

# World Journal of *Clinical Cases*

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*World Journal of Clinical Cases* (*WJCC*) is now indexed in PubMed, PubMed Central, Science Citation Index Expanded (also known as SciSearch®), and Journal Citation Reports/Science Edition. The 2018 Edition of Journal Citation Reports cites the 2017 impact factor for *WJCC* as 1.931 (5-year impact factor: N/A), ranking *WJCC* as 60 among 154 journals in Medicine, General and Internal (quartile in category Q2).

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**NAME OF JOURNAL**  
*World Journal of Clinical Cases*

**ISSN**  
ISSN 2307-8960 (online)

**LAUNCH DATE**  
April 16, 2013

**FREQUENCY**  
Semimonthly

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Fax: +1-925-2238243  
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Help Desk: <http://www.f6publishing.com/helpdesk>  
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**PUBLICATION DATE**  
November 6, 2018

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# Photodynamic therapy for middle-advanced stage upper gastrointestinal carcinomas: A systematic review and meta-analysis

Bo Chen, Li Xiong, Wei-Dong Chen, Xiao-Hua Zhao, Jun He, Yan-Wen Zheng, Fan-Hua Kong, Xi Liu, Zi-Jian Zhang, Xiong-Ying Miao

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**Supported by** the National Natural Science Foundation of China, No. 81372628, No. 81773293, and No.31660266; the Natural Science Foundation of Hunan Province, No. 12JJ5048; and the Science and Technology Plan Fund of Hunan Province, P.R. China, No. 2018JJ3758, No. 2017WK2063, No. 2017DK2011, No. 2015GK3117, and No. 2014WK2016.

**Conflict-of-interest statement:** No potential conflicts of interest relevant to this article are reported.

**PRISMA 2009 Checklist statement:** The manuscript was prepared and revised according to the PRISMA 2009 Checklist.

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**Manuscript source:** Unsolicited manuscript

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**Received:** July 19, 2018

**Peer-review started:** July 19, 2018

**First decision:** August 25, 2018

**Revised:** September 13, 2018

**Accepted:** October 11, 2018

**Article in press:** October 11, 2018

**Published online:** November 6, 2018

## Abstract

### AIM

To determine the therapeutic effect of photodynamic therapy (PDT) for middle-advanced stage upper gastrointestinal carcinomas.

### METHODS

We searched PubMed, EMBASE, the Cochrane Library, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Wanfang Database from inception to April 2018 for randomized controlled studies. These studies compared PDT with other palliative therapies (radiotherapy, chemotherapy, or Nd:YAG laser) and compared PDT, radiotherapy, or chemotherapy alone with PDT combined with chemotherapy/radiotherapy. In our meta-analysis, both fixed and random effects models were used to estimate



the risk ratio (RR) for dichotomous outcomes (the response rate and one-year survival rate).

## RESULTS

Ten random controlled clinical studies with 953 patients were included in the analysis. The effective rate for PDT was better than that of radiotherapy or Nd:YAG laser for the treatment of middle-advanced upper gastrointestinal carcinomas [RR = 1.36; 95% confidence interval (CI): 1.13-1.65;  $P = 0.001$ ]. In addition, PDT combined with chemotherapy had significantly better efficacy and a higher one-year survival rate than PDT or chemotherapy alone (significant remission rate, RR = 1.62; 95%CI: 1.34-1.97;  $P < 0.00001$ ; one-year survival rate, RR = 1.81; 95%CI: 1.13-2.89;  $P = 0.01$ ).

## CONCLUSION

PDT is a useful method for the treatment of middle-advanced stage upper gastrointestinal carcinomas. PDT combined with chemotherapy or radiotherapy can enhance its efficacy and prolong survival time.

**Key words:** Photodynamic therapy; Radiotherapy; Chemotherapy; Upper gastrointestinal tract; Nd:YAG laser; Gastrointestinal neoplasm; Gastrointestinal diseases; Meta-analysis

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**Core tip:** Photodynamic therapy (PDT) is minimally invasive compared with chemotherapy and radiotherapy for the treatment of cancers. Limited data exist regarding the efficacy of PDT alone or combined with radiotherapy and chemotherapy for the treatment of middle-advanced stage upper gastrointestinal carcinomas. Therefore, we performed a systematic review and meta-analysis of ten available randomized controlled clinical trials that addressed the efficacy of PDT alone or combined with radiotherapy and chemotherapy in patients with middle-advanced stage upper gastrointestinal carcinomas. Our analysis showed that PDT may be suitable for single or combined treatment of middle-advanced stage upper gastrointestinal carcinomas, especially for elderly patients, those with severe diseases, those with severe complications, and those unwilling to undergo surgery.

Chen B, Xiong L, Chen WD, Zhao XH, He J, Zheng YW, Kong FH, Liu X, Zhang ZJ, Miao XY. Photodynamic therapy for middle-advanced stage upper gastrointestinal carcinomas: A systematic review and meta-analysis. *World J Clin Cases* 2018; 6(13): 650-658 Available from: URL: <http://www.wjgnet.com/2307-8960/full/v6/i13/650.htm> DOI: <http://dx.doi.org/10.12998/wjcc.v6.i13.650>

## INTRODUCTION

Upper gastrointestinal carcinomas, including esophageal and gastric cancer, constitute major health problems

worldwide<sup>[1]</sup>. Gastric cancer is the fifth most common malignancy and is the third leading cause of cancer death. In 2012, there were approximately 95200 new cases of gastric cancer in the world. Esophageal carcinoma is the eighth most common cancer worldwide. In 2012, the number of new cases of esophageal cancer was approximately 456000, and the number of deaths was approximately 400000. The five-year survival rate ranged between 13% and 18%<sup>[2]</sup>.

At present, the standard treatment for upper gastrointestinal carcinomas is surgical resection. However, many patients are diagnosed in middle-advanced stage or are elderly, and most of them have lost their best chance of surgery. These patients can undergo palliative treatments only to relieve esophageal obstruction symptoms to improve their quality of life<sup>[3]</sup>. Palliatively, the principal regimens for middle-advanced stage upper gastrointestinal carcinomas include chemotherapy, radiotherapy, and endoscopic ablation<sup>[4]</sup>. Specially, endoscopic ablation treatment includes photodynamic therapy (PDT)<sup>[5]</sup>, Nd:YAG laser<sup>[6]</sup>, radiofrequency ablation<sup>[7]</sup>, and argon plasma coagulation<sup>[8]</sup>.

Chemotherapy and radiotherapy are curative treatment options for upper gastrointestinal carcinomas. Chemotherapy has a mitigating effect on a small group of patients whose disease is in the advanced stage. However, low response rates, severe toxic side-effects, and drug resistance have limited further use of chemotherapy<sup>[9]</sup>. Radiotherapy can cause extensive damage to adjacent organs, thereby reducing its clinical value<sup>[10]</sup>. Therefore, it is urgent to develop new antitumor treatments to overcome these limitations.

In recent decades, PDT has become an alternative to radiotherapy and chemotherapy for a variety of diseases including cancer because of its minimally invasive nature<sup>[11]</sup>. It utilizes a specific light wavelength to activate a photosensitizer in cells, thereby generating reactive oxygen species to damage cancer cells<sup>[12]</sup>. By virtue of the fact that PDT is noninvasive, highly selective, and lowly toxic, it can reduce damage to surrounding tissues of the intestine and decrease the risk of intestinal leakage. In addition, it has high patient acceptance/compliance and is a relatively simple procedure<sup>[13]</sup>. Therefore, PDT has played an increasingly important role in the treatment of upper gastrointestinal tumors and precancerous diseases. PDT can also be used in combination with chemotherapy or radiation to improve efficacy and reduce side-effects<sup>[14]</sup>.

Recently, several randomized controlled trials (RCTs) have verified the efficacy of PDT alone or PDT combined with radiotherapy/chemotherapy for treatment of middle-advanced stage upper gastrointestinal carcinomas. Therefore, we undertook a systematic review and meta-analysis of RCTs regarding the combination of PDT with chemotherapy or radiotherapy for the treatment of middle-advanced stage upper gastrointestinal carcinomas, with particular reference to survival rate and tumor response rate (the significant remission rate and effective rate).

## MATERIALS AND METHODS

### Literature search

PRISMA statement guidelines were followed for the calculation and reporting of meta-analysis data<sup>[15]</sup>. A literature retrieval was carried out in PubMed, EMBASE, the Cochrane Library, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Wanfang Database from inception to May 2018 using the following key words: "upper gastrointestinal carcinoma", "gastric carcinoma", "stomach cancer", "cardia carcinoma", "esophageal carcinoma", "esophagocardiac carcinoma", "photodynamic therapy", "endoscopic therapy", "ablation", "radiotherapy", "brachytherapy", "irradiation", "brachyradiotherapy", "chemotherapy", "randomized controlled trial", and "clinical studies". All analyses were based on previously published studies. Therefore, no ethics approval or patient consent was required.

### Inclusion and exclusion criteria

Studies that met the following criteria were included: adults with middle-advanced stage upper gastrointestinal carcinomas confirmed by endoscopy or pathologic diagnosis; the intervention arm was PDT alone or PDT combined with chemotherapy/radiotherapy; and the control arm was palliative treatment (radiotherapy, chemotherapy, or Nd: YAG laser). RCTs had access to the full text. The following studies were excluded: those with no control group; those in which the study outcomes did not include complete or available efficacy data; case reports, abstracts, letters, comments, reviews without original data; and studies that presented insufficient data.

### Study selection and data extraction

Two reviewers read the structured table to extract data from relevant articles. Any disagreement between the two reviewers was resolved by discussion with a third reviewer. For duplicated articles, we extracted relevant data from the most recent article. We extracted first author, publication year, study design, participant number, average age, proportion of men and women, type of upper gastrointestinal carcinomas, intervention methods, and primary outcomes.

### Quality assessment and publication bias

The Cochrane System Evaluation Manual Intervention was used to assess the quality of randomized controlled clinical studies. Funnel plots were constructed to assess the risk of publication bias.

### Statistical analysis

Tumor response rate (the significant remission rate and effective rate) was evaluated one month after PDT. The criteria for PDT established at the national conference held in 1984 were as follows: complete remission (CR), tumor disappearance and no histologic examination of cancer cells for at least one month; partial remission

(PR), extensive tumor necrosis and tumor volume regressed for at least 1 mo; mild remission (MR), the tumor volume decreased less than 50% for at least one month; and no remission (NR), no obvious necrosis and tumor volume decreased slightly or even increased. The significant remission rate included CR and PR. The effective rate included CR, PR, and MR. The meta-analysis was performed using Review Manager (version 5.3.0) software. We calculated risk ratio (RR) and 95% confidence interval (CI) values for binary variables. In addition, a  $P$ -value  $< 0.05$  was considered significant. Heterogeneity tests were performed using the chi-square statistic ( $P$ -value  $< 0.10$  considered significant) and  $I^2$  tests. If  $P < 0.10$  or  $I^2 > 50\%$ , indicating that the heterogeneity was large, a random effects model was used. If  $P > 0.10$  or  $I^2 < 50\%$ , indicating that the heterogeneity was small, a fixed effects model was used.

## RESULTS

### Characteristics of the included studies

A flow chart of the study selection process and exclusion criteria is shown in Figure 1. A total of 501 studies were identified based on the search criteria. We filtered by title, abstract, and full text. Eventually, ten studies met the inclusion and exclusion criteria<sup>[16-25]</sup>. The total number of patients was 953; of these patients, 523 underwent PDT alone or PDT combined with other palliative therapies (radiotherapy, chemotherapy), and 430 were in the control group. The characteristics of all included studies are shown in Table 1.

### Evaluation for equality of studies

We used the standards of the Cochrane System Evaluation Manual Intervention for this assessment<sup>[26]</sup>. For the included RCTs, assessment of the bias risk involved the following parameters: sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting bias, and other potential sources of bias. Detailed results of the assessments are shown in Figures 2 and 3.

### Risk of publication bias

Potential publication bias was assessed by visual inspection of the funnel plots (Figure 4), which suggested no obvious evidence of publication bias.

### Significant remission rates of PDT and other palliative treatments

Two studies reported the significant remission rates of PDT and other palliative treatments (Nd:YAG laser or radiotherapy). The result of meta-analysis showed that the value of the significant remission rate (CR + PR) increased with PDT therapy (RR = 1.36; 95%CI: 1.09-1.69;  $P = 0.007$ ;  $I^2 = 0\%$ ). Therefore, we used a fixed model (Figure 5A).

### Effective rates of PDT and other palliative treatments

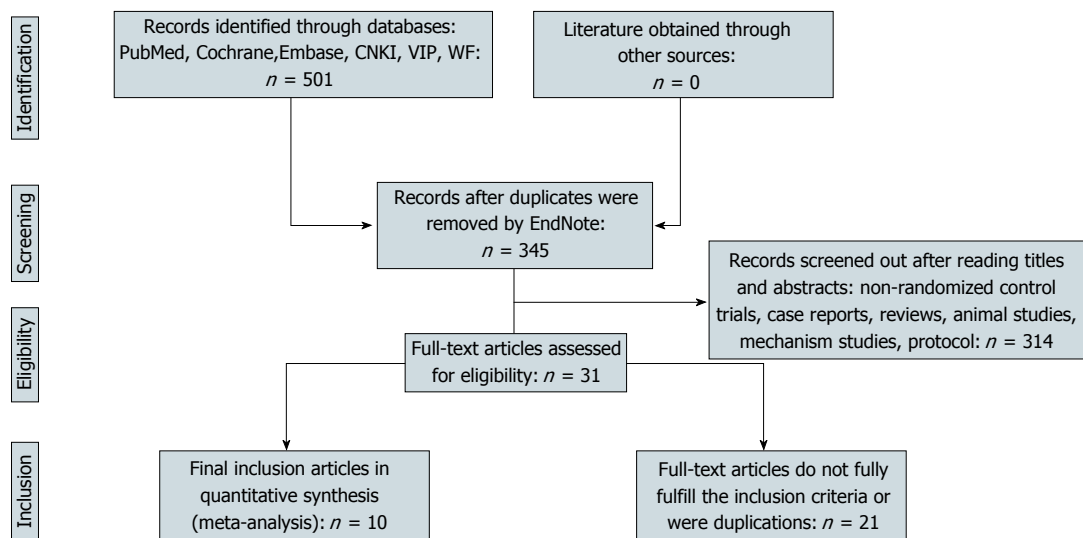
Three studies reported the effective rates of PDT



**Table 1** Ten randomized controlled trials studies meeting the criteria for the meta-analysis

Study	Study design	Time of case inclusion	Cancer type	Age (yr)	Gender (M/F)	Sample size (E/C)	Intervention		Main outcomes
							Experiment	Control	
Jin <i>et al</i> <sup>[16]</sup>	RCT	Sep. 1982-July 1990	Advanced cardiac cancer	(34-91)	139/5	144 (96/48)	PDT <sup>1</sup> + CHT <sup>2</sup>	CHT <sup>2</sup>	SR, ER, MST, OSR
Zhang <i>et al</i> <sup>[17]</sup>	RCT	1990-1994	Advanced upper gastrointestinal cancer	56.8 (29-77)	42/41	53 (13/40)	PDT <sup>1</sup> + CHT <sup>3</sup>	PDT <sup>1</sup>	SR, ER, MST
Heier <i>et al</i> <sup>[18]</sup>	RCT	NA	Esophageal cancer	69 (42-87)	26/16	42 (22/20)	PDT <sup>4</sup>	Nd:YAG <sup>5</sup>	ER, AEs, KPS, EG
Lightdale <i>et al</i> <sup>[19]</sup>	RCT	Sep. 1988-Aug. 1992	Esophageal cancer	70	169/67	236 (118/118)	PDT <sup>6</sup>	Nd:YAG <sup>7</sup>	SR, ER, AEs, SP
Qin <i>et al</i> <sup>[20]</sup>	RCT	June 1993-May 1995	Middle-advanced stage esophageal cancer	58.6 (43-73)	44/15	59 (32/27)	PDT <sup>8</sup> + RAT <sup>9</sup>	RAT <sup>9</sup>	SR
Zhang <i>et al</i> <sup>[21]</sup>	RCT	NA	Advanced esophagocardiac cancer	60.8 (40-81)	111/29	140 (98/42)	PDT <sup>10</sup> + CHT <sup>3</sup>	PDT <sup>10</sup>	SR, ER, OSR
Zhou <i>et al</i> <sup>[22]</sup>	RCT	Dec. 2007-June 2009	Middle-advanced stage cardiac cancer	59.5 (38-82)	63/21	84 (46/38)	PDT <sup>11</sup> + CHT <sup>12</sup>	CHT <sup>12</sup>	SR, ER, OSR
Li <i>et al</i> <sup>[23]</sup>	RCT	Jan. 2013-Oct. 2014	Middle-advanced stage gastric cancer	NA	45/19	64 (32/32)	PDT <sup>1</sup> + CHT <sup>13</sup>	PDT <sup>1</sup>	SR, ER, AEs
Li <i>et al</i> <sup>[24]</sup>	RCT	Feb. 2013- Feb. 2014	Advanced esophageal cancer	(53-83)	40/22	61 (31/30)	PDT <sup>1</sup>	RAT <sup>14</sup>	SR, ER, AEs
Jin <i>et al</i> <sup>[25]</sup>	RCT	Sep. 2014- Sep. 2015	Advanced esophageal cancer	(47-76)	41/29	70 (35/35)	PDT <sup>1</sup> + CHT <sup>15</sup>	CHT <sup>15</sup>	SR, ER, AEs, OSR

<sup>1</sup>Haematoporphyrin derivative (5 mg/kg); <sup>2</sup>UFTM (UFT 450 mg/d and mitomycin C 8-10 mg/wk); <sup>3</sup>5-FU (250-500 mg/time); <sup>4</sup>Photomedica (2 mg/kg); 590 W; 6Porfimer sodium (2 mg/kg); 715-90 W; <sup>8</sup>PsD-007 (5 mg/kg); <sup>9</sup>DT 55 -70 Gy; <sup>10</sup>PsD-007 (3-5 mg/kg); <sup>11</sup>PsD-007 (3-5 mg/kg); <sup>12</sup>5-Fu (250-500 mg/time) + bleomycin (15 mg/time); <sup>13</sup>S-1 (40 mg/m<sup>2</sup>); <sup>14</sup>DT 40-50 Gy; <sup>15</sup>NDP (80-100 mg/m<sup>2</sup>) + 5-FU (500-750 mg/m<sup>2</sup>). RCT: Randomized controlled trial; RAT: Radiotherapy; CHT: Chemotherapy; PDT: Photodynamic therapy; NA: Not available; M/F: Male/female; E/C: Experiment group/control group; AEs: Adverse events; SR: Significant remission rate; ER: Effective rate; MST: Mean survival time; OSR: One year survival rate; EG: Esophageal grade; SP: Symptom palliation.



**Figure 1** Flow diagram of included studies in the meta-analysis (up to April 2018). CNKI: China National Knowledge Infrastructure; VIP: China Science and Technology Journal Database; WF: Wanfang Database.

and other palliative treatments (Nd:YAG laser or radiotherapy). The result of meta-analysis showed that

the value of the effective rate (CR + PR + MR) increased with PDT therapy (RR = 1.36; 95%CI: 1.13-1.65; *P*

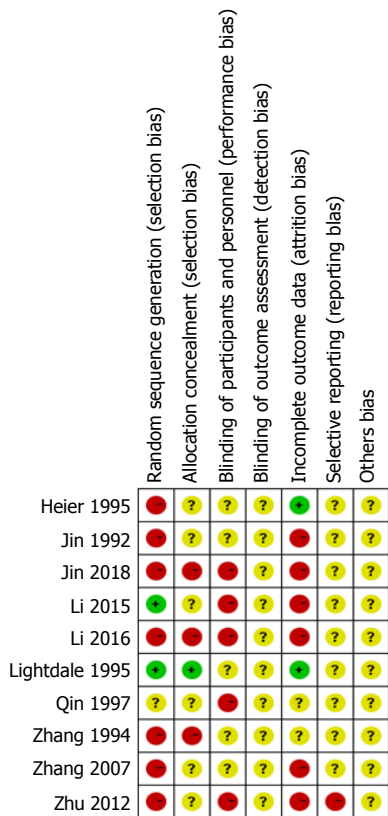


Figure 2 Risk of bias summary: review authors' judgements regarding risk of bias item for each included study.

= 0.001;  $I^2 = 0\%$ ). Therefore, we used a fixed model (Figure 5B).

**Significant remission rate of PDT combined with chemotherapy/ radiotherapy vs PDT/ chemotherapy/ radiotherapy**

Seven included studies reported the significant remission rates of PDT combined with chemotherapy/ radiotherapy and PDT/chemotherapy/ radiotherapy alone. The result of meta-analysis showed that the value of the significant remission rate increased in PDT combined with chemotherapy or radiotherapy (RR = 1.62; 95%CI: 1.34-1.97;  $P < 0.00001$ ;  $I^2 = 29\%$ ). Therefore, we used a fixed model (Figure 5C).

**Effective rate of PDT combined with chemotherapy vs PDT/chemotherapy**

Six included studies reported the effective rates of PDT combined with chemotherapy/radiotherapy and PDT/chemotherapy/radiotherapy alone. The result of meta-analysis showed that the value of the effective rate increased with PDT combined with chemotherapy (RR = 1.09; 95%CI: 1.00-1.19;  $P = 0.04$ ;  $I^2 = 42\%$ ). Therefore, we used a fixed model (Figure 5D).

**One-year survival rate for PDT combined with chemotherapy vs PDT/ chemotherapy**

Four included studies reported one-year survival rates

for PDT combined with chemotherapy and PDT or chemotherapy alone. The results of meta-analysis showed that the value of the one-year survival rate increased with PDT combined with chemotherapy (RR = 1.81; 95%CI: 1.13-2.89;  $P = 0.01$ ;  $I^2 = 58\%$ ). Therefore, we used a random model (Figure 5E).

**DISCUSSION**

Upper gastrointestinal carcinomas are the most common malignant tumors of the digestive tract. Because the early symptoms of patients are atypical, most of these diseases are already in the middle-advanced stage at diagnosis<sup>[27]</sup>. Currently, the primary method for radical treatment of upper gastrointestinal carcinomas is surgical resection. However, due to complicated patient conditions, old age, and high surgical risk, many patients are reluctant to undergo surgery<sup>[28]</sup>. In recent years, increasing numbers of domestic and foreign scholars have used PDT alone or in combination with other palliative therapies to treat middle-advanced stage upper gastrointestinal carcinomas. Although the total number of cases is small, the treatment of cancer has achieved positive results.

Lightdale *et al.*<sup>[19]</sup> reported that PDT was an effective method for treating esophageal cancer and that its efficacy was superior to that of Nd: YAG laser. Furthermore, this treatment can prolong the survival time of patients. The PDT procedure is also simple and more accepted by patients. Li *et al.*<sup>[24]</sup> reported that PDT alleviated the dysphagia associated with esophageal cancer. Dysphagia improved significantly during this period and the curative effect was better than that of local radiotherapy. Our study showed that PDT was suitable for middle-advanced stage upper gastrointestinal carcinomas, and that it increased the significant remission rate (CR + PR) and the effective rate (CR + PR + MR) over that of Nd:YAG laser or radiotherapy alone, which is in agreement with results from studies by Lightdale and Li<sup>[19,24]</sup>.

PDT has several potential advantages over traditional palliative treatments. Unlike chemotherapy and radiotherapy, neither tumor DNA nor rapidly dividing tumor cells are targeted by PDT, therefore, PDT rarely induces secondary tumorigenesis. PDT can also be reused in the same location without increasing its toxicity<sup>[29]</sup>. Unlike Nd:YAG laser, PDT selectively kills cancer cells without damaging the surrounding tissue, extending the healing time of wounds, or increasing the formation of scars after treatment, thereby reducing the possibility of posttreatment obstruction<sup>[30]</sup>.

However, due to the limited ability of the laser to penetrate tissue, PDT has little effect on deep invasive lesions<sup>[31]</sup>. PDT combined with chemotherapy or radiotherapy can improve overall efficacy. Zhang *et al.*<sup>[21]</sup> reported that PDT combined with local chemotherapy was a safe and effective way to treat advanced esophageal cancer. Local administration of 5-FU improved PDT efficacy and prolonged survival time. Qin *et al.*<sup>[20]</sup>

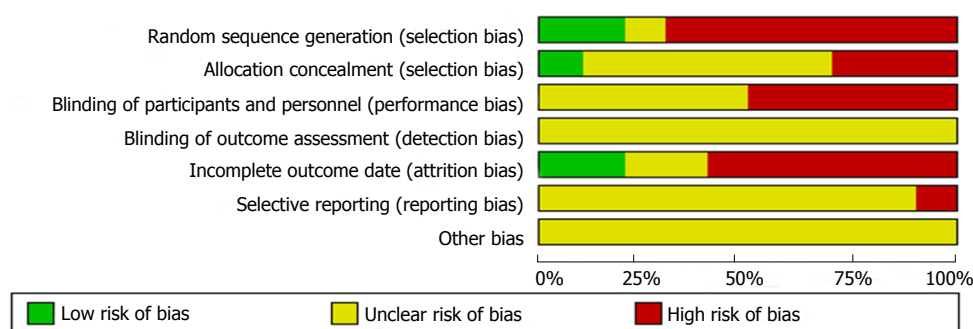


Figure 3 Risk of bias graph: review authors' judgements regarding risk of bias items presented as percentages across all included studies.

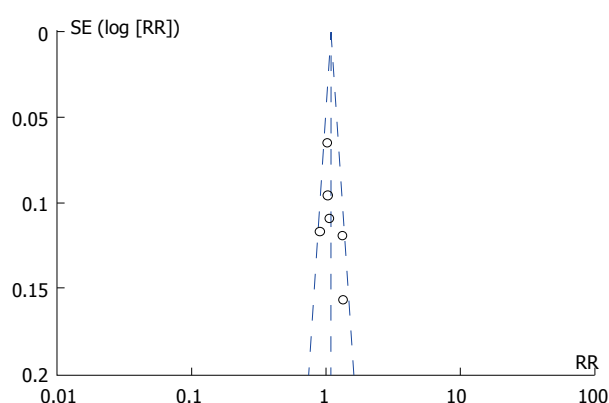


Figure 4 The funnel plot of the significant remission rate between photodynamic therapy combined with chemotherapy and photodynamic therapy/chemotherapy alone in middle-advanced upper gastrointestinal carcinomas. RR: Risk ratio.

reported that PDT combined with local radiotherapy was an effective treatment for advanced esophageal cancer. Local radiotherapy also improved radiological outcomes and extended survival time. Our study showed that PDT combined with radiotherapy or chemotherapy significantly improved the significant remission rate, the effective rate, and the one-year survival rate for middle-advanced stage upper gastrointestinal carcinomas over rates achieved with single therapy, which is consistent with the work of Zhang and Qin.

The primary mechanisms of the coordinated effect of PDT and chemotherapy are the following: first, PDT and chemotherapeutic drugs act on tumor cells in different cell cycles; second, chemotherapeutic drugs increase the uptake of photosensitizers by increasing the permeability of cell membrane to photosensitizers; third, chemotherapeutic drugs damage the repair function of cells, thereby enhancing photodynamic killing capacity<sup>[32,33]</sup>. The synergistic mechanism of PDT combined with radiotherapy is mainly because some anti-PDT tumor cells are sensitive to radiotherapy, and some anti-radiotherapy tumor cells are sensitive to PDT. In addition, it has been reported that some photosensitizers can also be used as radiosensitizers<sup>[34,35]</sup>.

To the best of our knowledge, this study is the first systematic review and meta-analysis of RCTs

to analyze the effect of PDT alone or PDT combined with chemotherapy or radiotherapy for the treatment of middle-advanced stage upper gastrointestinal carcinomas. Nevertheless, there were some deficiencies in the current meta-analysis. First, the number of studies included in this analysis was relatively small, and most of the studies were published a long time ago. Second, the evaluation of the literature indicated that the quality of the literature was generally low. Third, RCTs were conducted in different ways, including tumor characteristics, PDT treatment options, differences in chemotherapy or radiotherapy, and outcome assessment. These differences may lead to heterogeneity and may have an impact on our results. Therefore, it is necessary to carry out more and better RCTs to provide more rigorous evidence for the therapeutic effects of various interventions and to guide clinical practice.

In summary, the results of this meta-analysis provide evidence that PDT is an effective treatment for middle-advanced stage upper gastrointestinal carcinomas. Other palliative treatments (chemotherapy/radiotherapy/Nd: YAG laser) were less effective than PDT. Compared with PDT/radiotherapy/ chemotherapy alone, PDT combined with radiotherapy/chemotherapy gave significantly better tumor response rates and a higher one-year survival rate. Our results suggest that PDT may be suitable for single or combined treatment of middle-advanced stage upper gastrointestinal carcinomas, especially for elderly patients, those with severe diseases, those with severe complications, and those unwilling to undergo surgery.

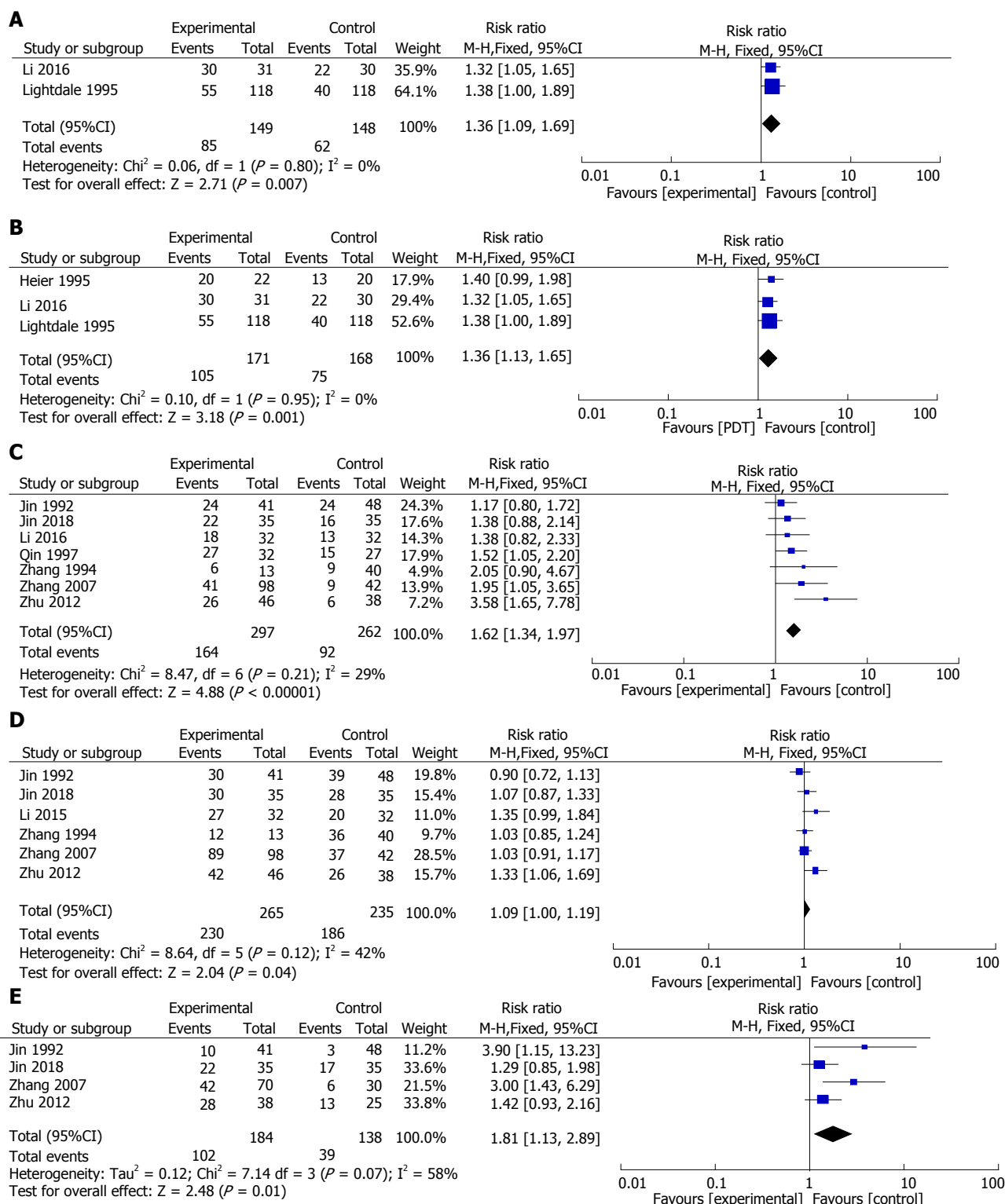
## ARTICLE HIGHLIGHTS

### Research background

The standard treatment for upper gastrointestinal cancers is surgical resection. However, many patients are diagnosed in middle-advanced stage or are elderly, and most of them have lost their best chance of surgery. These patients can only receive palliative treatments to relieve esophageal obstruction symptoms. Photodynamic therapy (PDT) can significantly improve the symptoms of patients with middle-advanced stage upper gastrointestinal carcinomas. PDT can also be used in combination with chemotherapy or radiation to improve efficacy and reduce side-effects.

### Research motivation

The main aim of the present study was to clarify the effect of PDT alone or in combination with radiotherapy/chemotherapy for the treatment of middle-advanced stage upper gastrointestinal carcinomas.



**Figure 5 Forest plots of the risk ratio.** A: Significant remission rate associated with middle-advanced stage upper gastrointestinal carcinomas; B: Effective rate associated with middle-advanced stage upper gastrointestinal carcinomas; C: Significant remission rate associated with middle-advanced stage upper gastrointestinal carcinomas; D: Effective rate associated with middle-advanced stage upper gastrointestinal carcinomas; E: One-year survival rate associated with middle-advanced stage upper gastrointestinal carcinomas. The box represents the RR point estimate of each study, and its area is proportional to the weight of the estimate. Horizontal lines represent the 95%CI. RR: Risk ratio; CI: Confidence interval.

## Research objectives

This was the first comprehensive article on this topic to take into account all the available evidence. We quantified the effect of PDT in addition to radiotherapy/chemotherapy for middle-advanced stage upper gastrointestinal carcinomas.

## Research methods

A meta-analysis was performed according to the guidelines of the PRISMA protocol. PubMed, Cochrane Library, EMBASE, Cochrane Library, China National Knowledge Infrastructure, and China Science and Technology Journal

Database databases were comprehensively searched for studies analyzing the effect of PDT alone or combined with radiotherapy/chemotherapy for middle-advanced stage upper gastrointestinal carcinomas. The risks of bias and quality of the individual studies were assessed using funnel plots and the Cochrane System Evaluation Manual Intervention. Both fixed and random effects models were used to estimate the risk ratios for dichotomous outcomes.

### Research results

The statistical analysis involved 953 patients with middle-advanced stage upper gastrointestinal carcinomas. The results showed that the effective rate of PDT was better than that of radiotherapy or Nd:YAG laser for the treatment of middle-advanced stage upper gastrointestinal carcinomas. Furthermore, PDT combined with chemotherapy gave significantly better efficacy and higher one-year survival rates than PDT or chemotherapy alone.

### Research conclusions

PDT may be suitable for single or combined treatment of middle-advanced stage upper gastrointestinal carcinomas, especially for patients in old age, with severe diseases, severe complications, or who are unwilling to undergo surgery.

### Research perspectives

Further research would be essential to understand the effect of PDT alone or combined with radiotherapy/chemotherapy in the treatment of middle-advanced stage upper gastrointestinal carcinomas. A multicenter, double-blind, randomized controlled trial could provide a better answer.

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