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Review Article

Effect of prolonging the length of gastric tube insertion on gastric lavage: a meta-analysis

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Abstract: Objective: To evaluate the effect of prolonging the insertion length of gastric tube in the rescue of acute organophosphorus pesticide poisoning (AOPP) and its clinical efficacy. Methods: The keywords, citations and related studies of all the randomized controlled trials (RCT) about prolonging the insertion length of gastric tube in the rescue of patients with AOPP were retrieved on the databases, including PubMed, EMBASE, Cochrane Library, Chinese Biomedical Literature Database (CBM), Chinese Journal Full-text Database (CNKI), Wanfang Database, Vip Database. The RCTs that fit the inclusion criteria were performed the quality evaluation according to the Cochrane systematic review and scored by the Jadad scale. The time for first liquid sucking out, the total gastric lavage time, the incident of bloody liquid in lavage fluid, the incidence of upper abdomen discomfort andthe success rate ofgastric lavage were analyzed. The meta-analysis was performed on the RevMa5.0 software and the data were dealt with fixed effect model or random effect model. The risk ratio (RR), standardized mean difference (SMD) and 95% CI were also calculated to determine the clinical efficacy of prolonging the insertion length of gastric tube in the rescue of patients with AOPP. Results: Eventually, 14 RCTs with 1504 cases were included. Meta-analysis showed that indicators including the time for first liquid sucking out (pooled SMD=-1.88; 95% CI, -2.04 to -1.73), total gastric lavage time (pooled SMD=-2.26; 95% CI, -2.42 to-2.10), the incident of bloody liquid in lavage fluid (pooled RR=0.17; 95% CI, 0.08 to 0.33), the incidence of upper abdominal discomfort (pooled RR=0.26; 95% CI, 0.16 to 0.40) and the success rate of gastric lavage (pooled RR=0.24; 95% CI, 0.15 to 0.38) of the patients treated with prolonged gastric tube were all superior to those treated with the traditional gastrictube insertion length. Conclusion: Prolonging the length of gastric tube insertion could shorten the time for first liquid sucking out and the total gastric lavage time, increase the rate of patients with bloody liquid in lavage fluid as well as the success rate of gastric lavageand reduce the incidence of upper abdominal discomfort.

Keywords: Prolonging the length of gastric tube insertion, traditional gastric tube, organophosphorus poisoning, meta-analysis

Introduction

Acute organophosphorus pesticide poisoning (AOPP) is a syndrome that organophosphorus pesticides rapidly absorbed into the human body and caused damage to the systems, especially nervous system. Gastric lavage is the best way to rescue the patients suffered AOPP with a significant improvement in the cure rate [1]. The recipe of common gastric lavage fluid includes 2% sodium bicarbonate, warm water, normal sodium, potassium permanganate solution (1:5,000) and so on. The traditional method of gastric lavage is to insert the gastric tubewith about 45 to 55 cm into the stomach after AOPP patients were admitted, and the patients should try to receive the gastric lavage within 6 hours after taking poison [2]. However, the disadvantages of traditional method are that the gastric juice flows slowly and has a lot of residual liquid, which result in an incomplete gastric lavage [3]. There fore, in clinic, prolonging for 10 to 15 cm on the basis of the original insertion length can make the top of the gastric reach the gastric antrum,the side hole completely enter the stomach and the gastric tube reach over the cardia for 10 to 15 cm [1].

Nevertheless, the effect of the extension of gastric tube insertion length for AOPP gastric lavage treatment is still controversial. It has been reported that prolonging the gastric tube

could shorten the time for first liquid sucking out and total gastric lavage time, and increase the incidence of bloody liquid in lavage fluid. But randomized controlled clinical studies with large samples were lacked to confirm that whether extending the gastric tube insertion length is superior to the traditional gastric tube length. Chen et al. found that atropine dosage and atropinization time of the patients with extended gastric tube insertion length was significantly shorter than that of the patients with traditional gastric tube insertion length, but Su et al. didn't report the same conclusion [2, 3]. Based on the Cochrane systematic review, this study comprehensively evaluated and compared the gastric lavage effect and clinical efficacy of traditional gastric tube insertion length and prolonged gastric tube insertion length in the treatment of AOPP, to provide evidence-based medicine basis for clinical application.

Materials and methods

This meta-analysis was reported according to PRISM report specification [4].

Database

Seven English and Chinese databases were retrievedin this meta-analysis, including PubMed, EMBASE, Cochrane Library, CBM disc, CNKI, WanFang database and Vip database.

Search keywords

The keywords were organophosphorus, poisoning and gastric lavage. The retrieval was performed upto 2017.

Literature screening

Literaturesmet the inclusion and exclusion criteria were selected out after retrieving the given keywords as above.

Inclusion criteria: Study type: It was the prospective randomized controlled trials (RCTs) for comparing and analyzing the treatment efficacy of AOPP by using extended gastric tube insertion length or traditional gastric tube insertion length, but there was no limit to the blind methods and the follow-up time, and the language was Chinese or English. Subjects: The adult patients with AOPP, without the limitation in gender, disease severity and basic condition. Clinical indicators: The time for first liquid sucking out, the total gastric lavage time, the incidences ofbloody liquid in lavage fluid and epigastric discomfort, successful rate of gastric lavage (gastric content was pumped out) and so forth.

Exclusion criteria: The subjects were not consistent with the AOPP diagnosis criteria or the subjects were animals; original research focused on the inserted length of extended gastric tube, but it didn't have valid data and analysis; information was incomplete; as for the repetitive published literature, such as reviews, comments, minutes, lectures, etc., the literatures with the most comprehensive data were selected.

Literature screening process: One researcher read the title to remove the duplicate literatures, and other two researchers read the title and abstract of literatures independently to screen out the literatures in accordance with the inclusion and exclusion criteria. Then the researches read all the included literatures carefully and independently to extract the information of clinical indicators and make data extraction table. Any dispute was solved by discussion.

Information extraction

Extracted data included the time for article publication, the number of patients, the random method, the blind method, age, the time of first liquid sucking out, the total gastric lavage time, the incidence of bloody liquid in lavage fluid and epigastric discomfort, the successful rate of gastric lavage (gastric content was pumped out) and so forth. Discussed when there was disagreement.

Quality evaluation of literature

The quality of literature was evaluated by Cochrane systematic review and scored by Jadad scale: low quality, 1-2 scores; high quality, 3-5 scores [5].

Observation indicator

The main observation indicators included the time of first liquid sucking out, the total time of gastric lavage, the rate of patients with bloody liquid in lavage fluid, the incidence of upper epigastric discomfort and the successful rate of gastric lavage (gastric content was pumped out).

Table 1. General information of included literature

Included literature	Cases (O/C)	Random method	Withdraw and loss of follow-up	Blind method	Concealment	Jadad scores
Niu Q (2016) [6]	82/82	RCT	N	Yes	No	3
Yi XW (2015) [7]	75/54	RCT	N	Yes	No	3
Yang SL (2014) [8]	93/76	RCT	N	Yes	No	3
Zhang QG (2012) [9]	42/42	RCT	N	Yes	Yes	4
Lai YQ (2012) [10]	32/30	RCT	D	Yes	No	4
Chen CJ (2011) [2]	35/35	RCT	N	Yes	Yes	4
Xu Y (2011) [11]	62/50	RCT	N	Yes	No	3
Zhao DY (2011) [12]	28/20	RCT	D	No	Yes	4
Liu SJ (2008) [13]	55/63	RCT	D	Yes	No	4
Wu CY (2007) [14]	50/55	RCT	N	Yes	Yes	4
Zhang WL (2006) [15]	40/45	RCT	N	Yes	No	3
Wei CY (2004) [16]	71/69	RCT	D	Yes	No	3
Su P (2003) [3]	50/50	RCT	D	Yes	No	4
Feng XM (2002) [17]	55/63	RCT	N	Yes	No	3

Note: N, not described; D, described; E, the experimental group which treated with prolonged gastric tube insertion length; C, the control group which treated with traditional gastric tube insertion length.

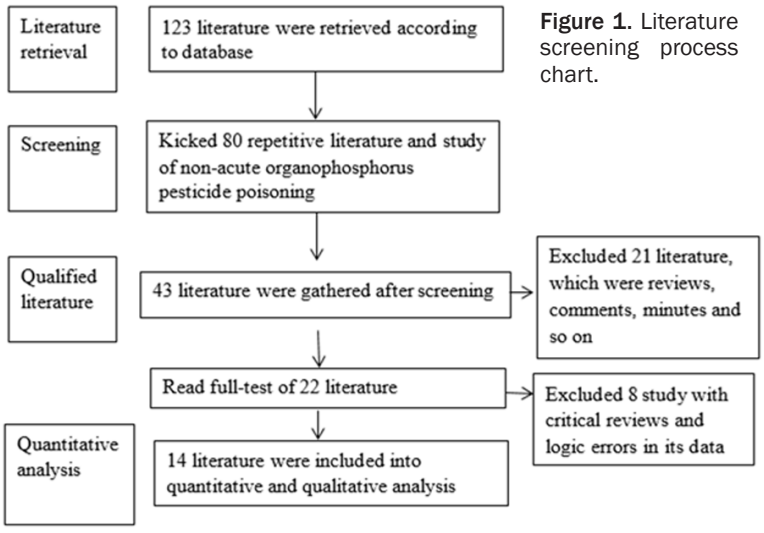

Figure 1. Literature screening process chart.

Statistical analysis

Microsoft Excel was used to establish database, and RevMan5.2 statistical software was used to analyze data. Enumeration data was analyzed by risk ratio (RR) and 95% confidence interval (CI). Continuous measurement data such as the time of first liquid sucking out, the total gastric lavage time, the incidence of bloody liquid in lavage fluid, etc. were analyzed bystandard mean difference (SMD) with 95% CI.

The degree of heterogeneity was judged according to I^2 value: 0-25%, non-heterogeneity; 25-50%, mild heterogeneity; 50-75%, moderate heterogeneity; 75-100%, high heterogeneity. Fixed effect model was used when the heterogeneity was not clear ($P \geq 0.1$, $I^2 < 50\%$). Random effect model was used when the heterogeneity was clear ($P < 0.1$, $I^2 > 50\%$) and sensibility analysis was used to explore the possible sources of heterogeneity. Funnel plots was used to judge the publication bias, and $\alpha = 0.05$ was the significant level.

Results

Inclusion and quality evaluation results of literature

According to retrieval strategy and data collection method mentioned above, 123 pieces of literature were selected out initially. After the stepwise screening, 22 pieces of literature were included and evaluated, and the full article of them was further reviewed. Finally, 14 pieces of literature were included for meta-analysis [2, 3, 6-17]. Among the 14 included pieces of literature, 770 patients treated with extended gastric tube insertion length and 734 patients treated with traditional gastric tube

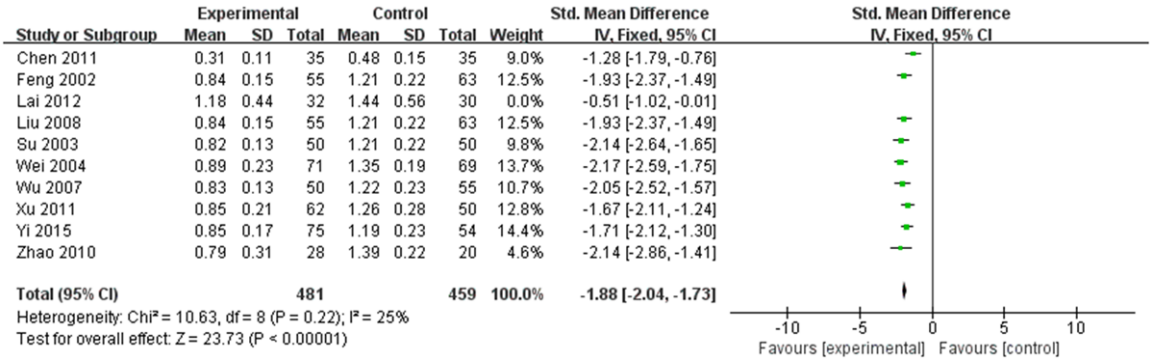

Figure 2. Meta-analysis of time for first liquid sucking out.

Table 2. Results of the meta-analysis of included literatures

Indicators	literature quantity	Heterogeneity test		Summary statistic (95% CI)	*P* value
		I^2 (%)	P		
Time for first liquid sucking out	10	25	0.22	-1.88 (-2.04, -1.73)	<0.00001
Total gastric lavage time	10	9	0.36	-2.26 (-2.42, -2.10)	<0.00001
Volume of washing fluid	7	0	0.80	0.17 (0.08, 0.33)	<0.00001
Upper abdomen discomfort	7	0	0.94	0.26 (0.16, 0.40)	<0.00001
Gastric content flowing out successfully	4	0	0.87	0.24 (0.15, 0.38)	<0.00001

insertion length. Basic information of inclusion literature was shown in **Table 1**.

Literature screening process and the results were shown in **Figure 1**. There were 10 pieces of literature that reported the time of first liquid sucking out in the experimental group (treated with extended gastric tube insertion length) and the control group (treated with traditional gastric tube insertion length), 10 reported the total time of gastric lavage, 7 reported the rate of patients appeared bloody liquid in lavagefluid, 7 reported epigastric discomfort incidence, and 4 reported success rate of gastric lavage.

According to the Jadad score system, among the 14 included literatures, the quality score of 7 literatures were 3, and other 7 pieces of literature were 4, indicating a high quality.

Meta-analysis

Comparison of the time for first liquid suck out: Among the included literatures, ten of them studied the time for first liquid suck out, the results of meta-analysis were shown in **Figure 2** and **Table 2**. Results of heterogeneity test: X^2=10.63, P=0.22, I^2=25%. These researches had comparatively good homogeneity and were analyzed with fixed effect model. The analysis results showed that the total sample size was 940 cases, with 481 cases in the experimental group and 459 cases in control group. The test results for overall effect: Z=23.73 (P<0.00001), total SMD=-1.88, 95% CI=(-2.04, -1.73). Therefore, compared with the traditional gastric tube insertion length, prolonged gastric tube insertion length had an obvious shorter time for the first liquid suck out, and the difference was statistically significant.

Comparison of total gastric lavage time: In the included literatures, ten of them researched the total gastric lavage time, and the results of meta-analysis were illustrated in **Figure 3** and **Table 2**. Results of heterogeneity test: X^2=8.75, P=0.36, I^2=9%. These researches had unclear homogeneity and analyzed with fixed effect model. The final result of the analysis showed that total sample size contained 999 cases, with 513 cases in the experimental group and 486 cases in the control group. The test results of overall effect: Z=27.58 (P<0.00001), total SMD=-2.26, 95% CI=(-2.42,-2.10). In conclude, compared with the traditional gastric tube insertion length, prolonged gastric tube insertion length had an apparently shorter total gas-

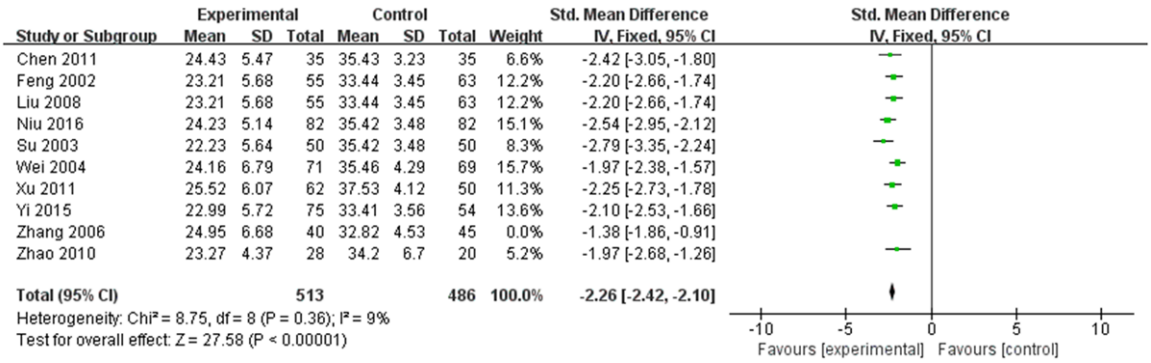

Figure 3. Meta-analysis of total gastric lavage time.

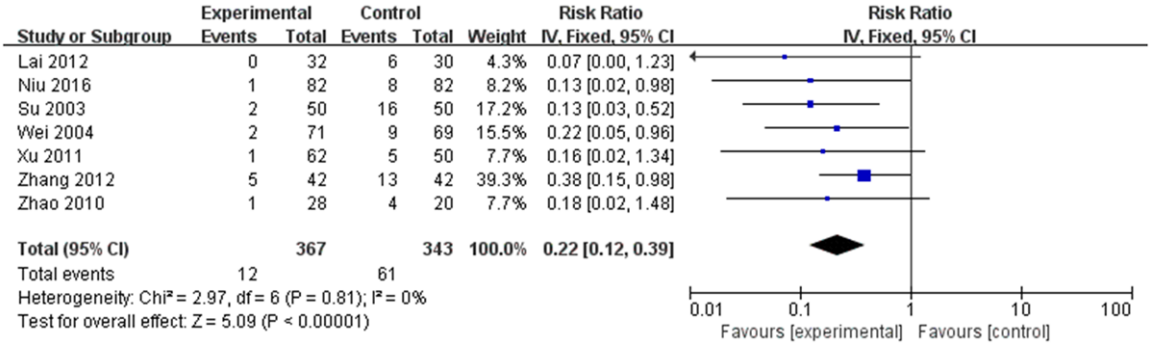

Figure 4. Meta-analysis of the incidence of bloody liquid in lavage fluid.

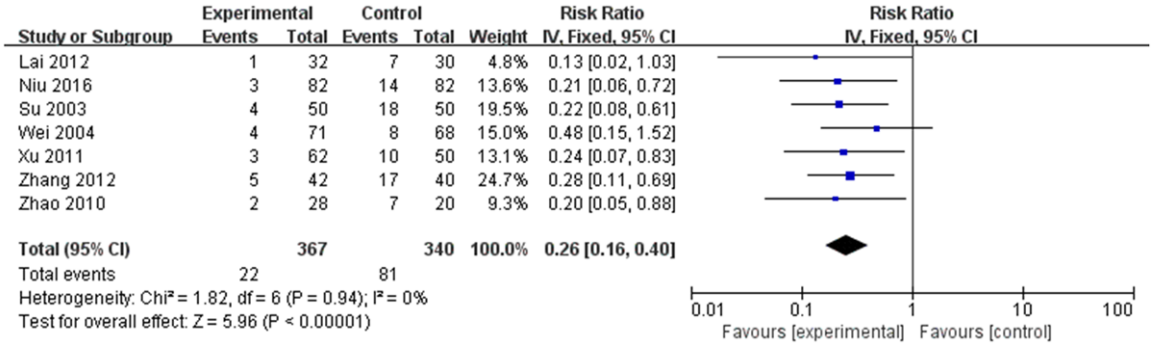

Figure 5. Meta-analysis of incidenceof upper abdomen discomfort.

tric lavage time, andthe difference was statistically significant.

Comparison of the rate of patients with bloody liquid in lavage fluid: There were 7 included literature studied theincidence ofbloody liquid in lavage fluid. See **Figure 4** and **Table 2** for the result of meta-analysis. Results of heterogeneity test: X^2=2.97, P=0.81, I^2=0%. These researches had fine homogeneity and were analyzed with fixed effect model. The final results of the analysis appeared that the total sample size was 710 cases, with 367 cases in the experimental group and 343 cases in the control group. The test results for overall effect: Z=5.09 (P<0.00001), total RR=0.22, 95% CI=(0.12, 0.39). Thus, the volume of washing fluid in the experimental group which treated with prolongedgastric tube insertion length was more than that in the control group whichtreated with traditional gastric tube insertion length, and the difference was statistically significant.

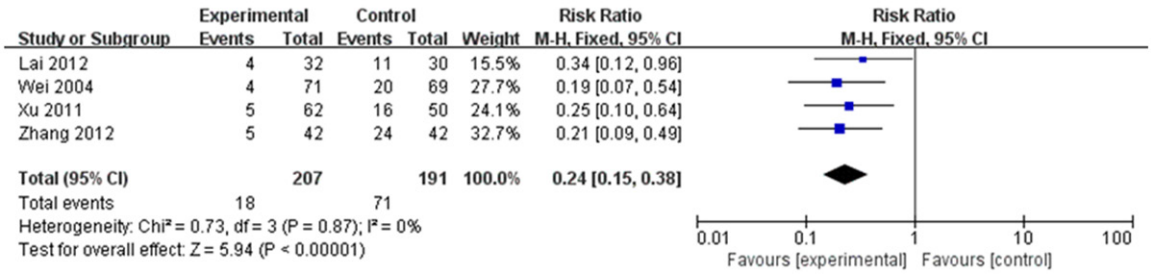

Figure 6. Comparison of gastric lavage successful rate.

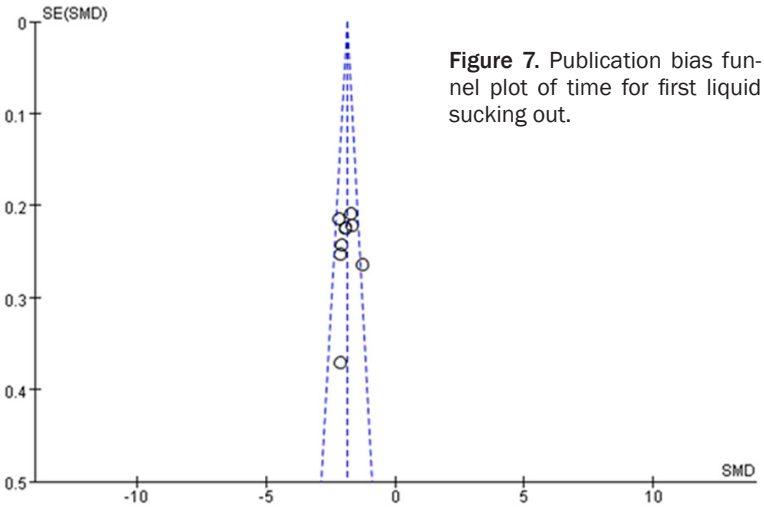

Figure 7. Publication bias funnel plot of time for first liquid sucking out.

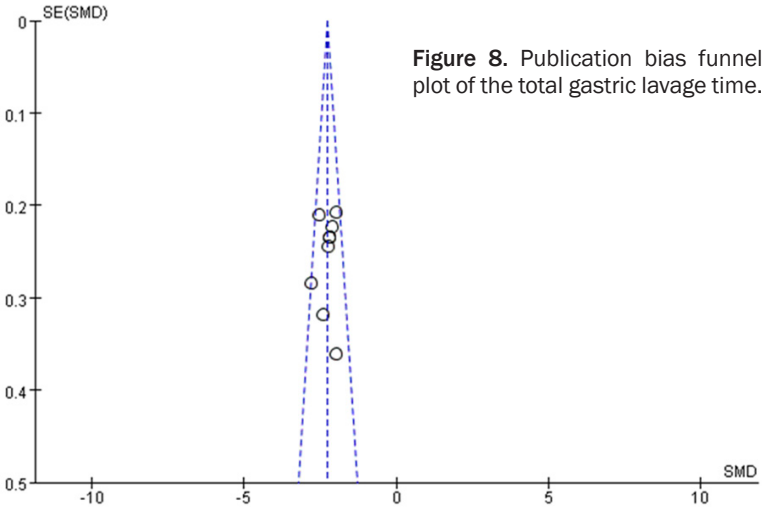

Figure 8. Publication bias funnel plot of the total gastric lavage time.

Comparison of incidence of upper abdomen discomfort: Among the included literature, seven of them studied the incidence of upper abdomen discomfort. See **Figure 5** and **Table 2** for the results of meta-analysis. The results of heterogeneity test: X^2=1.82, P=0.94, I^2=0%. These researches had a preferable canalyzed with fixed effect model. The result of final analysis showed that the total sample size was 707 cases, with 367 cases in experimental group and 340 cases in the control group. The test results for overall effect: Z=5.96 (P<0.00001), total RR=0.26, 95% CI=(0.16, 0.40). Hence, the incidence of upper abdomen discomfort of prolonged gastric tube insertion length was much less than that of traditional gastric tube insertion length, and the difference was statistically significant.

Proportion of patient with successful gastric lavage: Among the included literature, four studied the successful rate of gastric lavage. The result of meta-analysis was shown in **Figure 6** and **Table 2**. The results of heterogeneity test: X^2=0.73, P=0.87, I^2=0%. These studies presented a good-homogeneity and fixed effect model analysis was performed. Finally, the results of the analysis indicated that the total sample sizewas 398 cases, with 207 in the experimental group and 191 in the control group. The test results for overall effect: Z=5.94 (P< 0.00001), RR=0.24, 95% CI=(0.15, 0.38). Th erefore, when the insertion length of gastric tube was prolonged, the success rate of gastric contents pumped out was higher than thatof

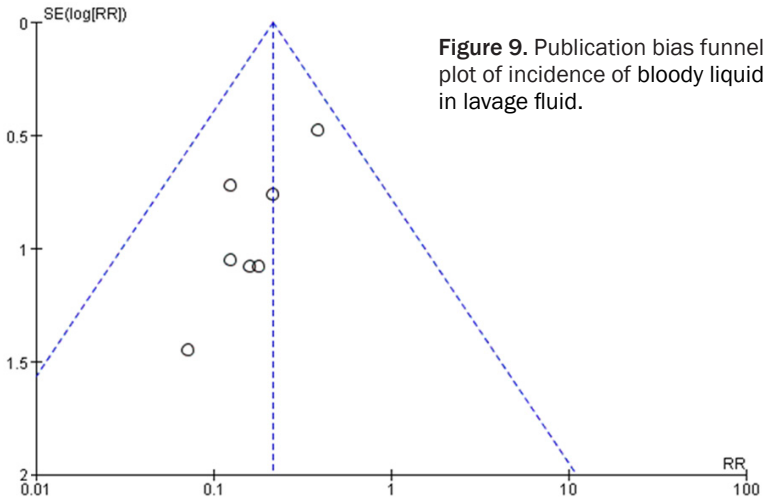

Figure 9. Publication bias funnel plot of incidence of bloody liquid in lavage fluid.

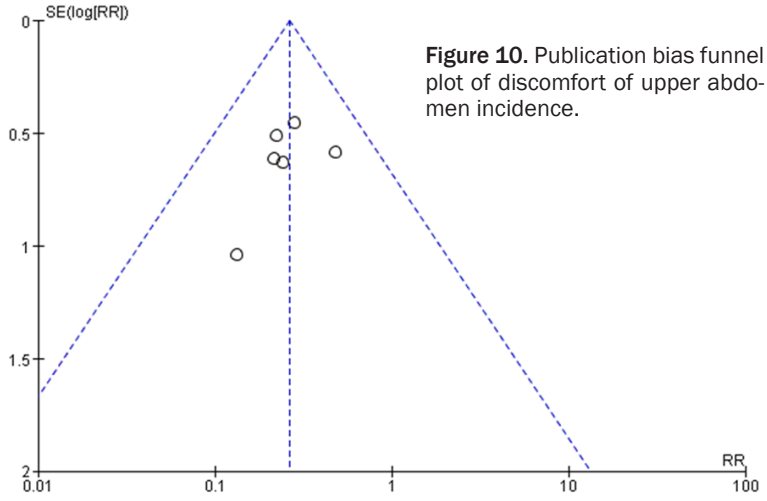

Figure 10. Publication bias funnel plot of discomfort of upper abdomen incidence.

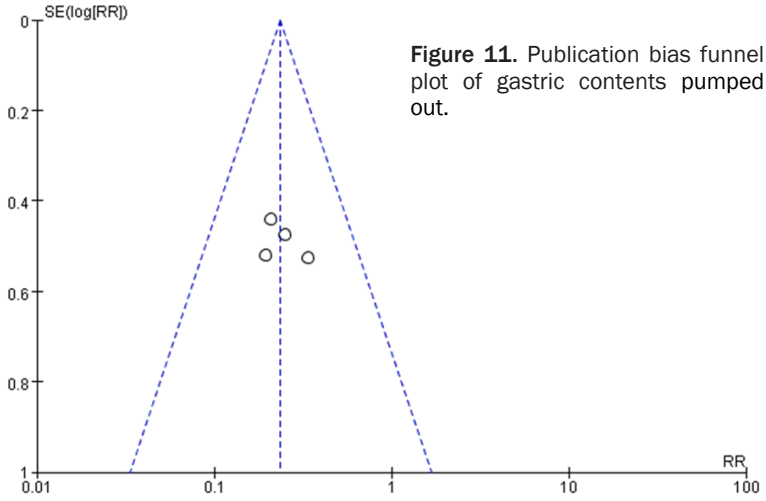

Figure 11. Publication bias funnel plot of gastric contents pumped out.

traditional gastric tube insertion length, and the difference was statistically significant.

Publication bias

Publication bias analysis was performed for the retrieved articles concerning the time for first liquid sucking out, total gastric lavage time, the rate of patients with bloody liquid in lavage fluid, the incidence of upper abdomen discomfort and the success rate of gastric lavage. Funnel plots distributions of these articles which included the above indexes were symmetric without bias (**Figures 7**-**11**).

Discussion

This study found that in the first aid of patients with AOPP, the success rate of gastric lavage in the patients with prolonged gastric tubeinsertion length was higher than that with traditional gastric tubeinsertion length and the-RR was 0.24 with 95% CI of (0.15, 0.38), which indicated that in the treatment of AOPP, the improved gastric lavage method can increase success rate significantly. The studies also found that prolonging the insertion length of gastric tubecould obviously shorten the time for first liquid sucking out in comparison with traditional gastric tube insertion length as SMD was -1.88 with 95% CI of (-2.04, -1.73). Meanwhile, the rate of patients with bloody liquid in lavage fluid significantly increased as RR=0.22 and 95% CI=(0.12, 0.39). The insertion length of traditional gastric tubeand extended gastric tube are 40 to 45 cm and 50 to 55 cm respectively so that the top of latter can reach gastric antrum with side holes entering in stomach completely and the gastric tube can reach below cardia 10 to 15 cm. In this way, the gastric lavage is com-

pletely achieved and the gastric lavage time is shortened, accordingly, the success rate of AOPP first aid is increased [18, 19].

According to the result of this study, we can conclude that prolong the insertion length of gastric tube can relieve the discomfort of upper abdomenas RR=0.26 and 95% CI=(0.16, 0.40). In addition, the study of Wang et al. has found that performing gastric lavage by laparotomy can relieve the discomfort of upper abdomen of patients with AOPP [20]. And the study of Mao et al. also showed that by prolonging the insertion length of gastric tube, the discomfort of upper abdomen of patients with AOPP can be significantly reduced [18]. When large amounts of organophosphorus enter the stomach, the reflex spasm appears, and the poison remains in gastric mucosal folds which is difficult to discharge. Traditional gastric tubecannot reach gastric fundus and gastric antrum, so the poison couldn't be completely discharged. When the gastric tube insertion length is prolonged, the tube can not only reach thegastric fundus and gastric antrum successfully so as to discharge thepoisonous gastric contents completely, but also protect the gastric mucosa as the patients were given gastric lavage on theleft lateral decubitus position which can reduce the contact area between gastric tube and gastric mucosa [20, 21].

There are some limitations in this study as well. It is reported that therapeutic effects and complications of gastric lavage vary by the differences of degree of organophosphorus poisoning and age of patients. For example, thesuccess rate of first aid in patients over 50 is lower than that in young patients andthe deeper of the extent of organophosphate poisoning, the lower of the success rate of first aid [22, 23]. Articles with poor quality which were included in this research would also cause the limitation of Meta-analysis. Meanwhile, the incomplete retrievalmay lead the possible bias as well. Even though comprehensive data retrieval has been done, the size of included articles in this study are not large enough, especially, all these articles only involvedpatients in China.

In conclusion, prolonging the insertion length of gastric tube can shorten the time for first liquid sucking out as well as total gastric lavage time, increase the rate of patients with bloody liquid in lavage fluid and the success rate of gastric lavage, and reduce the incidence of upper abdomen discomfort, so as to significantly increase the success rate in the first aid of patients with APOO.

Disclosure of conflict of interest

None.

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