotal edema ($RR = 4.20$, 95% CI = 2.60–6.81, $p < 0.001$) (Figure 3(b)), testicular hydrocele ($RR = 6.58$, 95% CI = 1.19–36.20, $p = 0.030$) (Figure 3(c)), and orchiepididymitis ($RR = 6.33$, 95% CI = 2.08–19.31, $p = 0.001$) (Figure 3(d)) than microsurgical varicocelectomy without TD postoperatively (Table 3).

3.3.3. Effects on Semen Parameters. When it came to sperm viability and total sperm count, microsurgical varicocelectomy with TD was not superior to the group who did not

Table 1: Main characteristics of the eligible studies included in this meta-analysis.

First author (reference)	Year	Design	Surgical approach	Follow-up	With TD	Without TD	Total	Age (mean ± SD)		Varicocele grade
								With TD	Without TD	
Choi et al. [34]	2017	Prospective cohort study	Subinguinal	12 months	25	33	58	12.8 ± 3.08	13.2 ± 3.19	I–III
Wang et al. [14]	2020	RCT	Subinguinal	12 months	40	40	80	25 ± 11		II–III
Spinelli et al. [32]	2016	RCT	inguinal	12 months	35	35	70	14.6	14.4	NA
Allameh et al. [29]	2018	RCT	Subinguinal	6 months	200	197	397	25.9 ± 4.6	27.3 ± 6.1	III
Jiang et al. [16]	2019	RCT	Subinguinal	12 months	49	49	98	26.76 ± 2.24	26.62 ± 2.98	II–III
Wald et al. [20]	2021	Retrospective cohort study	Subinguinal	15.8 weeks	162	151	313	35 (28–43) [a]	34 (28–39) [a]	I–III
Nie et al. [31]	2017	RCT	Subinguinal	6 months	20	20	40	26.7		NA
Fan [15]	2017	RCT	Subinguinal	6 months	38	45	83	28.32 ± 3.89	27.94 ± 3.46	I–III
Longhuan et al. [35]	2020	Retrospective cohort study	Subinguinal	NA	30	30	60	32.99 ± 2.33	32.36 ± 2.12	NA
Jin et al. [17]	2020	Prospective cohort study	Subinguinal	6 months	67	114	181	27.30 ± 3.69	27.75 ± 4.74	I–III
Liu et al. [18]	2019	RCT	Subinguinal	6 months	71	64	135	28.82 ± 3.68	27.95 ± 2.96	II–III
Peiting and Liqing [19]	2021	Retrospective cohort study	Subinguinal	12 months	38	46	84	28.65 ± 3.02	28.70 ± 2.98	II–III
Ramasamy and Schlegel [36]	2006	Retrospective cohort study	inguinal	24 months	55	110	165	NA		I–III
Xu [21]	2016	RCT	Subinguinal	12 months	50	50	100	26.06 ± 2.53	26.40 ± 2.90	II–III
Li et al. [33]	2017	RCT	Subinguinal	3 months	54	73	127	23.6	24.8	II–III
Hou et al. [30]	2015	RCT	Subinguinal	12 months	50	50	100	27.94 ± 3.46	28.32 ± 3.89	I–III
Yang et al. [37]	2018	Retrospective cohort study	Subinguinal	6 months	40	123	163	24.7 ± 5.9	27.6 ± 8.2	I–III

Note: RCT, randomized controlled trial; NA, not available; TD, testicular delivery. [a]Median (interquartile range).

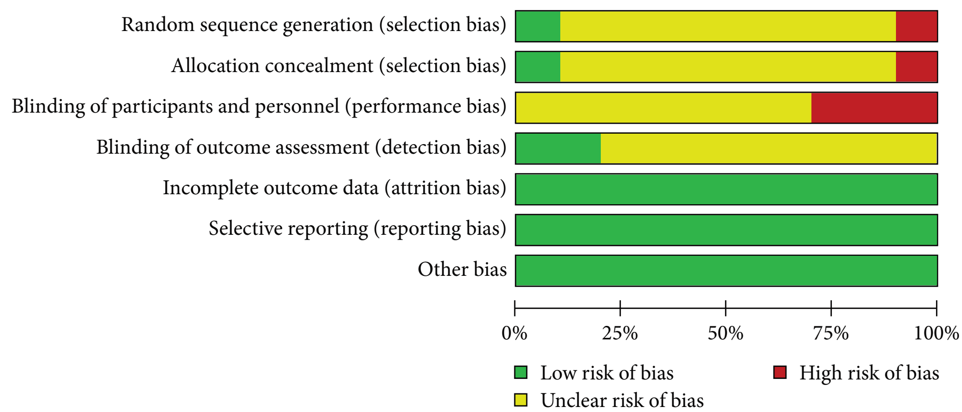


Figure 2: The risk of bias assessment for RCTs by Cochrane Risk of Bias Tool.

receive TD (sperm viability: SMD = 0.44, 95% CI = −0.03 to 0.91, $p = 0.068$; total sperm count: SMD = 0.38, 95% CI = −0.41 to 1.17, $p = 0.352$) (Table 2). Similar outcomes were observed for improving sperm concentration at the short-term follow-up of 3 and 6 months (3 months: SMD = −0.15, 95% CI = −0.71 to 0.42, $p = 0.607$; 6 months: SMD = 0.05, 95% CI = −0.39 to 0.49, $p = 0.828$) and at the 1-year long-term follow-up (SMD = −0.08, 95% CI = −0.34 to 0.19, $p = 0.585$) (Table 2). We measured progressive sperm motility at 3-month, 6-month, and 1-year follow-up with similar findings ($p > 0.05$ and Table 2). There was no obvious advantage in decreasing abnormal sperm with microsurgical varicocelectomy in combination with TD (SMD = 0.26, 95% CI = −0.10 to 0.62, $p = 0.150$).

3.3.4. Natural Pregnancy and Improvement of Serum Testosterone. When natural pregnancy was taken into account, the pooled RR indicated that there was no advantage for patients with TD (RR = 0.89, 95% CI = 0.71–1.11, $p = 0.311$) (Table 3). We also failed to find a difference between receiving TD and not improving testosterone levels (SMD = −0.09, 95% CI = −0.76 to 0.59, $p = 0.798$) (Table 2).

3.3.5. Subgroup Analysis in Grade II–III Varicocele. To further estimate the impact of varicocele severity upon postoperative semen quality, we performed this subgroup analysis based on data from participants diagnosed with grade II or III varicocele. TD during varicocelectomy failed to significantly improve sperm concentration, sperm viability, total sperm count, and progressive sperm motility compared to that without TD ($p > 0.05$ and Table 2). Overall, the presence of TD had no significant effect on semen parameters in patients with varicocele of grade II or III.

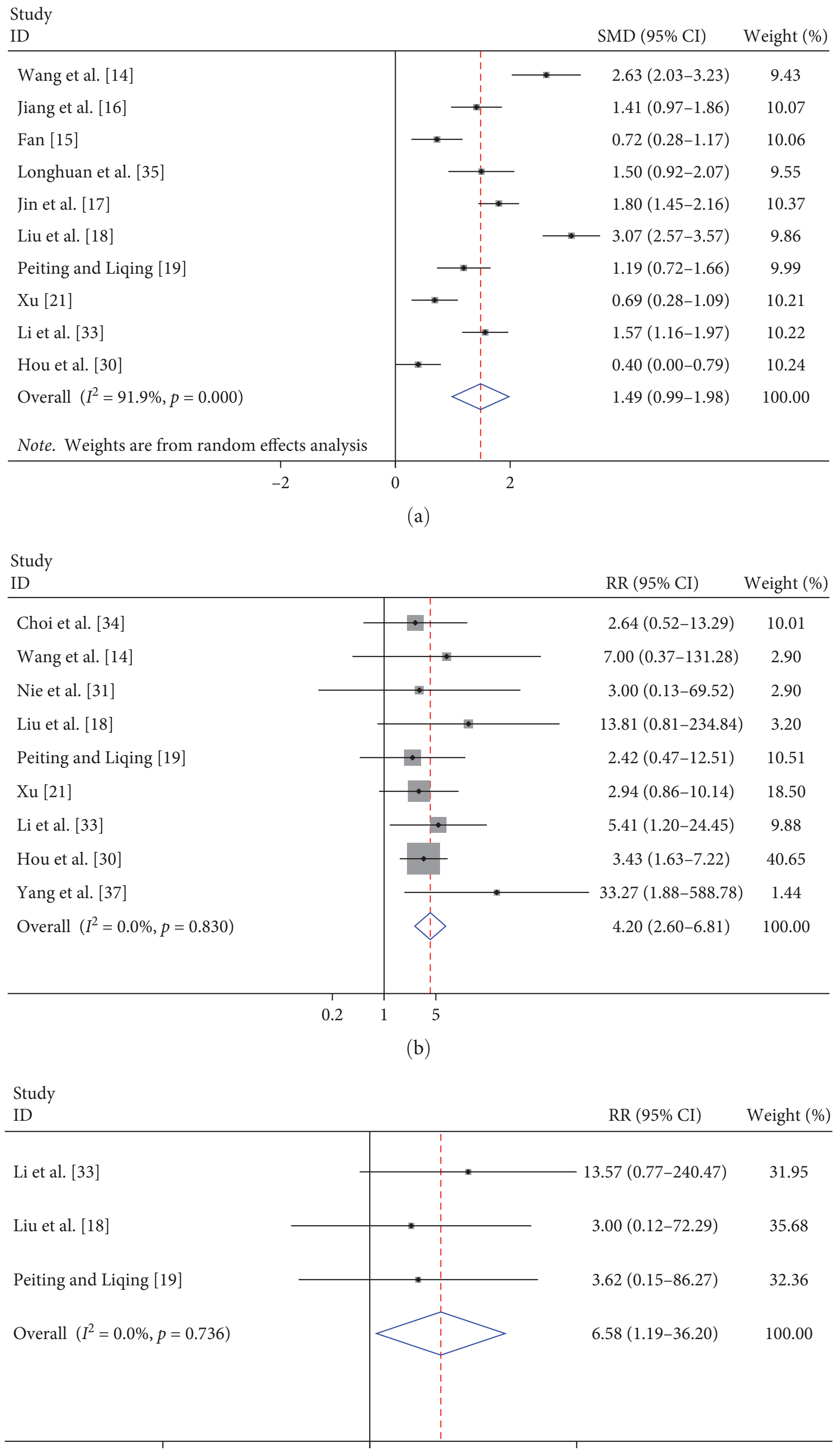
3.3.6. Publication Bias and Sensitivity Analyses. We adopted sensitivity analyses to evaluate the effect of the data from every single study on the pooled outcomes, thereby verifying the robustness and reliability of the conclusions. The influence of every single study on the overall outcomes was estimated by deleting one enrolled literature at a time. As shown in Figure 4, the pooled results of this research were stable with no individual study altering these combined SMDs or RRs. We used Begger's and Egger's tests to assess publication bias in our study and failed to detect publication bias, indicating that the combined results were reliable ($p > 0.05$, Figure 5 and Tables 2 and 3).

4. Discussion

Varicocele is a common male condition that not only causes uncomfortable symptoms such as scrotal cramping or pulling pain, but also predisposes to infertility. Microsurgical varicocelectomy is the gold standard for the treatment of varicocele [38, 39]. Despite the clear advantages of microsurgical varicocelectomy over the conventional surgical approach, recurrence and various complications of varicocele could still occur and the major cause of recurrence remains controversial. Although incompletely ligated branches of the internal spermatic vein can contribute to the recurrence of varicocele, dilated external spermatic veins, and gubernaculum veins may also contribute to the development of recurrence [40]. Some investigators have found that dilated testicular gubernacular veins were present in some people with recurrent varicocele [41]. This clinical finding set the stage for delivery of the testis and ligation of the gubernacular veins during microsurgical varicocelectomy. Therefore, TD and ligation of the gubernacular veins may significantly reduce the recurrence of varicocele [10].

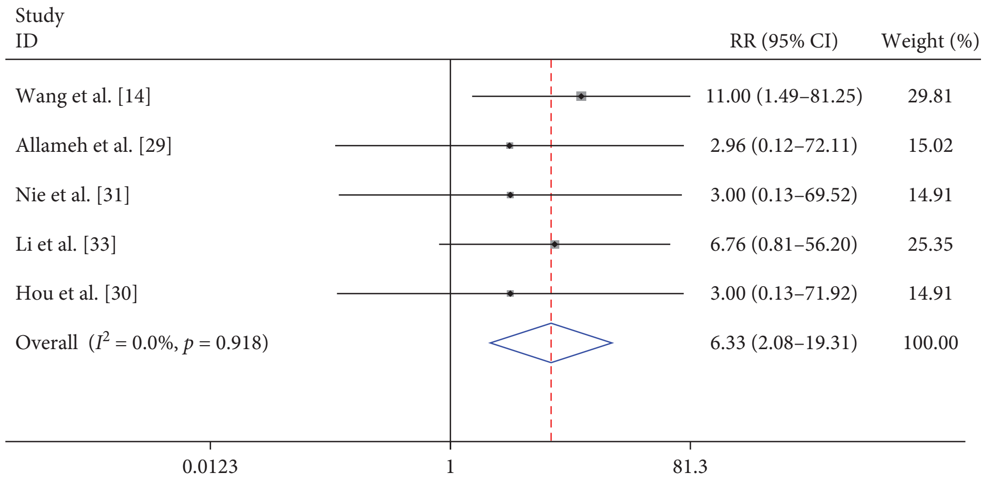
Our research is an updated meta-analysis of clinical outcomes and safety of microsurgical varicocelectomy with TD for varicocele based on the latest available evidence, including 10 RCTs and 7 cohort studies. Compared to varicocelectomy without TD, complications such as scrotal edema, testicular hydrocele, and orchiepididymitis were more frequent after varicocelectomy with TD, and in terms of serum testosterone levels, semen parameters, varicocele recurrence, and natural pregnancy rates, we found no significant differences between them.

However, an earlier meta-analysis based on a limited number of studies suggested that TD could reduce varicocele recurrence [12], which arouse controversy about the effects of TD on recurrence. In our updated meta-analysis, pooled results of 17 articles indicated that TD in microsurgical varicocelectomy is not effective in decreasing the recurrence of varicocele. The updated meta-analysis enrolled more high-



(c)

FIGURE 3: Continued.



(d)

FIGURE 3: (a) Forest plot of comparison of duration of surgery; (b) forest plot of comparison of scrotal edema; (c) forest plot of comparison of testicular hydrocele; and (d) forest plot of comparison of orchiepididymitis.

quality RCTs than the earlier meta-analysis, which might be used to explain the different results of recurrence between the two meta-analyses.

A variety of complications can occur after microsurgical varicocelectomy, of which scrotal edema is the most frequent, and the cause is mainly related to extravasation of lymphatic fluid due to intraoperative lymphatic vessel injury. If the extravasated lymphatic fluid is not absorbed, it may lead to testicular hydrocele [42]. The combination of microsurgical varicocelectomy with TD may be more likely to damage the lymphatic vessels, resulting in a higher incidence of scrotal edema and testicular hydrocele. Previous studies have not focused on the impact of microsurgical varicocelectomy on testicular hydrocele [12, 13]. In addition, testicular epididymitis is also more likely to develop after delivery of the testis, which may increase the patient's pain. Therefore, microsurgical varicocelectomy without TD is a more minimally invasive and safer surgical approach.

The ability to effectively improve pivotal semen parameters is an important indicator of the efficacy of varicocelectomy. Analysis of the results of semen parameters after microsurgical varicocelectomy suggested that patients in the TD group did not show significant improvement in pivotal sperm parameters compared with those without TD. In addition, a subgroup analysis based on patients with more severe varicocele yielded similar results. Contrary to the recent research [13], our findings indicate that microsurgical varicocelectomy with TD did not yield significant improvements in sperm concentration during both short-term and long-term follow-up periods. Furthermore, there was no observed increase in total sperm count. TD in microsurgical varicocelectomy failed to significantly elevate serum testosterone levels in our present study, while the earlier meta-analysis identified lower serum testosterone levels after TD [12]. In addition, this additional operation of TD in microsurgical varicocelectomy contributed to a longer operative time compared to varicocelectomy without TD in our present study, whereas the earlier meta-analysis found no significant difference in operation time [12]. The previous meta-analysis enrolled a small number of studies for these two outcomes and our meta-analysis contained a larger number of eligible studies, which might be used to explain the differences between the two meta-analyses regarding serum testosterone and operative time.

In comparison to analogous meta-analyses conducted by Liao et al. [12] and Song et al. [13], the present study encompassed 17 articles focusing on varicocele patients, which consisted of 10 RCTs. Consequently, the present study provides detailed and comprehensive information along with extensive recommendations, as shown in Table 4. The present study did not indicate any publication bias and additionally conducted subgroup analyses considering follow-up duration and varicocele grades. The present study highlights the association of TD with numerous complications and its ineffectiveness in improving semen parameters or reducing varicocele recurrence. It is important to note the limited number of studies included in the earlier analysis [12], which suggested that TD could not reduce varicocele recurrence and prolong the operation time. In addition, Song et al. [13] emphasized the necessity for additional high-quality studies in this field. In summary, the conclusions drawn from the statistical analysis in this article are considered more reliable, the data are comprehensive, and they hold greater value for clinicians in their daily practice.

There are some advantages in this meta-analysis. First, we designed an extensive literature search process and selected a larger sample size of high-quality studies than previous meta-analyses. Second, we obtained more results by detailed stratification analyses. Third, we included up to 10 high-quality RCTs, which provided strong evidence support for the final outcomes. Although this study provided more solid and convincing conclusions, there were some limitations. Heterogeneity was observed in some results despite following strict inclusion and exclusion criteria.

Table 2: Meta-analysis results of operative time, hospital stay, serum testosterone, semen parameters, complications, varicocele recurrence, natural pregnancy, and subgroup analysis in grade II–III varicocele.

Outcomes	Heterogeneity		Effect model	SMD (95% CI)	p	Begger's test P
	I^2 (%)	$p_{\text{Heterogeneity}}$				
Duration of surgery (min)	91.9	0.000	Random model	1.49 (0.99–1.98)	0.000	0.283
Hospital stay (day)	93.5	0.000	Random model	0.38 (−0.26 to 1.01)	0.244	1.000
Improvement of serum testosterone (ng/dl)	94.4	0.000	Random model	−0.09 (−0.76 to 0.59)	0.798	0.806
Decrease of abnormal sperm (%)	0.0	0.843	Fixed model	0.26 (−0.10 to 0.62)	0.150	1.000
Improvement of sperm viability (%)	91.0	0.000	Random model	0.44 (−0.03 to 0.91)	0.068	1.000
Improvement of total sperm count (10^6 per ejaculation)	91.0	0.000	Random model	0.38 (−0.41 to 1.17)	0.352	0.296
Improvement of sperm concentration (10^6/ml)						
3-months follow-up	85.6	0.001	Random model	−0.15 (−0.71 to 0.42)	0.607	0.669
6-months follow-up	89.8	0.000	Random model	0.05 (−0.39 to 0.49)	0.828	0.669
1-year follow-up	43.4	0.151	Fixed model	−0.08 (−0.34 to 0.19)	0.585	0.669
Improvement of progressive sperm motility (%)						
3-months follow-up	98.5	0.000	Random model	−0.63 (−2.55 to 1.28)	0.518	0.855
6-months follow-up	99.1	0.000	Random model	0.72 (−0.99 to 2.43)	0.409	0.855
1-year follow-up	0.0	0.590	Fixed model	−0.03 (−0.23 to 0.17)	0.755	0.855
Subgroup analysis in grade II–III varicocele						
Improvement of sperm viability (%)	92.0	0.000	Random model	0.24 (−0.32 to 0.80)	0.407	0.941
Improvement of sperm concentration (10^6/ml)	89.0	0.000	Random model	0.02 (−0.35 to 0.39)	0.923	0.941
Improvement of progressive sperm motility (%)	98.9	0.000	Random model	0.19 (−1.15 to 1.53)	0.782	0.941
Improvement of total sperm count (10^6 per ejaculation)	91.2	0.001	Random model	0.12 (−0.83 to 1.06)	0.811	0.941

Note: CI, confidence interval; SMD, standardized mean difference.

Table 3: Meta-analysis results of varicocele recurrence, complications, and natural pregnancy.

Outcomes	Heterogeneity I^2 (%)	Heterogeneity $p_{\text{Heterogeneity}}$	Effect model	RR (95% CI)	p	Begger's test P
Varicocele recurrence	52.0	0.080	Random model	0.59 (0.15–2.29)	0.443	1.000
Orchiepididymitis	0.0	0.918	Fixed model	6.33 (2.08–19.31)	0.001	0.221
Scrotal edema	0.0	0.830	Fixed model	4.20 (2.60–6.81)	0.001	0.076
Testicular hydrocele	0.0	0.706	Fixed model	6.58 (1.19–36.20)	0.030	0.296
Wound infection	0.0	0.698	Fixed model	0.89 (0.31–2.55)	0.834	1.000
Natural pregnancy	0.0	0.844	Fixed model	0.89 (0.71–1.11)	0.311	0.462

Note: CI, confidence interval; RR, relative risk.

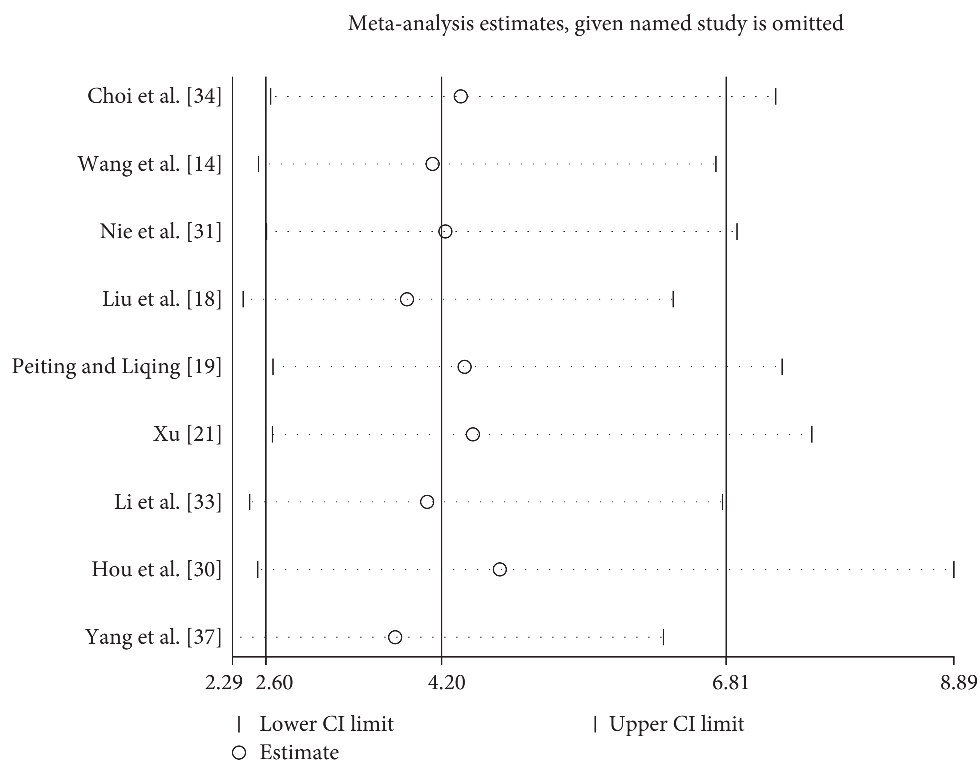


Figure 4: Sensitivity analysis (scrotal edema).

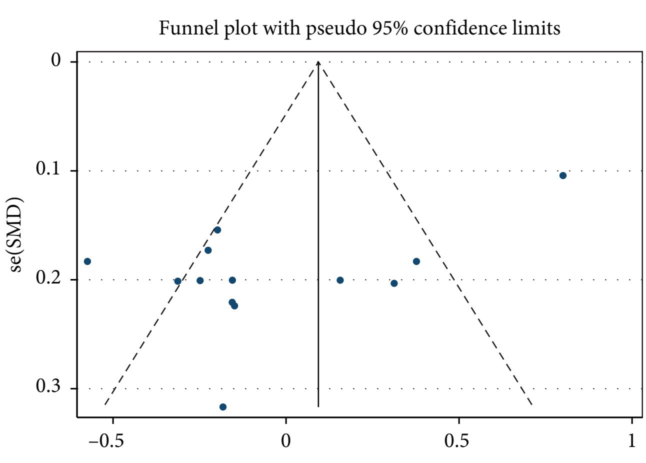


Figure 5: Funnel plot to detect publication bias (sperm concentration).

Table 4: Comparison with other similar meta-analyses.

Items	Liao et al. [12]	Song et al. [13]	Current study
Publication year	2019	2019	2023
Included studies	4 RCTs and 3 cohort studies	5 RCTs and 3 cohort studies	10 RCTs and 7 cohort studies
Included the number of patients	993	1,139	2,254
Surgical approach	Subinguinal	Subinguinal/inguinal	Subinguinal/inguinal
Whether included preoperative semen parameters and testosterone levels	Yes	No	No
Whether included subgroup analysis	No	Yes	Yes
Whether included data for different follow-up times	No	Yes	Yes
Kinds of postoperative complications	Unknown	4	5
Kinds of semen parameters	3	5	5
Whether there was grade evaluation on evidence	Yes	Yes	Yes
Whether there were publication biases	No	No	No
Whether there was inconsistency among analyses	Yes	Little, but acceptable	No
Evidence quality	Low	Low to moderate	Moderate to high

Note: RCT, randomized controlled trial.

The enrolled retrospective cohort studies may have the risk of bias, reducing the credibility of our study.

5. Conclusion

TD during microsurgical varicocelectomy may lead to more postoperative complications and may not be beneficial for semen parameters, recurrence of varicocele, and natural pregnancy.

Data Availability

Data available on request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Yulong Wang and Yuxuan Song contributed equally to this work.

Acknowledgments

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Supplementary Materials

Table S1: PubMed/Medline Search strategy. Table S2: Web of Science Search strategy. Table S3: Embase Search strategy. Table S4: Cochrane Library Search strategy. Table S5: China National Knowledge Infrastructure Search strategy. (*Supplementary Materials*)

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