PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	**Hand-assisted laparoscopic splenectomy is a useful surgical treatment method for patients with excessive splenomegaly: a meta-analysis**	Title 1
ABSTRACT			
Structured summary	2	Hand-assisted laparoscopic splenectomy (HALS) can help to overcome the drawbacks of laparoscopic splenectomy (LS) while maintaining the superiority of LS. This study was aimed to evaluate the efficacy and advantage of HALS for splenomegaly. Relevant literature was searched using the PubMed, Embase, Cochrane, Ovid Medline and Wanfang databases to compare clinical outcomes of HALS and LS. We calculated odds ratios or mean differences with 95% confidence intervals (CIs) for fixed-effects and random-effects models. 16 studies for a total of 754 patients were selected to satisfy the inclusion criteria. For pure splenectomy, compared with LS group, the HALS group blood loss ($P < 0.001$) and conversion rate ($P = 0.008$) were lower. For splenomegaly, compared with LS group, the HALS group operative time ($P = 0.04$) was shorter, blood loss ($P < 0.001$) and conversion rate ($P = 0.001$) were lower. However, there was also no significant difference for hospital stay, blood transfusion, time to diet, complications and mortality between the two groups. In addition, for splenectomy and devascularization of the upper stomach (DUS), compared with LS+DUS group, the HALS+DUS group operative time ($P = 0.04$) was shorter, blood loss ($P < 0.001$) and conversion rate ($P = 0.05$) were lower. However, there was also no significant difference for hospital stay, time to diet and complications between the two groups. HALS can maximize the benefits for patients, while maintaining the advantages of LS. It is the ideal surgical treatment for splenomegaly.	Abstract 2
INTRODUCTION			
Rationale	3	As we know, a high incidence of the patients with chronic hepatitis B and C infections worldwide, have portal hypertension secondary to liver cirrhosis [1,2]. Hypersplenism and splenomegaly, which are common	Introduction 3

		major complications of liver cirrhosis, occur in approximately 24-80% of cases [3,4]. Therefore, a large number of patients suffer from complications of Hypersplenism and splenomegaly. Splenomegaly was undoubtedly brought great challenge for splenectomy because of dense adhesions and increased tissue vascularity, making retrieval difficult, with the necessity of making a longer incision to retrieve the specimen. With rapidly advancing in laparoscopic surgery, laparoscopic splenectomy (LS) has been proved to be safe and effective for splenectomy [5-7]. The superiority of LS was not only reflected in less trauma, quicker recovery, but also less post-operative pain compared with open splenectomy (OS) [8-10]. However, for patients with splenomegaly, they often combined with hypersplenism, frequent coexistence of varices and thickening, perisplenic collateral vessels distortions, splenomegaly due to limited space of abdominal cavity, and thrombocytopenia all lead to an increased risk of intraoperative hemorrhage and conversion to open surgery [11,12], the benefits of LS were not provided to all patients who need splenectomy because lack of advantages of laparotomy such as operating horizon and space, tactile feedback and hand-eye coordination [13]. Moreover, with the increasing demand for safe and effective surgical treatment, hand-assisted laparoscopic splenectomy (HALS) is advocated by people as it combines the advantages of laparotomy and laparoscopy surgical at the same time.	
Objectives	4	we conducted this study to further divided into pure splenectomy, splenomegaly, splenectomy and devascularization of the upper stomach (DUS) three subgroup evaluate the safety and feasibility of HALS compared with LS techniques.	Introduction 3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No
Eligibility criteria	6	Case-control and cohort studies, published in English and Chinese only.	Material and methods 4
Information sources	7	A systematic search was carried out using PubMed, Embase, Cochrane, Ovid Medline and Wanfang databases with the following keywords: hand assisted, hand port, laparoscopic and splenectomy. The search was conducted to include articles published between the date of the creation of the electronic	Material and methods 4

		resource and January 20, 2018.	
Search	8	hand assisted, hand port, laparoscopic and splenectomy	Material and methods 4
Study selection	9	All case-control studies in which HALS were compared with LS were selected. Studies were included if they involved patients with no requirement of additional procedures, no history of upper laparotomy and who had splenectomy (including malignant, benign and normal results). Additionally, included studies must have reported data on Gender, Spleen weight (Kg), Body mass index (MBI), the maximum diameter (centimetre), Malignant, Transfused, Conversion rate, Mortality, Total morbidity, Operative time (minutes), Hospital stay (days), Blood loss (milliliters) or Time to diet (days).	Material and methods 4
Data collection process	10	Data extraction was conducted independently by 2 investigators. Disagreement on article inclusion between the two reviewers was resolved via a third reviewer.	Material and methods 4
Data items	11	The exclusion criteria were articles not reporting outcomes, editorials, review articles, and animal studies. Neither authorship nor publisher information influenced our which articles were included.	Material and methods 4
Risk of bias in individual studies	12	We used funnel plots to assess the publication bias, and tested for funnel plot asymmetry using Egger's test and Begg's test.	Material and methods 4
Summary measures	13	Hazard Ratio	Material and methods 5
Synthesis of results	14	The analyses were performed using Review Manager version 5.1 (RevMan, Cochrane Collaboration, Oxford, UK). The results of this meta-analysis are expressed as the odds ratios (ORs) for dichotomous data and mean differences (MDs) for continuous data, with 95% confidence intervals (CIs) for both. The inverse variance method was used for continuous variables, whereas the Mantel–Haenszel method was used for	Material and methods 5

		dichotomous variables. Statistical heterogeneity was evaluated by χ^2 test. $P < 0.05$ was considered significant. If heterogeneity was significant, we used the random-effects model. Otherwise, we used the fixed-effects model. If data were reported as median and range rather than mean and standard deviation (SD), the mean and SD were estimated as described previously.[17,18]	

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Risk of bias across studies	15	The potential publication bias was evaluated by funnel plots.	Material and methods 5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	No
RESULTS			
Study selection	17	See Fig 1.	Results 5
Study characteristics	18	See table 1	Results 5
Risk of bias within studies	19	See Fig 2 and Fig 3, 4,5，6.	Results 5-6
Results of individual studies	20	16 studies for a total of 754 patients were selected to satisfy the inclusion criteria. For pure splenectomy, compared with LS group, the HALS group blood loss ($P < 0.001$) and conversion rate ($P = 0.008$) were lower. For splenomegaly, compared with LS group, the HALS group operative time ($P = 0.04$) was shorter, blood loss ($P < 0.001$) and conversion rate ($P = 0.001$) were lower. However, there was also no significant difference for hospital stay, blood transfusion, time to diet, complications and mortality between the two groups. In addition, for splenectomy and devascularization of the upper stomach (DUS), compared with LS+DUS group, the HALS+DUS group operative time ($P = 0.04$) was shorter, blood loss ($P < 0.001$) and conversion rate ($P = 0.05$) were lower. However, there was also no significant difference for hospital stay, time to diet and	Results 5-6

		complications between the two groups.	
Synthesis of results	21	**4.1 Study selection and characteristics** Figure 1 illustrates the search process and the final selection of relevant studies. We analyzed 16 trials,[10,13,19-32] (Table 1) involving 754 patients, that met the criteria. There are 11 trials9, [20,13,19-27] involving 639 patients to compared HALS with LS for pure splenectomy, 9 trials [20,13,19-21,23-25,27] involving 181 patients to compared HALS with LS for splenomegaly, 5 trials [28-32] to compared hand-assisted laparoscopic splenectomy + devascularization of the upper stomach (HALS+DUS) with laparoscopic splenectomy + devascularization of the upper stomach. **4.2 HALS versus LS for pure splenectomy** There are 11 trials involving 754 patients to compared HALS with LS for splenectomy. The splenic weight in the HALS group was significantly larger than that in the LS group (MD 0.82, 95% CI 0.18 to 1.47; *P* = 0.01; Figure 2D). In addition, the maximum diameter of spleen (MD 2.68, 95% CI 0.94 to 4.42; *P* = 0.002; Figure 2F) in the HALS group were significantly larger than in the LS group. However, there was no significant difference for BMI (MD 0.45, 95% CI -0.32 to 1.22; *P* = 0.25; Figure 2A) between the two groups. Compared with LS group, the HALS group blood loss (MD –63.07, 95% CI −86.23 to −39.90; *P* < 0.001; Figure 2B) and conversion rate (OR 0.34, 95% CI 0.15–0.75; *P* = 0.008; Figure 3D) were lower. However, there was no significant difference for operative time (MD −22.12, 95% CI −52.33 to 8.09; *P* = 0.15; Figure 2E), hospital stay (MD 0.04, 95% CI −1.28 to 1.35; *P* = 0.96; Figure 2G), blood transfusion (OR 0.82, 95% CI 0.44–1.54; *P* = 0.54; Figure 3B), time to diet (MD -0.09, 95% CI −0.21 to 0.04; *P* = 0.18; Figure 2C), complications (OR 0.95, 95% CI 0.45–1.99; *P* = 0.88; Figure 3A) and Mortality (OR 0.65, 95% CI 0.21–1.542.07; *P* = 0.47; Figure 3C) between the two groups.	Results 6

4.3 HALS versus LS for splenomegaly

There are 9 trials involving 639 patients to compared HALS with LS for splenectomy. There was no significant difference for splenic weight (MD 0.60, 95% CI -0.12 to 1.32; *P* = 0.1; Figure 4C) and BMI (MD 0.71, 95% CI -0.16 to 1.58; *P* = 0.11; Figure 4A) between the two groups.

Compared with LS group, the HALS group operative time (MD −32.74, 95% CI −63.32 to -2.17; *P* = 0.04; Figure 4E) was shorter, blood loss (MD –65.13, 95% CI −88.36 to −41.89; *P* < 0.001; Figure 4D) and conversion rate (OR 0.23, 95% CI 0.09–0.56; *P* = 0.001; Figure 5D) were lower. However, there was also no significant difference for hospital stay (MD -0.39, 95% CI −1.69 to 0.9; *P* = 0.55; Figure 4G), blood transfusion (OR 0.51, 95% CI 0.24–1.12; *P* = 0.09; Figure 5B), time to diet (MD -0.1, 95% CI −0.23 to 0.02; *P* = 0.11; Figure 4B), complications (OR 0.76, 95% CI 0.31–1.88; *P* = 0.55; Figure 5A) and Mortality (OR 0.54, 95% CI 0.20–2.02; *P* = 0.45; Figure 5C) between the two groups.

4.4 HALS+DUS versus LS+DUS

There are 5 trials involving 181 patients to compared HALS+DUS with LS+DUS for splenectomy. There was no significant difference for splenic weight (MD 139.51, 95% CI -37.35 to 316.36; *P* = 0.12; Figure 6F) between the two groups.

Compared with LS+DUS group, the HALS+DUS group operative time (MD -36.56, 95% CI −72.24 to -0.88; *P* = 0.04; Figure 6D) was shorter, blood loss (MD –85.77, 95% CI −127.31 to −44.22; *P* < 0.001; Figure 6B) and conversion rate (OR 0.12, 95% CI 0.01–1.02; *P* = 0.05; Figure 6E) were lower. However, there was also no significant difference for hospital stay (MD 0.35, 95% CI −0.32 to 1.02; *P* = 0.31; Figure 6G), time to diet (MD -0.02, 95% CI −0.54 to 0.5; *P* = 0.94; Figure 6C) and complications (OR 0.73, 95% CI 0.30–1.75; *P* = 0.48; Figure 6A) between the two groups.

Risk of bias across studies	22	Significant heterogeneities were found with regard to splenic weight, blood loss. However, with regard to operative times, conversion rate no significant heterogeneities existed. No significant publication bias was observed. The results were similar, and the combined results were highly reliable.	Results 7
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	No
DISCUSSION			
Summary of evidence	24	Because of the high incidence of chronic hepatitis B and C infections worldwide, a large number of those patients suffer portal hypertension secondary to liver cirrhosis and need splenectomy treatment [1,2]. People are getting more and more concerned about the safety of the operation, while ensuring minimally invasive surgery. Although LS has many advantages and has been considered as the mature treatment [5-7], it's risk is greater such as longer operation time, more blood loss and higher conversion rate due to lack of tactile sensation, impaired hand-eye coordination and the loss of three-dimensional visualization of intra-abdominal structures, especially for splenomegaly [15,19,23]. Fortunately, HALS, first described in 1995 [33], can overcome these drawbacks, has become an alternative to LS while maintaining the advantages of LS and OS [15,34]. HALS has not been widely recognized and accepted. Hence, this research came into being. And the results revealed that HALS should be a preferred choice for the treatment for splenectomy or splenectomy + DUS no matter there is splenomegaly.	Discussion 7-8
Limitations	25	This study should be interpreted with caution due to its limitations. First, the patient selection process may have been biased. The standards were different for different trials, depending on the technology used, on the expertise level of the surgeons, and on the anatomical conditions of the patients. Second, no randomized controlled trials were included in our study. Third, although we	Discussion 9

		tried to identify all relevant data, potential publication bias was unavoidable; therefore, some relevant data may have been overlooked. Finally, since this study was based only on reports published in English and Chinese, publication bias could not be completely ruled out.	
Conclusions	26	HALS can maximize the benefits for patients, while maintaining the advantages of LS. It is the ideal surgical treatment for splenomegaly.	Discussion 9-10
FUNDING			
Funding	27		Acknowledgments 10

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