Laparoscopic versus Conventional Open Peritoneal Dialysis Catheter Insertion in China: A Meta-Analysis

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ABSTRACT

Purpose: To compare the risk of complications between laparoscopic peritoneal dialysis (PD) catheter placement and open PD catheter placement.
Methods: We searched numerous databases, including SinoMed, CNKI, cqVIP, WanFang, Pubmed, Web of Science, OVID, Cochrane and Scopus, for published randomized controlled trials (RCTs) and non-randomized controlled trials (non-RCTs) .
Results: Ten studies were included(n=1341). The overall statistical results showed that patients receiving laparoscopic insertion of the PD catheter had a lower risk of catheter migration, inadequate drainage and blockage. The risk of leakage was higher in the laparoscopic group in studies performed prior to 2015; in studies performed after 2015, the risk of leakage was lower than in the conventional open-placement group. For the risk of developing pain, the risk was lower in the subgroup of laparoscopic patients starting PD within 1 day after catheter insertion; however, there was no significant difference between the subgroups starting PD 1 week or 2 weeks after catheter insertion. The risk outcome for abdominal bleeding was similar to that for pain, with a lower risk in the subgroup of laparoscopic patients starting PD within 1 day. The overall research quality was moderate.
Conclusion: Laparoscopic placement of the PD catheter has unique advantages over conventional open surgical placement, especially in special conditions such as emergency initiation. In addition, we found that some factors that were previously considered irrelevant may have an impact on the results for Asians. However, this conclusion still needs to be substantiated by further large samples in multicenter, high quality Randomized Controlled Trials (RCTs).

INTRODUCTION

In recent years, with the increase in hypertension, type 2 diabetes and an ageing population, the number of people with end-stage renal disease (ESRD) is increasing worldwide(1). Renal replacement therapy, which is still the main treatment for ESRD patients, involves renal transplantation, hemodialysis and peritoneal dialysis (PD). Due to the shortage of kidney transplant donors, hemodialysis and PD are currently the main treatment options. Compared to hemodialysis, PD offers lower treatment costs, easier access to treatment sites and less dietary control(2). However, the way in which PD catheters are inserted remains controversial. To determine the optimal approach for inserting the PD catheter, there have been several published meta-analyzes that have compared the open-surgery and laparoscopic methods in terms of the risk of complications(3-7). However, the results of these studies seem to be slightly different from our clinical experience in some aspects. We believe that regional differences are one of the reasons for this situation. Therefore, we try to focus on a smaller scope, so as to reduce this bias, and further obtain more targeted and definite results. To provide more targeted basis for Asian doctors to choose PD placement method.

In this meta-analysis, we systematically reviewed and analyzed previous randomized controlled trials (RCTs) and non-randomized controlled trials (non-RCTs) that studied Chinese PD patients to compare complications of laparoscopic and conventional open PD placement.

METHODS

Protocol registration

We registered the protocol for this meta-analysis with PROSPERO (CRD42022296373).

Search strategy

We conducted a comprehensive search by searching the SinoMed, CNKI, cqVIP, WanFang, Pubmed, Web of Science, OVID , Cochrane databases and Scopus and obtained 4940 results. We searched all the literatures until November 1, 2021.We did not set any language restrictions and used the following MeSH terms: "Laparoscopes", "Peritoneal Dialysis", "Catheters, Indwelling" and their corresponding free words. We considered all potentially eligible studies for review, regardless of primary outcome or language. In addition, we also manually searched citations of key articles to obtain two relevant results.

Selection criteria

We conducted the screening and selected controlled studies that met the criteria. We set the selection criteria for the meta-analysis in accordance with the PICOS criteria(8). The specific criteria were: 1) population: Chinese patients with an ESRD requiring dialysis treatment; 2) intervention: laparoscopic PD catheter placement; 3) comparison: conventional open PD catheter placement; 4) outcome: complications; 5) study design: clinical experimental studies including RCTs and non-RCTs. We excluded all studies that did not meet these requirements, including studies in which the subjects were designated as children and elderly, those in which the procedure involved an emergency start or a specific procedure, those involving the same sample, and those that did not meet the PICOS criteria described above. Any disagreements that arose were communicated and resolved by a third investigator.

The following data was extracted from each of the selected studies: total number of patients and groups, study approach, interventions, number of postoperative complications (including catheter shift, leak, peritonitis, exit-and-tunnel infections, inadequate catheter drainage, blockage, abdominal bleeding, pain, hernia).

Study risk of bias assessment:

All selected studies were assessed for risk of bias by two independent researchers. RCTs were assessed according to the Revised Cochrane risk-of-bias tool(9) for randomized trials, and non-RCTs were assessed according to the MINORS(10). Disagreements between the two investigators were resolved by a third investigator after discussion.

Resume the statistical analysis:
We evaluated the outcomes of laparoscopic and conventional open surgery in PD placement by 9 outcome indicators: catheter shift, peritubular leakage, peritonitis, exit-site and tunnel infection, inadequate catheter drainage, blockage, abdominal bleeding, pain and hernia. And these indicators were used as dichotomous variables to calculate the relative risk (*RR*).
In this meta-analysis, we used RevMan 5.4.1 software (Revman International, Inc., New York, NY, provided by The Cochrane Collaboration) and Stata 17 (StataCorp LLC, Inc., Texas, provided by StataCorp LLC) for data analysis. We considered $P < 0.05$ to be statistically significant. For dichotomous variable data, we used the Mantel-Haenszel method[11]. We defined the criteria for heterogeneity (I^2) as follows: $I^2 \leq 25$ was considered ground heterogeneity; $25 < I^2 \leq 50$ was considered medium heterogeneity; $50 < I^2 \leq 75$ was considered high heterogeneity; and I^2>75 was considered to be a large difference between studies. For studies with low and medium heterogeneity, we adopted a fixed effects model, while for studies with higher heterogeneity, we used a random effects model and use meta-regression model to detect the source of heterogeneity.
We explored the extent to which the studies influenced the combined effect size and the robustness of the results by excluding one study at a time, recalculating the combined effect size and comparing it with the results of the meta-analysis before the exclusion. If the results did not change significantly after the exclusion, the sensitivity was considered to be low and the results were regarded as more robust and credible. Conversely, if the exclusion yielded widely different or even diametrically opposed conclusions, we considered this to indicate higher sensitivity and less robust results; therefore, great care was taken when interpreting the results and drawing conclusions. In this case, the results suggested the presence of important and potentially biasing factors related to the effect of the intervention, which required further clarification of the source of these factors and adjustment of possible influencing factors in subgroup analysis.
We used GRADEpro 3.6 software (McMaster University and Evidence Prime Inc., Hamilton, Canada, provided by GRADEpro GDT) to assess the quality of the included studies.

RESULTS
Study selection
In the initial search, we obtained 4940 results. Of these, 4938 were from databases and 2 were from citation searches of key literature. In the first screening, we selected 18 articles that might meet the requirements of this study by reading the title, authors and abstract. Of these 18 articles, we excluded 8 by carefully reading the full text. Ultimately, ten studies[12-21] with a total sample size of 1341 were included in this meta-analysis. Four RCTs[12-15] and six non-RCTs[16-21] were included. The characteristics of these studies (country, design, sample size, age, follow-up and outcomes) are described in Table 1. The screening process is represented in the flow diagram shown in Figure 1.
Risk of bias in studies:
As shown in Figure 2, three RCTs had moderate quality, as well as a lower risk of bias, with the exception of one study which was of low quality and had a higher risk of bias, according to the Revised Cochrane risk-of-bias tool for randomized trials. The six additional non-RCTs were of moderate quality with an average score of 15 on the MINORS scale Table 2. We use the funnel plot to estimate whether there is bias in the included study, and use the Trim and filling method to determine whether the main source of bias is publication bias.
Sensitivity analysis:
In conducting the sensitivity analyzes, we made decisions to exclude or perform subgroup analyzes as appropriate by carefully reading and analyzing the highly heterogeneous literature, followed by discussion. This is described below.

Catheter shift

There were nine studies(13-21) that evaluated the occurrence of catheter dislocation in a total of 1251 patients. Of these, 512 patients underwent laparoscopy for PD catheter placement, compared to 739 patients undergoing conventional open surgery. After statistical analysis, heterogeneity was very low (I^2 = 0%), so we used a fixed effects model. The results of the statistical analysis showed that patients who underwent laparoscopy for PD placement had a significantly lower risk of catheter migration ($P <$ .00001, RR = 0.15, 95% confidence interval [CI]: 0.07 to 0.29). This is shown in Figure 3 I.

Leak

All ten studies(12-21) evaluated the occurrence of leakage in a total of 1341 patients. Of these, 559 patients underwent laparoscopy with PD catheter placement, while 782 patients underwent conventional open surgery. After statistical analysis, the heterogeneity was high (I^2 = 56%), so we used a random effects model. The results of the overall statistical analysis showed that patients who underwent laparoscopic PD placement had a higher risk of postoperative leakage than those who underwent conventional open surgery, but the results were not statistically significant (P = 0.80, RR = 1.11, 95% CI: 0.50 to 2.48; Figure 3 II).

We found that publication time is the main source of heterogeneity, after careful reading of the full text and discussion, we divided the ten studies with leakage in the outcomes into two subgroups by study date (post-2015(12,13,17,18) and pre-2015(14-16,19-21)) for statistical analysis, as shown in Figure 3 III. Both subgroups had low heterogeneity of studies within the group (study date after 2015, I^2 = 0%; study date before 2015, I^2 = 0%). The statistical results showed that in the post-2015 subgroup, patients who underwent laparoscopic PD placement had a significantly lower risk of postoperative leakage than controls who underwent conventional open surgical placement (P = .007, RR = 0.23, 95% CI: 0.08 to 0.67). Conversely, in the pre-2015 subgroup, traditional open PD placement was associated with a lower risk of leakage than laparoscopic PD placement (P = .0003, RR = 2.44, 95% CI: 1.50 to 3.99). In addition, there was significant heterogeneity between the two subgroups in the statistical analysis of this outcome (I^2 = 93.6%), which was highly suggestive that the date of the study was an important factor in the outcome.

Peritonitis

Ten studies(12-21) looked at the progression of peritonitis in 1341 patients. A total of 559 patients underwent laparoscopy for PD catheter insertion, compared to 782 patients who had open-surgery PD placement. We selected a fixed effects model because the heterogeneity was moderate (I^2 = 50%) after statistical analysis. The statistical analysis revealed a trend toward decreased incidence of postoperative peritonitis after laparoscopic PD installation compared to open-surgery placement, although the difference was not statistically significant (P =0.52, RR = 0.92, 95% CI: 0.73 to 1.18; Figure 3 IV).

Exit-site and tunnel infection

In a total of 611 patients, seven investigations(12-14,17-19,21) looked at the occurrence of exit-site and tunnel infection. In these studies, 279 patients had laparoscopic PD catheterization versus 332 patients with conventional open-surgery insertion. Heterogeneity was low (I^2 = 0%) after statistical analysis, hence a fixed effects model was chosen. The statistical analysis revealed that laparoscopic PD placement had a lower incidence of exit-site and tunnel infection compared to traditional open placement, although the difference was not statistically significant (P =0.31, RR = 0.72, 95% CI: 0.38 to 1.37; Figure 3 V).

Inadequate catheter drainage

A total of 580 patients were studied in five investigations(13,14,18-20) to see if they had inadequate catheter drainage. Of these patients, 240 of them received laparoscopic PD catheter placement versus 340 patients who underwent traditional open-surgery insertion. Heterogeneity was low (I^2 = 0%) after statistical analysis, hence a fixed effects model was adopted. Patients who underwent laparoscopic PD installation had a significantly decreased risk of inadequate catheter drainage (*P* = .0010, *RR* = 0.33, 95% CI: 0.17 to 0.64), according to the statistical analysis (Figure 3 VI).

Blockage

Three studies[13,14,17] including a total of 213 patients looked at the incidence of blockage. A total of 105 patients had laparoscopic PD catheter implantation compared to 108 patients who underwent open surgery. We selected a fixed effects model since the heterogeneity was modest (I^2 = 0%) after statistical analysis. Patients who underwent laparoscopic PD catheter implantation had a considerably decreased risk of catheter occlusion (*P* =0.05, *RR* = 0.31, 95% CI: 0.10 to 0.98), according to the statistical analysis shown in Figure 4 I.

Abdominal hemorrhage

Four studies[17-20] evaluated the occurrence of abdominal bleeding in a total of 493 patients. Of these, laparoscopic PD catheter placements were performed in 195 cases, while 298 cases underwent conventional open surgery. After statistical analysis, heterogeneity was moderate (I^2 = 42%), so we used a fixed effects model. The results of the statistical analysis showed a trend toward a lower incidence of abdominal hemorrhage with laparoscopic PD placement compared to conventional open-surgery placement, but the difference was not statistically significant (*P* =0.07, *RR* = 0.61, 95% CI: 0.36 to 1.03), as shown in Figure 4 II.

We performed a subgroup analysis based on the time of PD initiation after catheter placement. As Hong et al. 2019[17] did not record the start time, it was excluded from the subgroup analysis. We divided the remaining three studies into groups '1 day' (1 study[18]) and '2 weeks' (2 studies[19,20]) according to the PD start delay. Heterogeneity in the subgroups was low (group '1 day', I^2 = /; group '2 weeks', I^2 = 0%). In the subgroup starting PD on the same day, the risk of abdominal hemorrhage was lower in the laparoscopic group (*P* = .008, *RR* = 0.24, 95% CI: 0.08 to 0.69); in the subgroup starting 2 weeks after conventional surgery, there was little difference in the risk of abdominal hemorrhage between the laparoscopic and open-surgery groups (Figure 4 III).

Pain

A total of 799 patients were studied in four investigations[14,16,20,21] to see if they experienced pain. Of these, 290 patients had laparoscopic PD catheter placement, whereas 509 had traditional open-surgery placement. We selected a random effects model because the heterogeneity was high (I^2 = 57%) after statistical analysis. The statistical analysis revealed a trend toward decreased pain occurrence with laparoscopic PD installation compared to open surgical placement, but the difference was not statistically significant (*P* =0.06, *RR* = 0.44, 95% CI: 0.18 to 1.05, Figure 4 IV).

Following sensitivity analyzes, we determined that differences in the time to begin PD after surgery were the most likely source of heterogeneity, so we decided to divide the four studies into three groups reflecting this statistic based on the delay before beginning PD: 2 weeks (2 studies[14,20]), 1 week (1 study[21]) and 1 day (1 study[16]). For these subgroups, the heterogeneity of studies was modest (group '2 weeks', I^2 = 37%; group '1 week', I^2 = /; group '1 day', I^2 = /). Statistical results showed the risk of pain was significantly lower in the laparoscopic group than in the conventional open-surgery group in group '1 day' (*P* = .007, *RR* = 0.06, 95% CI: 0.01 to 0.47), while the laparoscopic group showed a lower tendency to develop pain at a start time of 1 week postoperatively, but the results were not statistically significant (*P* =0.08 *RR* = 0.60, 95% CI: 0.34 to 1.06). In the PD subgroup starting 2 weeks postoperatively, the difference between the laparoscopic and open-surgery groups was minimal (*P* = 0.48, *RR* = 0.61, 95% CI: 0.16 to 2.38; Figure 4 V).

Hernias

A total of 364 patients were studied in four studies[14,15,17,21] to determine if they developed hernias. In 156 of these cases, laparoscopic PD catheter implantation was performed, whereas

208 of the cases required open-surgery placement. We selected a fixed effects model since the heterogeneity was considerable ($I^2 = 40\%$) after statistical analysis. The statistical analysis revealed a tendency toward decreased incidence of hernias with laparoscopic PD implantation compared to open surgical installation, but the difference was not statistically significant (P =0.69, RR = 0.81, 95% CI: 0.30 to 2.22); Figure 4 VI).

Publication bias

After evaluation, we found that there was a large bias in the analysis involving leak, peritonitis, exit-site and tunnel infection and hernias. We used the Trim and filling method to evaluate the source of bias, and finally ruled out the possibility that the bias mainly came from publication bias.

Certainty of evidence

All of the statistical evidence was graded moderate or lower, and most of the reasons for downgrading the evidence were the risk of bias, as summarized below in Figure 5.

DISCUSSION

In our statistics, patients who underwent laparoscopic PD placement had a significantly lower risk of catheter migration, poor drainage, blockage and pain compared to those who underwent conventional open surgery. Most other indicators showed a trend toward a lower risk of complications in patients undergoing laparoscopy, although the results were not statistically significant. Surprisingly, patients who underwent laparoscopic PD placement showed a trend toward a higher risk of catheter leakage in contrast to the other results in the overall statistics, but again the results were not statistically significant.

Catheter-related disfunction is a common cause of PD failure. The correct positioning of the catheter is one of the keys to effective PD — the catheter needs to be inserted correctly and stably into either the rectal bladder trap (in male patients) or the rectal uterine trap (in female patients). However, over time, various factors may cause the tip of the catheter to migrate out of the pelvis, thus severely compromising the effectiveness of PD[2]. In the statistics of this study, we found that laparoscopy for PD placement significantly reduced the risk of catheter drift. This is most likely due to the advantages of laparoscopy in terms of visualization and operability, allowing operations such as fixation of the PD catheter to be performed under the scope. This is consistent with the results of previously published articles.

Leakage is likewise one of the complications that affects the outcome of PD[2]. We found that taking 2015 as the boundary, the trend of catheter leakage in the previous and subsequent research results showed an opposite result. We speculate that this may be due to the impact of some Asian studies published around 2015 on doctors' surgical decisions in Asia [22,23]. But this difference has been covered up in the global research. Unfortunately, due to the lack of details included in the experiment, we cannot determine the main reason for this difference.

Infection is one of the most important factors affecting the outcome of PD. In our results, the laparoscopic PD placement method does not offer much advantage over the conventional open procedure in terms of reducing the risk of infection. This is in line with the findings of Strippoli[24] and Hagen[23]. Of the ten studies included in this meta-analysis, three explicitly stated that cephalosporin antibiotics (or vancomycin if the patient had a cephalosporin allergy) were used to prevent infection before and after placement; the other seven studies did not state the antibiotic used. Such differences are likely to have biased the results..

In our statistics, we found that in studies with early postoperative initiation of PD, laparoscopy showed an advantage over conventional open surgery in terms of lower incidence of abdominal bleeding and pain; in studies with delayed initiation of PD, this advantage tended to be smaller with the conventional 2-week delayed initiation. The risk of peritoneal hemorrhage as well as pain was almost the same between the two groups in the study with delayed starts. The initiation of PD is generally at least two weeks after PD catheter placement[25]. Nowadays, PD has become one of the main choices for the treatment of acute kidney injury (AKI). Our results provide some basis for Asian doctors to choose PD catheterization for AKI patients who need early drainage.

There were some limitations to our study. As there were too few RCT studies, we also included non-RCTsHowever, patients with these non-RCTs are grouped voluntarily after doctors introduce the advantages and disadvantages of the two surgical methods. There are significant subjective factors, which greatly increases the possibility of confounding bias in the study. Also, these non-RCTs did not indicate whether adjustment was made for confounding factors during the analysis of results, which further increased the obstacles to obtaining accurate results in this study. In the study of small sample, there may be sparse-data bias due to too few complications. In the analysis of some data, due to the increase of heterogeneity, the random effect model is used, which further improves the proportion of small sample research in the meta-analysis, thus increasing the possibility of sparse-data bias[26]. As a result, some possible differences are covered up.

According to our quality of evidence evaluation, the majority of the statistical analyzes had a moderate level of evidence, with two additional studies showing a low level. The included studies also failed to record many details, such as the type of catheter and the BMI, which are likely to have impacted the meta-analysis results. In addition, recent studies have found that serum potassium can be an independent risk factor for catheter dysfunction[27], However, no studies have considered serum potassium as an influencing factor in their studies, which is also likely to create bias.

CONCLUSION

According to our analysis, Laparoscopic PD placement significantly reduces the risk of catheter displacement, leakage, insufficient catheter drainage, and blockage in Asian patients. In addition to these advantages, laparoscopic PD placement in patients upon emergency initiation of PD shows a reduction in abdominal bleeding and pain, but this advantage diminishes with the delay in PD initiation. Overall, the laparoscopic technique should be one of the recommended procedures for PD placement under current general conditions and offers significant advantages over the traditional open-surgery procedure, especially in specific conditions such as emergency initiation. Although our study still has limitations, it nonetheless provides a concrete answer to the current controversial surgical approach. However, more and larger RCTs are still needed to provide stronger evidence for surgical options.

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CONFLICT OF INTEREST

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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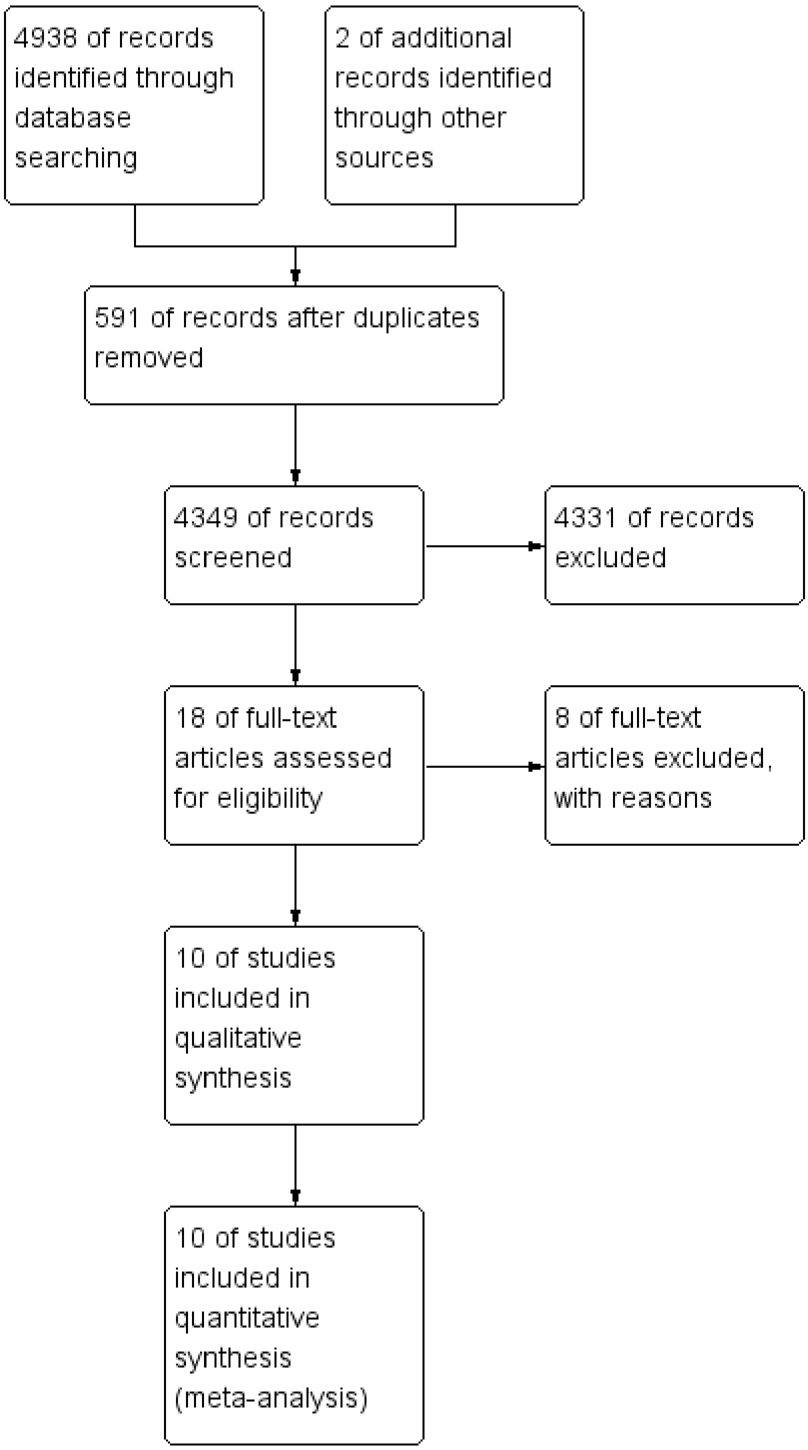
Figure legends:

Figure 1. Flow chart of the studies included in the meta-analysis.
Figure 2. Risk-of-bias summary graph for RCTs. The green symbol indicates a low level of bias, red represents a high level of bias, and yellow indicates that the risk of bias was unclear.
Figure 3.I) Forest plot of risk ratios for the incidence of catheter shift after laparoscopic and conventional PD catheter insertion. CI: confidence interval; II) Forest plot of risk ratios for the incidence of leaks after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; III) Forest plot of risk ratios for the incidence of leaks in the subgroups “Study Date ≥2015” and “Study Date <2015” after laparoscopic and conventional PD catheter insertion. CI: confidence interval; IV) Forest plot of risk ratios for the incidence of peritonitis after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; V) Forest plot of risk ratios for the incidence of exit-site and tunnel infection after laparoscopic and conventional PD catheter insertion. CI: confidence interval; VI) Forest plot of risk ratios for the incidence of inadequate catheter drainage after laparoscopic and conventional PD catheter insertion. CI: confidence interval.
Figure 4.I) Forest plot of risk ratios for the incidence of blockage after laparoscopic and conventional PD catheter insertion. CI: confidence interval; II) Forest plot of risk ratios for the incidence of abdominal hemorrhage after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; III) Forest plot of risk ratios for the incidence of abdominal hemorrhage in subgroups “2 weeks” and “1 day” after laparoscopic and conventional PD catheter insertion. CI: confidence interval; IV) Forest plot of risk ratios for the incidence of pain after laparoscopic and conventional PD catheter insertion. CI: confidence interval; V) Forest plot of risk ratios for the incidence of pain in the subgroups “2 weeks”, “1 week” and “1 day” after laparoscopic and conventional PD catheter insertion. CI: confidence interval; VI) Forest plot of risk ratios for the incidence of hernias after laparoscopic and conventional PD catheter

insertion. CI: confidence interval.
Figure 5. Question: Should laparoscopic or conventional open surgery be used for PD catheter placement?

Figure 1. Flow chart of the studies included in the meta-analysis.



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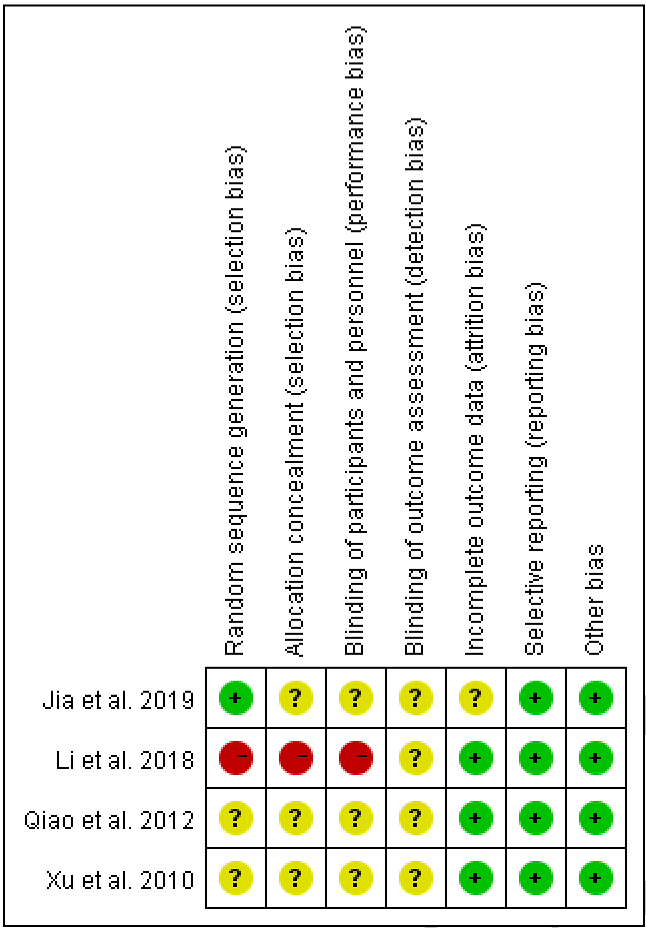
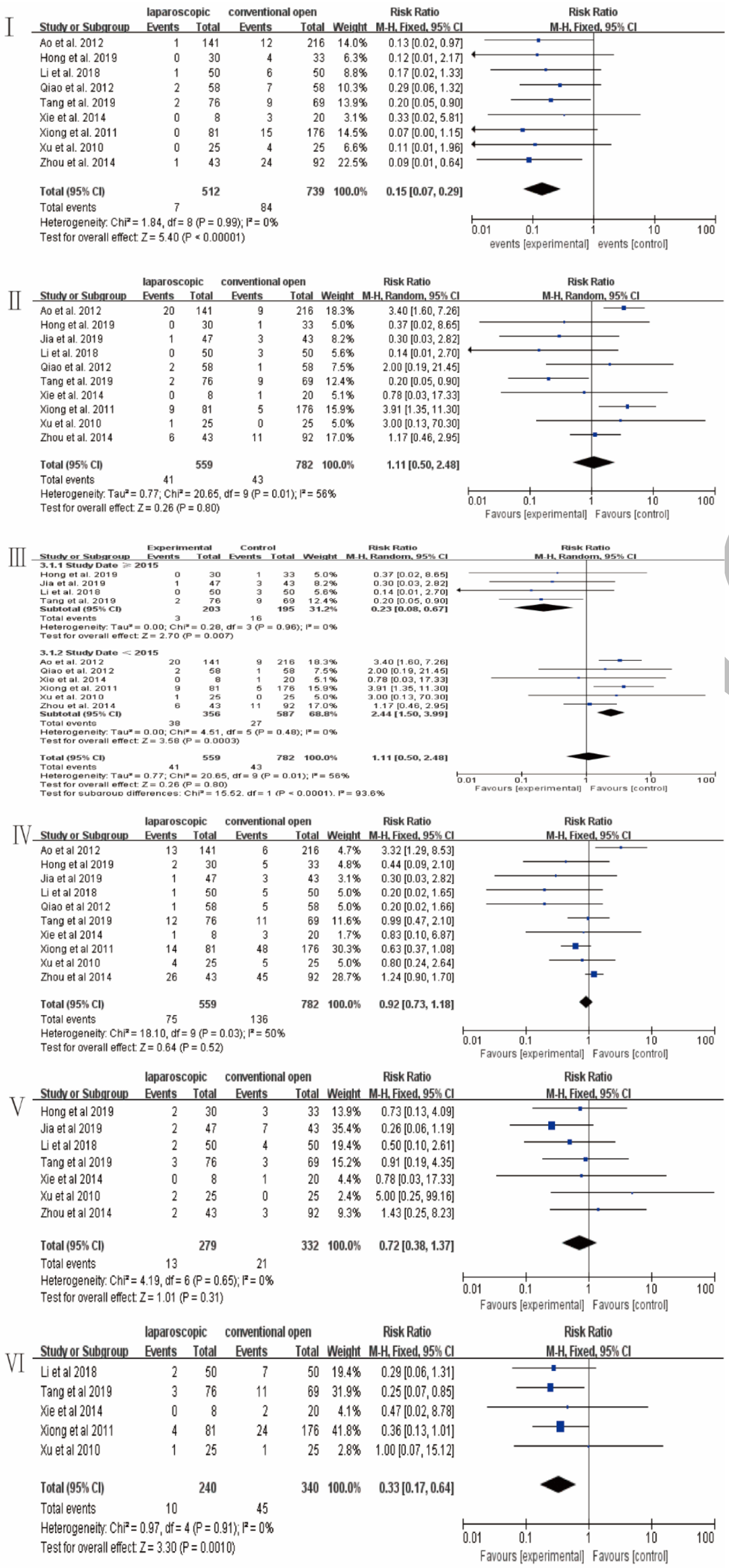


Figure 3. Ⅰ) Forest plot of risk ratios for the incidence of catheter shift after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅱ) Forest plot of risk ratios for the incidence of leaks after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; Ⅲ) Forest plot of risk ratios for the incidence of leaks in the subgroups "Study Date ≥2015" and "Study Date <2015" after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅳ) Forest plot of risk ratios for the incidence of peritonitis after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; Ⅴ) Forest plot of risk ratios for the incidence of exit-site and tunnel infection after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅵ) Forest plot of risk ratios for the incidence of inadequate catheter drainage after laparoscopic and conventional PD catheter insertion. CI: confidence interval.



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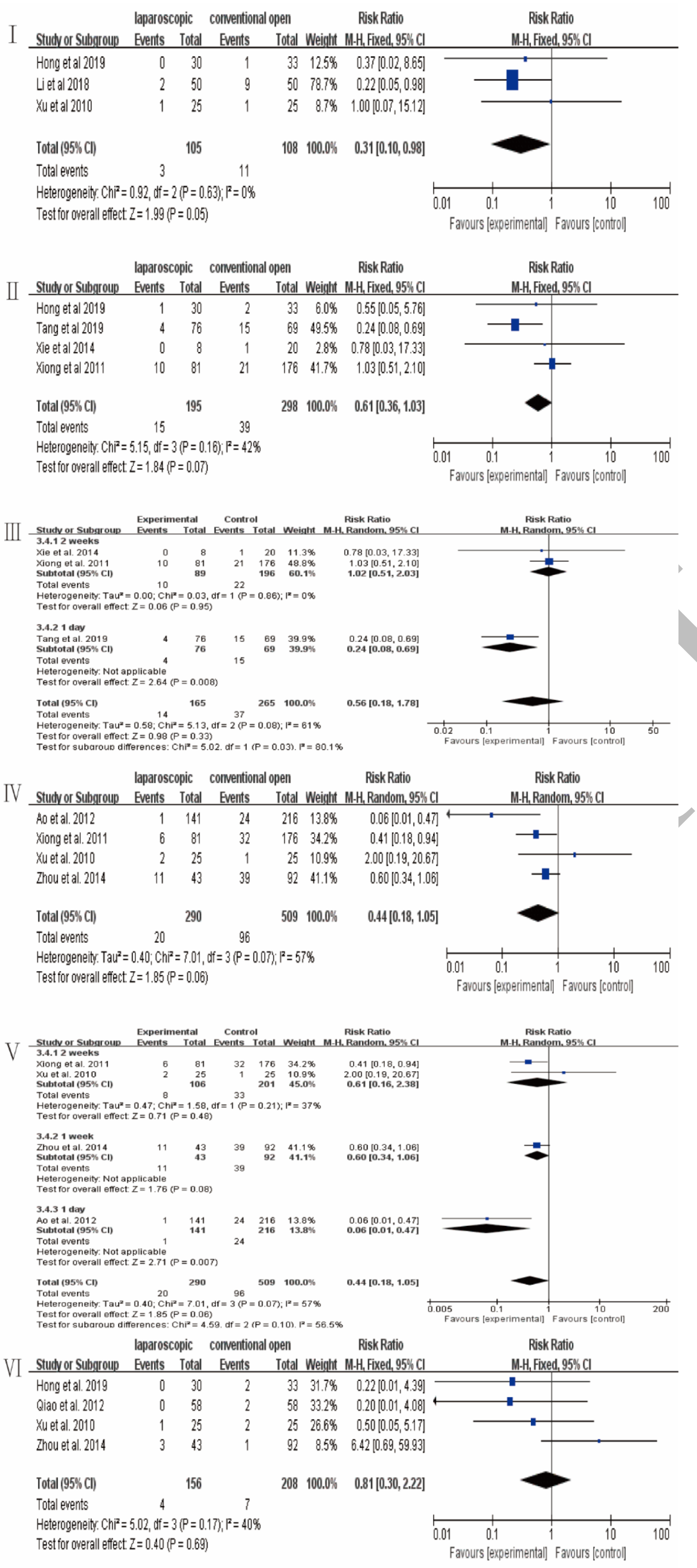
laparoscopic | conventional open | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Fixed, 95% CI | M-H, Fixed, 95% CI
Ao et al. 2012 | 1 | 141 | 12 | 216 | 14.0% | 0.13 [0.02, 0.97]
Hong et al. 2019 | 0 | 30 | 4 | 33 | 6.3% | 0.12 [0.01, 2.17]
Li et al. 2018 | 1 | 50 | 6 | 50 | 8.8% | 0.17 [0.02, 1.33]
Qiao et al. 2012 | 2 | 58 | 7 | 58 | 10.3% | 0.29 [0.06, 1.32]
Tang et al. 2019 | 2 | 76 | 9 | 69 | 13.9% | 0.20 [0.05, 0.90]
Xie et al. 2014 | 0 | 8 | 3 | 20 | 3.1% | 0.33 [0.02, 5.81]
Xiong et al. 2011 | 0 | 81 | 15 | 176 | 14.5% | 0.07 [0.00, 1.15]
Xu et al. 2010 | 0 | 25 | 4 | 25 | 6.6% | 0.11 [0.01, 1.96]
Zhou et al. 2014 | 1 | 43 | 24 | 92 | 22.5% | 0.09 [0.01, 0.64]
Total (95% CI) | 512 | 739 | 100.0% | 0.15 [0.07, 0.29]
Total events | 7 | 84
Heterogeneity: Chi² = 1.84, df = 8 (P = 0.99); I² = 0%
Test for overall effect: Z = 5.40 (P < 0.00001)
0.01 0.1 1 10 100
events [experimental] events [control]
II
laparoscopic | conventional open | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Random, 95% CI | M-H, Random, 95% CI
Ao et al. 2012 | 20 | 141 | 9 | 216 | 18.3% | 3.40 [1.60, 7.26]
Hong et al. 2019 | 0 | 30 | 1 | 33 | 5.0% | 0.37 [0.02, 8.65]
Jia et al. 2019 | 1 | 47 | 3 | 43 | 8.2% | 0.30 [0.03, 2.82]
Li et al. 2018 | 0 | 50 | 3 | 50 | 5.6% | 0.14 [0.01, 2.70]
Qiao et al. 2012 | 2 | 58 | 1 | 58 | 7.5% | 2.00 [0.19, 21.45]
Tang et al. 2019 | 2 | 76 | 9 | 69 | 12.4% | 0.20 [0.05, 0.90]
Xie et al. 2014 | 0 | 8 | 1 | 20 | 5.1% | 0.78 [0.03, 17.33]
Xiong et al. 2011 | 9 | 81 | 5 | 176 | 15.9% | 3.91 [1.35, 11.30]
Xu et al. 2010 | 1 | 25 | 0 | 25 | 5.0% | 3.00 [0.13, 70.30]
Zhou et al. 2014 | 6 | 43 | 11 | 92 | 17.0% | 1.17 [0.46, 2.95]
Total (95% CI) | 559 | 782 | 100.0% | 1.11 [0.50, 2.48]
Total events | 41 | 43
Heterogeneity: Tau² = 0.77; Chi² = 20.65, df = 9 (P = 0.01); I² = 56%
Test for overall effect: Z = 0.26 (P = 0.80)
0.01 0.1 1 10 100
Favours [experimental] Favours [control]
III
Experimental | Control | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Random, 95% CI | M-H, Random, 95% CI
3.1.1 Study Date ≥ 2015
Hong et al. 2019 | 0 | 30 | 1 | 33 | 5.0% | 0.37 [0.02, 8.65]
Jia et al. 2019 | 1 | 47 | 3 | 43 | 8.2% | 0.30 [0.03, 2.82]
Li et al. 2018 | 0 | 50 | 3 | 50 | 5.6% | 0.14 [0.01, 2.70]
Tang et al. 2019 | 2 | 76 | 9 | 69 | 12.4% | 0.20 [0.05, 0.90]
Subtotal (95% CI) | 203 | 195 | 31.2% | 0.23 [0.08, 0.67]
Total events | 3 | 16
Heterogeneity: Tau² = 0.00; Chi² = 0.28, df = 3 (P = 0.96); I² = 0%
Test for overall effect: Z = 2.70 (P = 0.007)
3.1.2 Study Date < 2015
Ao et al. 2012 | 20 | 141 | 9 | 216 | 18.3% | 3.40 [1.60, 7.26]
Qiao et al. 2012 | 2 | 58 | 1 | 58 | 7.5% | 2.00 [0.19, 21.45]
Xie et al. 2014 | 0 | 8 | 1 | 20 | 5.1% | 0.78 [0.03, 17.33]
Xiong et al. 2011 | 9 | 81 | 5 | 176 | 15.9% | 3.91 [1.35, 11.30]
Xu et al. 2010 | 1 | 25 | 0 | 25 | 5.0% | 3.00 [0.13, 70.30]
Zhou et al. 2014 | 6 | 43 | 11 | 92 | 17.0% | 1.17 [0.46, 2.95]
Subtotal (95% CI) | 356 | 587 | 68.8% | 2.44 [1.50, 3.99]
Total events | 38 | 27
Heterogeneity: Tau² = 0.00; Chi² = 4.51, df = 5 (P = 0.48); I² = 0%
Test for overall effect: Z = 3.58 (P = 0.0003)
Total (95% CI) | 559 | 782 | 100.0% | 1.11 [0.50, 2.48]
Total events | 41 | 43
Heterogeneity: Tau² = 0.77; Chi² = 20.65, df = 9 (P = 0.01); I² = 56%
Test for overall effect: Z = 0.26 (P = 0.80)
Test for subgroup differences: Chi² = 15.52, df = 1 (P < 0.0001), I² = 93.6%
0.01 0.1 1 10 100
Favours [experimental] Favours [control]
IV
laparoscopic | conventional open | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Fixed, 95% CI | M-H, Fixed, 95% CI
Ao et al 2012 | 13 | 141 | 6 | 216 | 4.7% | 3.32 [1.29, 8.53]
Hong et al 2019 | 2 | 30 | 5 | 33 | 4.8% | 0.44 [0.09, 2.10]
Jia et al 2019 | 1 | 47 | 3 | 43 | 3.1% | 0.30 [0.03, 2.82]
Li et al 2018 | 1 | 50 | 5 | 50 | 5.0% | 0.20 [0.02, 1.65]
Qiao et al 2012 | 1 | 58 | 5 | 58 | 5.0% | 0.20 [0.02, 1.66]
Tang et al 2019 | 12 | 76 | 11 | 69 | 11.6% | 0.99 [0.47, 2.10]
Xie et al 2014 | 1 | 8 | 3 | 20 | 1.7% | 0.83 [0.10, 6.87]
Xiong et al 2011 | 14 | 81 | 48 | 176 | 30.3% | 0.63 [0.37, 1.08]
Xu et al 2010 | 4 | 25 | 5 | 25 | 5.0% | 0.80 [0.24, 2.64]
Zhou et al 2014 | 26 | 43 | 45 | 92 | 28.7% | 1.24 [0.90, 1.70]
Total (95% CI) | 559 | 782 | 100.0% | 0.92 [0.73, 1.18]
Total events | 75 | 136
Heterogeneity: Chi² = 18.10, df = 9 (P = 0.03); I² = 50%
Test for overall effect: Z = 0.64 (P = 0.52)
0.01 0.1 1 10 100
Favours [experimental] Favours [control]
V
laparoscopic | conventional open | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Fixed, 95% CI | M-H, Fixed, 95% CI
Hong et al 2019 | 2 | 30 | 3 | 33 | 13.9% | 0.73 [0.13, 4.09]
Jia et al 2019 | 2 | 47 | 7 | 43 | 35.4% | 0.26 [0.06, 1.19]
Li et al 2018 | 2 | 50 | 4 | 50 | 19.4% | 0.50 [0.10, 2.61]
Tang et al 2019 | 3 | 76 | 3 | 69 | 15.2% | 0.91 [0.19, 4.35]
Xie et al 2014 | 0 | 8 | 1 | 20 | 4.4% | 0.78 [0.03, 17.33]
Xu et al 2010 | 2 | 25 | 0 | 25 | 2.4% | 5.00 [0.25, 99.16]
Zhou et al 2014 | 2 | 43 | 3 | 92 | 9.3% | 1.43 [0.25, 8.23]
Total (95% CI) | 279 | 332 | 100.0% | 0.72 [0.38, 1.37]
Total events | 13 | 21
Heterogeneity: Chi² = 4.19, df = 6 (P = 0.65); I² = 0%
Test for overall effect: Z = 1.01 (P = 0.31)
0.01 0.1 1 10 100
Favours [experimental] Favours [control]
VI
laparoscopic | conventional open | Risk Ratio | Risk Ratio
Study or Subgroup | Events | Total | Events | Total | Weight | M-H, Fixed, 95% CI | M-H, Fixed, 95% CI
Li et al 2018 | 2 | 50 | 7 | 50 | 19.4% | 0.29 [0.06, 1.31]
Tang et al 2019 | 3 | 76 | 11 | 69 | 31.9% | 0.25 [0.07, 0.85]
Xie et al 2014 | 0 | 8 | 2 | 20 | 4.1% | 0.47 [0.02, 8.78]
Xiong et al 2011 | 4 | 81 | 24 | 176 | 41.8% | 0.36 [0.13, 1.01]
Xu et al 2010 | 1 | 25 | 1 | 25 | 2.8% | 1.00 [0.07, 15.12]
Total (95% CI) | 240 | 340 | 100.0% | 0.33 [0.17, 0.64]
Total events | 10 | 45
Heterogeneity: Chi² = 0.97, df = 4 (P = 0.91); I² = 0%
Test for overall effect: Z = 3.30 (P = 0.0010)
0.01 0.1 1 10 100
Favours [experimental] Favours [control]

Figure 4. Ⅰ) Forest plot of risk ratios for the incidence of blockage after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅱ) Forest plot of risk ratios for the incidence of abdominal hemorrhage after laparoscopic and conventional PD catheter insertion. CI: confidence interval.; Ⅲ) Forest plot of risk ratios for the incidence of abdominal hemorrhage in subgroups “2 weeks” and “1 day” after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅳ) Forest plot of risk ratios for the incidence of pain after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅴ) Forest plot of risk ratios for the incidence of pain in the subgroups “2 weeks”, “1 week” and “1 day” after laparoscopic and conventional PD catheter insertion. CI: confidence interval; Ⅵ) Forest plot of risk ratios for the incidence of hernias after laparoscopic and conventional PD catheter insertion. CI: confidence interval.



I
laparoscopic / conventional open / Risk Ratio M-H, Fixed, 95% CI
Hong et al 2019 0 30 1 33 12.5% 0.37 [0.02, 8.65]
Li et al 2018 2 50 9 50 78.7% 0.22 [0.05, 0.98]
Xu et al 2010 1 25 1 25 8.7% 1.00 [0.07, 15.12]
Total (95% CI) 105 108 100.0% 0.31 [0.10, 0.98]
Total events 3 11
Heterogeneity: Chi² = 0.92, df = 2 (P = 0.63); I² = 0%
Test for overall effect: Z = 1.99 (P = 0.05)
Favours [experimental] Favours [control]
II
Hong et al 2019 1 30 2 33 6.0% 0.55 [0.05, 5.76]
Tang et al 2019 4 76 15 69 49.5% 0.24 [0.08, 0.69]
Xie et al 2014 0 8 1 20 2.8% 0.78 [0.03, 17.33]
Xiong et al 2011 10 81 21 176 41.7% 1.03 [0.51, 2.10]
Total (95% CI) 195 298 100.0% 0.61 [0.36, 1.03]
Total events 15 39
Heterogeneity: Chi² = 5.15, df = 3 (P = 0.16); I² = 42%
Test for overall effect: Z = 1.84 (P = 0.07)
III
3.4.1 2 weeks
Xie et al. 2014 0 8 1 20 11.3% 0.78 [0.03, 17.33]
Xiong et al. 2011 10 81 21 176 48.8% 1.03 [0.51, 2.10]
Subtotal (95% CI) 89 196 60.1% 1.02 [0.51, 2.03]
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%
Test for overall effect: Z = 0.06 (P = 0.95)
3.4.2 1 day
Tang et al. 2019 4 76 15 69 39.9% 0.24 [0.08, 0.69]
Subtotal (95% CI) 76 69 39.9% 0.24 [0.08, 0.69]
Test for overall effect: Z = 2.64 (P = 0.008)
Total (95% CI) 165 265 100.0% 0.56 [0.18, 1.78]
Total events 14 37
Heterogeneity: Tau² = 0.58; Chi² = 5.13, df = 2 (P = 0.08); I² = 61%
Test for overall effect: Z = 0.98 (P = 0.33)
Test for subgroup differences: Chi² = 5.02, df = 1 (P = 0.03), I² = 80.1%
IV
Ao et al. 2012 1 141 24 216 13.8% 0.06 [0.01, 0.47]
Xiong et al. 2011 6 81 32 176 34.2% 0.41 [0.18, 0.94]
Xu et al. 2010 2 25 1 25 10.9% 2.00 [0.19, 20.67]
Zhou et al. 2014 11 43 39 92 41.1% 0.60 [0.34, 1.06]
Total (95% CI) 290 509 100.0% 0.44 [0.18, 1.05]
Total events 20 96
Heterogeneity: Tau² = 0.40; Chi² = 7.01, df = 3 (P = 0.07); I² = 57%
Test for overall effect: Z = 1.85 (P = 0.06)
V
3.4.1 2 weeks
Xiong et al. 2011 6 81 32 176 34.2% 0.41 [0.18, 0.94]
Xu et al. 2010 2 25 1 25 10.9% 2.00 [0.19, 20.67]
Subtotal (95% CI) 106 201 45.0% 0.61 [0.16, 2.38]
Heterogeneity: Tau² = 0.47; Chi² = 1.58, df = 1 (P = 0.21); I² = 37%
Test for overall effect: Z = 0.71 (P = 0.48)
3.4.2 1 week
Zhou et al. 2014 11 43 39 92 41.1% 0.60 [0.34, 1.06]
Test for overall effect: Z = 1.76 (P = 0.08)
3.4.3 1 day
Ao et al. 2012 1 141 24 216 13.8% 0.06 [0.01, 0.47]
Test for overall effect: Z = 2.71 (P = 0.007)
Total (95% CI) 290 509 100.0% 0.44 [0.18, 1.05]
Test for subgroup differences: Chi² = 4.59, df = 2 (P = 0.10), I² = 56.5%
VI
Hong et al. 2019 0 30 2 33 31.7% 0.22 [0.01, 4.39]
Qiao et al. 2012 0 58 2 58 33.2% 0.20 [0.01, 4.08]
Xu et al. 2010 1 25 2 25 26.6% 0.50 [0.05, 5.17]
Zhou et al. 2014 3 43 1 92 8.5% 6.42 [0.69, 59.93]
Total (95% CI) 156 208 100.0% 0.81 [0.30, 2.22]
Total events 4 7
Heterogeneity: Chi² = 5.02, df = 3 (P = 0.17); I² = 40%
Test for overall effect: Z = 0.40 (P = 0.69)

Figure 5. Question: Should laparoscopic or conventional open surgery be used for PD catheter placement?

laparoscopic compared to conventional open for PD Catheter placement

Patient or population: patients with PD Catheter placement
Settings: in China
Intervention: laparoscopic
Comparison: coventional open

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Coventional open	Corresponding risk Laparoscopic	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Catheter Shift Risk Radio Follow-up: median 17.68 months	**Study population**		**RR 0.15** (0.07 to 0.29)	1251 (9 studies)	⊕⊕⊕⊝ **moderate**[1]	
	114 per 1000	**17 per 1000** (8 to 33)				
	Moderate					
	121 per 1000	**18 per 1000** (8 to 35)				
Catheter Leak Risk Radio Follow-up: median 16.8 months	**Study population**		**RR 1.11** (0.5 to 2.48)	1341 (10 studies)	⊕⊕⊕⊝ **moderate**[1]	
	55 per 1000	**61 per 1000** (27 to 136)				
	Moderate					
	46 per 1000	**51 per 1000** (23 to 114)				
Peritonitis Riak Radio Follow-up: median 16.8 months	**Study population**		**RR 0.92** (0.73 to 1.18)	1341 (10 studies)	⊕⊕⊕⊝ **moderate**[1]	
	174 per 1000	**160 per 1000** (127 to 205)				
	Moderate					
	151 per 1000	**139 per 1000** (110 to 178)				
Exit-site and Tunnel Infection Risk Radio Follow-up: median 24 months	**Study population**		**RR 0.72** (0.38 to 1.37)	611 (7 studies)	⊕⊕⊕⊝ **moderate**[1]	
	63 per 1000	**46 per 1000** (24 to 87)				
	Moderate					
	50 per 1000	**36 per 1000** (19 to 69)				
Inadequate Catheter Drainage Risk Radio Follow-up: median 17.68 months	**Study population**		**RR 0.33** (0.17 to 0.64)	580 (5 studies)	⊕⊕⊕⊝ **moderate**[1]	
	132 per 1000	**44 per 1000** (23 to 85)				
	Moderate					
	136 per 1000	**45 per 1000** (23 to 87)				
Blockage Risk Radio Follow-up: median 17.68 months	**Study population**		**RR 0.31** (0.1 to 0.98)	213 (3 studies)	⊕⊕⊕⊝ **moderate**[1]	
	102 per 1000	**32 per 1000** (10 to 100)				
	Moderate					
	40 per 1000	**12 per 1000** (4 to 39)				
Abdominal haemorrhage Risk Radio Follow-up: 24	**Study population**		**RR 0.61** (0.36 to 1.03)	493 (4 studies)	⊕⊕⊕⊝ **moderate**[1]	
	131 per 1000	**80 per 1000** (47 to 135)				
	Moderate					
	90 per 1000	**55 per 1000** (32 to 93)				
Pain Risk Radio Follow-up: median 9.91 months	**Study population**		**RR 0.44** (0.18 to 1.05)	799 (3 studies)	⊕⊕⊝⊝ **low**[1]	
	189 per 1000	**83 per 1000** (34 to 198)				
	Moderate					
	147 per 1000	**65 per 1000** (26 to 154)				
Hernias Risk Radio Follow-up: median 24 months	**Study population**		**RR 0.81** (0.3 to 2.22)	364 (4 studies)	⊕⊕⊕⊝ **moderate**[1]	
	34 per 1000	**27 per 1000** (10 to 75)				
	Moderate					
	48 per 1000	**39 per 1000** (14 to 107)				

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Potential selection bias

Tables:

Table 1. Main characteristics of the included studies.

Abbreviations: RCT, randomized controlled trials; non-RCT, non-randomized controlled trials.

Study	Country	Design	Sample Size		Age（year)			Follow-up(month)		Outcomes
			Laparoscopic	Conventional	Laparoscopic	Conventional	Total	Early	Late	
Ao et al. 2012	China	non-RCT	141	216	39.9	40.6	40.32	1	12	Complications
Hong et al. 2019	China	non-RCT	30	33			52.10	1	36	Complications
Jia et al. 2019	China	RCT	47	43	46.72	46.22	46.48			Complications
Li et al. 2018	China	RCT	50	50	55.42	57.51	56.47		17.68	Complications
Qiao et al. 2012	China	RCT	58	58			47.64		24	Complications
Tang et al. 2019	China	non-RCT	76	69	58.4	57.3	57.88		24	Complications
Xie et al. 2014	China	non-RCT	8	20	60.3	55.9	57.16		24	Complications
Xiong et al. 2011	China	non-RCT	81	176	57.1	55.8	56.21		16.8	Complications
Xu et al. 2010	China	RCT	25	25	53.68	59.2	56.44		9.91	Complications
Zhou et al. 2014	China	non-RCT	43	92	48.07	48.48	48.35	1		Complications

Table 2. Risk of bias in published non-randomized controlled trials. (MINORS Scale)

Study / MINORS	Ao et al. 2012	Hong et al. 2019	Tang et al. 2019	Xie et al. 2014	Xiong et al. 2011	Zhou et al. 2014
1. A stated aim of the study	2	1	1	2	2	2
2. Inclusion of consecutive patients	2	0	2	2	2	2
3. Prospective collection of data	2	1	2	2	2	2
4. Endpoint appropriate to the study aim	2	2	2	2	2	2
5. Unbiased evaluation of endpoints	0	0	0	0	0	0
6. Follow-up period appropriate to the major endpoint	1	1	2	1	2	1
7. Loss to follow up not exceeding 5%	1	1	1	1	1	1
8. A control group having the gold standard intervention	0	0	0	0	0	0
9. Contemporary groups	2	2	2	2	2	2
10. Baseline equivalence of groups	1	1	1	1	1	1
11. Prospective calculation of the sample size	1	1	2	2	2	1
12. Statistical analyzes adapted to the study design	1	1	1	1	1	1
Total	15	11	16	16	17	15