

Original Article

Meta-analysis of the clinical application on gasless laparoscopic cholecystectomy in China

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Abstract: Objective: We aim to perform systematic reviews of the clinical effects of the abdominal wall suspension technique in laparoscopic cholecystectomy in China. Methods: We retrieved databases of literature on randomized controlled trials involving abdominal wall suspension laparoscopic cholecystectomy. Then, we conducted screenings, extracted data, and performed quality assessment and meta-analysis. Results: We analyzed 611 patients. Our analysis showed that the abdominal wall suspension group compared to the traditional group had reduced length of hospital stay (SMD = -0.91, 95% CI = -1.76~-0.06, P = 0.04), had shortened postoperative first exhaust time (SMD = -0.65, 95% CI = -1.11~-0.20, P = 0.005), and had diminished incidence of postoperative complications (P < 0.001), which decreased the cost of hospitalization. Conclusions: Application of abdominal wall suspension endoscopic technique can significantly speed up the rehabilitation of laparoscopic cholecystectomy patients; therefore, it is worthy of further research and clinical application.

Keywords: Laparoscopic cholecystectomy, abdominal wall suspension, randomized controlled trials, meta-analysis

Introduction

The laparoscopic technique is preferred to open surgery by both doctors and patients because it is less invasive, has lower risk of side effects (infection and/or hemorrhaging), and shorter healing times. The most common approach to laparoscopic cholecystectomy today is the use of CO₂ insufflation, pneumoperitoneum (PP), to obtain a surgical view. However, pneumoperitoneum is often associated with increased cardiac filling pressures, an increase in blood pressure, and systemic vascular resistance [1-7]. In recent years, there have been several different methods of elevating the abdominal wall without the use of gas insufflation. Abdominal wall-lifting (AWL) by mechanical means (also known as gasless AWL), which utilizes conventional laparoscopic devices coupled with constant suction, has emerged as one of the most promising alternative methods [8-10]. Compared with the CO₂-PP method, the gasless AWL method provides remarkably less exposure to the surgical area, thus, hindering the manipulation of the instru-

mentation and making the procedure more technically challenging. In this meta-analysis, we collected and analyzed the relevant randomized controlled trials (RCTs) and retrospective analysis published in the publicly available literature databases to gain a better understanding about the benefits and costs associated with the two approaches.

Methods

Inclusion criteria

Type of research: The research included all randomized controlled trials involving laparoscopic cholecystectomy whether or not they were select blinded experiments, full-text literatures, or had language restrictions. However, the study treatment group's dropout rate must not be more than 20%.

Object of study: Patients with benign gallbladder disease that needed laparoscopic cholecystectomy were included irrespective of gender and age.

Gasless laparoscopic cholecystectomy

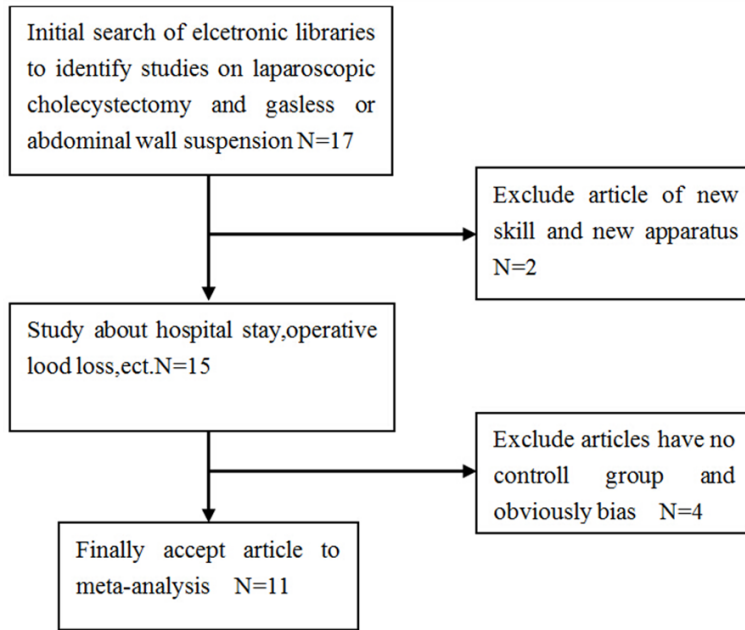


Figure 1. Flow diagram of the study selection process.

Intervening measure: The control group included patients who underwent the traditional methods of laparoscopic cholecystectomy while the experimental group included patients who underwent the gasless abdominal wall suspension technique during operation.

Outcome indicator: The main outcome indicators include time of hospital stay, the first passing wind time, operative time, intraoperative blood loss, postoperative complications, and hospital expenses.

Exclusion criteria

We excluded articles that used new skills or new apparatus. In addition, we excluded articles if they did not have the following measures: hospital stay, the first passing wind time, operative time, intraoperative blood loss, postoperative complication, and hospital expenses. We also excluded articles with no control group.

Search strategy

We retrieved articles from the Cochrane Library, Pubmed, Embase, China journal full-text database, and other databases. We retrieved articles that were published before March 2014. The search terms included the following: gasless laparoscopic, abdominal wall lifting/

suspension, laparoscopic cholecystectomy. The search strategy of this meta-analysis is as follows: (“gasless laparoscopic”) [All Fields], OR (“abdominal wall lifting”) [All Fields], OR (“abdominal wall lifting”) [All Fields], AND (“laparoscopic cholecystectomy”) [All Fields]. This search strategy was used in Google Scholar, Baidu, China National Knowledge Internet (CNKI, 1994-2014 Mar), and Wan Fang Database (1997-2014 Mar) engines to find relevant literature on the internet.

Literature screening

The literature was screened by two researchers independently. We cross-checked the results in each study. Lost information has been supplemented by contacting the author through phone or mail.

Data extraction

The extracted data was as follows: general information (title, author name, publication date, and sources), study characteristics (patient’s general condition, baseline comparability, and intervention measures), and outcome indicators (first passing of wind time, operative time, intraoperative blood loss, and the length of hospital stay).

Quality assessment

We assessed the quality evaluation standard of the randomized controlled trials by using the Cochrane 5.1.2 Manual. The evaluation indicators included the following: random sequence generation, allocation concealment, blinding, missing data, selective reporting results, and other possible bias. Quality assessment and crosschecks were carried out by two researchers independently.

Statistical analysis

Continuous variables were assessed using standardized mean difference (SMD), and dichotomous variables were analyzed using the

Table 1. The general conditions of the literature included

research	object of study	n		age		gender		Disease type		Way of operation
		T/N	T/N	T/N	T/N	Male T/N	Female T/N	calculus; polyp T/N		
Fengfeng Xu 2009	a, c, j	37/38	47.9 ± 11.4/4.5 ± 12.8	17/15	20/23	23/24, 8/10			Four hole	
Yao Wang 2009	c, j, k	23/34	68.5 ± 5.4/50.6 ± 9.2	13/20	10/14	14/21, 4/6			Three hole	
Tianbao Song 2010	c, e, f, j, h, k, l, g	30/30	-	-	-	-			Three hole	
Yonghong Tang 2011	a, c, j, e, k	35/40	56.2 ± 6.2/53.6 ± 5.3	13/15	22/25	30/34, 5/6			Three hole	
Qingyun Du 2011	c, j, l, e, a, h	40/40	49.58 ± 10.23/51.69 ± 11.07	12/10	28/30	35/34, 5/6			Two hole	
Shuangqi Li 2012	a, c, j, l, h	25/25	16 ± 21	19/21	-	-			Single hole	
Zhiming Zhang 2012	a, c, j, h, d, l	30/40	38 ± 21/40 ± 18	25/5	30/10	-			Single hole	
Jianping Ao 2012	a, c, e, k, j	31/36	69.1 ± 6.0/69.4 ± 5.7	18/25	13/11	25/27			Three hole	
Wei lu 2012	b, c, j, g	60/67	31~90/35~82	23/29	37/38	51/55, 9/12			Single hole	
Nan Liu 2011	b, c, d, j, k	34/35	38 ± 9.13/46.58 ± 16.77	17/15	15/20	14/20, 18/15			Single hole	
Mingxing Zhang 2014	b, c, h, j, k	32/32	54.9 ± 5.8/55.2 ± 5.5	18/17	14/15	24/22, 8/10			Single hole	

Note: a: Hospital stay; b: Postoperative hospital stay; c: Operative time; d: First food intake; e: First gas passage; g: Hospital charges; h: Time to getting out of bed; i: Length of liquid infusion; j: Intraoperative blood loss; k: Postoperative complications; -: Not reported.

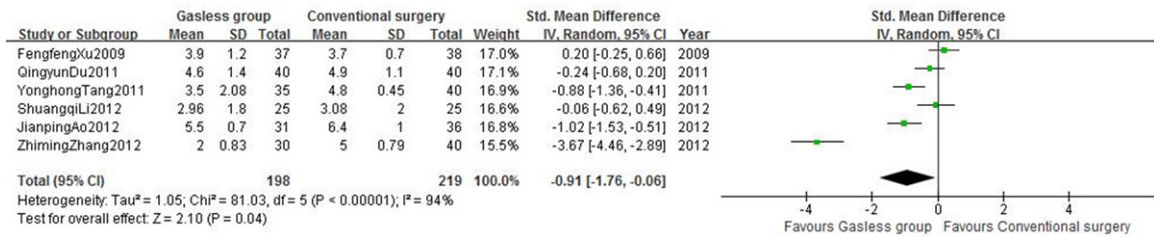


Figure 2. Forest plots for hospital stay of the Gasless group and LC groups in the studies analyzed.

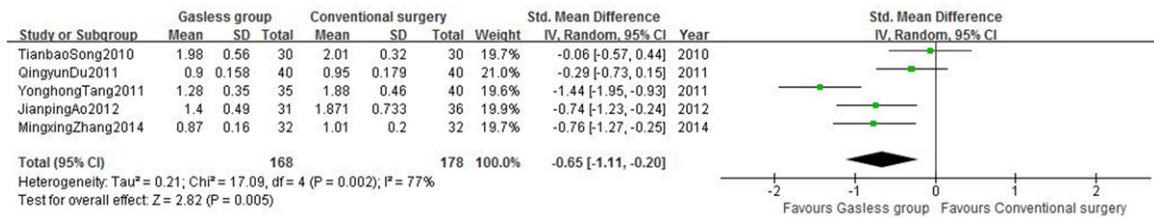


Figure 3. Forest plots for first postoperative anal exhaust time of the Gasless group and LC groups in the studies analyzed.

odds ratio (OR). The Q test and I² were used to evaluate statistical heterogeneity. I² values 25%, 50% and 75% were considered evidence of low, moderate, and severe statistical heterogeneity, respectively. If I² > 50% or P value < 0.1, we considered it heterogeneous and a random effects model was used for data synthesis. If not, a fixed effect model was used. The potential publication bias was assessed using funnel plots. Statistical analysis was performed using RevMan5.1 software, which was provided by the Cochrane Collaboration. All tests were 2 tailed and for all the tests except the Q test for heterogeneity, P < 0.05 was considered as sig-

nificant in the meta-analysis, and corresponding confidence intervals (CI) were calculated.

Results

Search results

The preliminary search mentioned before yielded 17 potential articles for the study. After reading the title and abstract, we ruled out 4 of the articles. After reading the full text, 11 articles ultimately met our criteria for inclusion. The 11 articles included 794 patients (**Figure 1**).

Gasless laparoscopic cholecystectomy

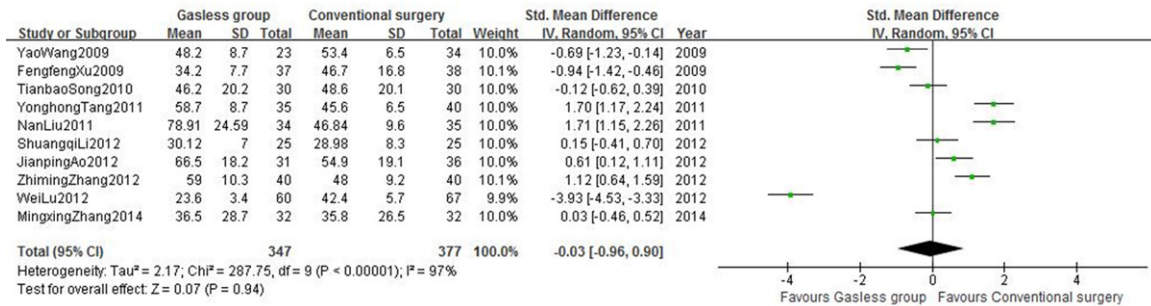


Figure 4. Forest plots for operation time of the Gasless group and LC groups in the studies analyzed.

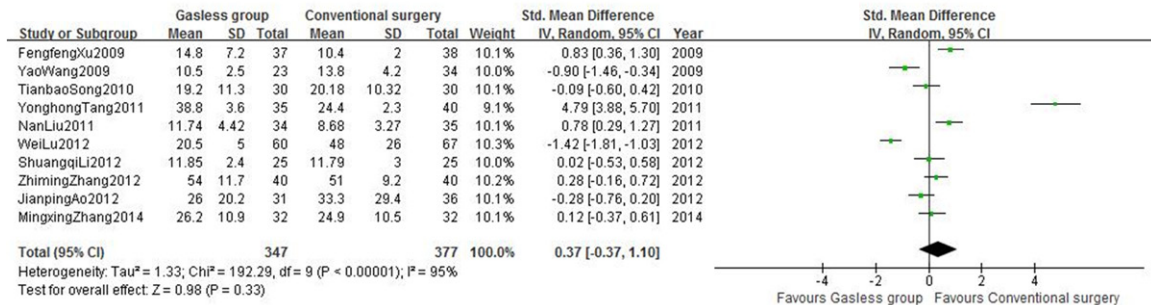


Figure 5. Forest plots for inoperative blood loss of the Gasless group and LC groups in the studies analyzed.

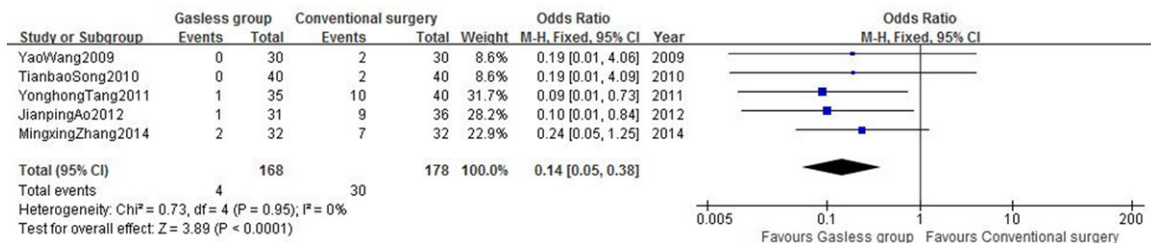


Figure 6. Forest plots for postoperative complications of the Gasless group and LC groups in the studies analyzed.

Characteristics of included articles

The general characteristics of the included studies (author, year of publication, sex ratio, age, and measurement indicators) are shown in **Table 1**.

The differences between the group without pneumoperitoneum and the traditional group in the surgical treatment are as follows:

(1). Abdominal wall suspension group: In nine authors, three of them adopt the single-hole method, and two of the three authors adopt single hole around Cullen. The other punches in the middle of the xiphoid and to the right of the Costal margin. One author adopts two-hole

method in Cullen and a xiphoid incision. The remaining five adopt either a 3-hole or a 4-hole method. (2). Suspension method: Subcutaneous suspension and full-thickness suspensions were both used in 9 authors. They were suspended in full-thickness in the umbilical incision and endoscopic placement, combined with a subcutaneous kirschner wire suspension in the xiphoid below and right of the rib margin. Abdominal wall suspension is generally done in the lower edge of the navel with a longitudinal incision in the skin. Then, the skin is separated layer by layer to get into the abdominal cavity. Next, insert the abdominal wall hanger and lift the abdominal wall to make gallbladder surgery space. At the same time, insert 10 mm trocar in

Gasless laparoscopic cholecystectomy

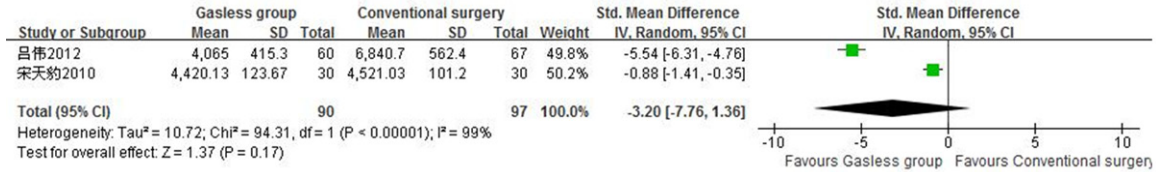


Figure 7. Forest plots for hospital charges of the Gasless group and LC groups in the studies analyzed.

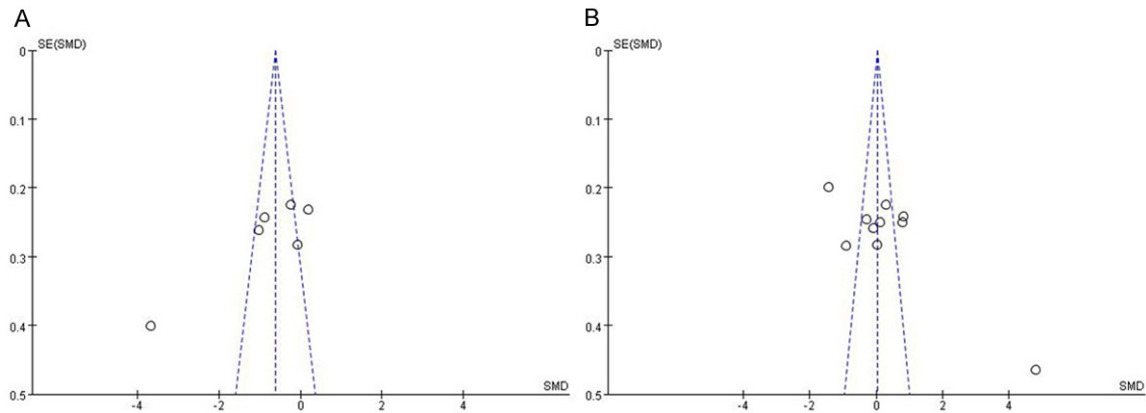


Figure 8. A. Funnel plot of hospital stay; B. Funnel plot of blood loss in operation.

order to visualize the inside of the abdomen with laparoscopy. Subcutaneous suspension method (Nagai way) needs to use a special abdominal wall suspension equipment which includes abdominal wall puncture needle, suspension handle, and suspension frame. After placing 10 mm Trocar in the umbilical for laparoscopy, kirschner wire was placed through the abdominal subcutaneous wall to fix with the suspension handle. To prevent damage to the patient's skin, the needle on both sides was trapped with the plastic tube. The abdominal wall was suspended, and the roll chain was fixed to the suspension frame with suspension height being adjustable. Doctor can use single point or multi-point suspension, act 3-4 hole laparoscopic cholecystectomy in accordance with the habits of the operator. (3). Traditional group: 1 cm umbilical incision was sliced, and the abdominal wall was pulled up by two towel forceps. A puncture using veress needle was made to make the pneumoperitoneum. After the pressure reached about 10~12 mmHg, the needle was pulled out. 1 cm trocar devices were placed in xiphoid below the costal margin to operate. The remaining steps were similar to the gasless group.

Quality assessment of included studies

Of the 11 studies in our study, 6 were randomized controlled trials and 4 were retrospective analyses. One of which had random numbers assigned, none of the remaining literature described any particular random method. All included studies did not mention whether they used the blinded method, have non-selective data reported, or have missing data description. 5 studies were retrospective analysis, all of them have control group, all data have no difference such as age, gender and disease in statistical significance.

Meta-analysis results of the various studies index

Hospital stay: There is significant heterogeneity between 6 reported studies [11-15, 17] (I² = 94%). Meta-analysis shows abdominal wall lifting significantly reduces the length of hospital stay (SMD = -0.91, 95% CI = -1.76~-0.06, P = 0.04) (**Figure 2**).

First postoperative anal exhaust time: There is significant heterogeneity between 5 reported researches [12-14, 16, 24] (I² = 82%). Meta-

analysis showed that the suspension group significantly advances the first postoperative exhaust time compared to the traditional group (SMD = -0.65, 95% CI = -1.11~-0.20, P = 0.005) (**Figure 3**).

Operative time: There is significant heterogeneity between 10 reported researches [11-13, 15-19, 21, 24] ($I^2 = 97\%$). Meta-analysis showed that there is not a statistically significant difference in operation time between suspension group and traditional group (SMD = -0.03, 95% CI = -0.96~0.90, P = 0.94) (**Figure 4**).

Inoperative blood loss: There is no significant heterogeneity between 10 reported researches [11-13, 15-19, 21, 24] ($I^2 = 96\%$). Meta-analysis showed that the inoperative blood loss of abdominal wall lifting was not significantly different compared with the traditional group (SMD = 0.02, 95% CI = -0.13~0.18, P = 0.76) (**Figure 5**).

Postoperative complications (lung infections and gastrointestinal complications): There are 5 researches reports [12, 13, 16, 18, 24]. Abdominal wall lifting group had significantly reduced complications (P < 0.001) (**Figure 6**).

Hospital charges: There is significant heterogeneity between 2 reported research studies [16, 19] ($I^2 = 99\%$). Meta-analysis showed that there is no significant difference between the abdominal wall lifting group and the normal group (SMD = -3.17, 95% CI = -7.7~1.36, P = 0.17) (**Figure 7**).

Publication bias: The main index of publication bias (**Figure 8**).

Discussion

The results of this study show that compared with CO₂ pneumoperitoneum laparoscopic cholecystectomy, abdominal wall suspension endoscopic cholecystectomy can shorten the length of hospital stay and postoperative exhaust time. Furthermore, it not only can reduce the incidence of post-operative complications but also improve the postoperative rehabilitation. It's glad to see all studies have shown that abdominal wall suspension change to open operation rate is zero. Because there was a reduction of the anesthetic medication and hospital time for the patients, the hospital charges are also lower than those of the tradi-

tional group. Thus, laparoscopic cholecystectomy by abdominal wall suspension can not only save medical resources but also speed up the rehabilitation of patients. The abdominal wall suspension technique can reduce the incidence of complications in abdominal operation, thus, reducing the risk of operation.

This study shows that there is a lower incidence of postoperative complications in the abdominal wall hanging group. However, the operative time and blood loss between the two groups was not statistically different. As you see, abdominal wall suspension technique applied to laparoscopic cholecystectomy is safe based on the existing studies. However, because the quality of the literature included varies widely and the reports of intervention data and outcome data are insufficient, the research studies need to be improved.

At the same time, the technological improvements of laparoscopic cholecystectomy on the basis of the abdominal wall suspension technique in recent years, develop the application of this technique. The "three-tube, one-hole, one-viscera technology" adopted by Jinlong Yu not only gives full play to the advantages of gasless laparoscopic surgery but also makes up the right side of the costal arch pulling difficulties and the deficiency of surgical field. A combination of both can give play to complementary advantages [19]. The "one-hole, dual-view gasless laparoscopic cholecystectomy" with the laparoscopic system reported by Wei Lu reveals the advantages in surgical lighting, imaging and anatomical separation, and makes the surgical operation more meticulous and safe [20]. However, Dr. Guangyong Zhang uses the flexible laparoscope at single hole to accomplish laparoscopic cholecystectomy, considering that GLESS with AWL is safe and feasible for cholecystectomy. The techniques provide satisfactory operative field exposure and an easier access method for LESS [22-24].

In conclusion, compared with conventional laparoscopic cholecystectomy surgery, abdominal wall suspension laparoscopic cholecystectomy has the following advantages: significantly shortens the length of hospital stay, reduces hospitalization charges, shortens the first postoperative exhaust time, and avoids increasing the risk of operation and postoperative complications. The conclusions should be interpreted

cautiously due to the possible bias in this study. As a result, large-sample and multi-center clinical research studies on this topic are worthwhile and necessary.

Disclosure of conflict of interest

None.

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