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 and the success rate of gastric 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 gastric tube 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 lavage and 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 tube with 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]. Therefore, 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
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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 retrieved in 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 up to 2017.

Literature screening

Literatures met 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 of bloody 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).
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Table 1. General information of included literature

<table>
<thead>
<tr>
<th>Included literature</th>
<th>Cases (O/C)</th>
<th>Random method</th>
<th>Withdraw and loss of follow-up</th>
<th>Blind method</th>
<th>Concealment</th>
<th>Jadad scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niu Q (2016) [6]</td>
<td>82/82</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>Yi XW (2015) [7]</td>
<td>75/54</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>Yang SL (2014) [8]</td>
<td>93/76</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>Zhang QG (2012) [9]</td>
<td>42/42</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Lai YQ (2012) [10]</td>
<td>32/30</td>
<td>RCT</td>
<td>D</td>
<td>Yes</td>
<td>No</td>
<td>4</td>
</tr>
<tr>
<td>Chen CJ (2011) [2]</td>
<td>35/35</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Zhao DY (2011) [12]</td>
<td>28/20</td>
<td>RCT</td>
<td>D</td>
<td>No</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Wu CY (2007) [14]</td>
<td>50/55</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Wei CY (2004) [16]</td>
<td>71/69</td>
<td>RCT</td>
<td>D</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>Feng XM (2002) [17]</td>
<td>55/63</td>
<td>RCT</td>
<td>N</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
</tbody>
</table>

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 by standard 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 ($P≥0.1$, $I^2<50%$). 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 $α=0.05$ 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 insertion length.
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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 lavage flu, 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 sucking out: Among the included literatures, ten of them studied the time for first liquid sucked 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% Cl=(-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% Cl=(-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-
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Comparison of the rate of patients with bloody liquid in lavage fluid: There were 7 included literature studied the incidence of bloody liquid in lavage fluid. See Figure 4 and Table 2 for the result of meta-analysis. Results of heterogeneity test: $X^2=2.97, P=0.081, I^2=0\%$. 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 prolonged gastric tube insertion length was more than that in the control group which treated with traditional gastric tube insertion length, and the difference was statistically significant.
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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: $\chi^2=1.82$, $P=0.94$, $I^2=0\%$.

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.

Figure 6. Comparison of gastric lavage successful rate.

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: $\chi^2=0.73$, $P=0.87$, $I^2=0\%$. These studies presented a good-homogeneity and fixed effect model analysis was performed. Finally, the results of the analysis indicated that the total sample size was 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). Therefore, when the insertion length of gastric tube was prolonged, the success rate of gastric contents pumped out was higher than that of...
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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.

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 tube insertion length was higher than that with traditional gastric tube insertion 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 tube could 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 tube and 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-
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完全实现和胃管插入时间缩短，相应地，成功率的AOPP急救率增加[18，19]。据本研究结果，可得出延长胃管插入长度可缓解上腹部的不适RR=0.26和95% CI=(0.16, 0.40)。此外，王等人[20]的研究发现，通过胃管插入长度的延长，可以显著降低AOPP患者的上腹部不适。当大量有机磷进入胃部，反射痉挛出现，毒物难以排出。传统胃管无法达到胃底和胃窦，所以毒物不能完全排出。当胃管插入长度延长时，胃管不仅可以到达胃窦和胃窦，而且可以保护胃黏膜，患者在左侧卧位进行胃管操作时，胃管与胃黏膜的接触面积可以减少[20, 21]。

有些限制在本文中存在。据报道，含有毒物和并发症的胃洗液的治疗效果和器官磷中毒的浓度和年龄有关。例如，如果在50岁以上患者中的第一洗液成功率高于年轻患者，深度的器官磷中毒，成功率的降低[22, 23]。文献有低质量，以及未在本研究中被纳入。Meanwhile，不完整的检索可能会导致可能的偏差。甚至尽管全面数据的收集，本文研究中包含的二次文献的数量可能不够大，尤其是所有这些文章只涉及在中国的患者。

在结论中，延长胃管插入长度可以缩短第一次洗液的时间，以及总胃洗液时间，增加患者有血性洗液和成功的胃洗液，减少上腹部不适的发生，从而显著提高AOPP患者的急救成功率。

Disclosure of conflict of interest
None.

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