Review Article

Effects of propofol intravenous general anesthesia and inhalational anesthesia on T-lymphocyte activity after breast cancer surgery: A meta-analysis

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Background: Breast cancer is one of the most common cancers in women. General anesthesia is a commonly used anesthesia method for breast cancer surgery, and studies have confirmed that general anesthesia can induce immunosuppression in breast cancer patients and increase the metastasis rate of tumors. However, the difference between the effects of intravenous general anesthesia and inhalation anesthesia on the function of T-lymphocytes is still controversial, and it is necessary to explore reasonable anesthesia methods to reduce immunosuppression caused by surgery and anesthesia. **Materials and Methods:** Databases (Embase, PubMed, Cochrane Library, CBM, CNKI, and Wanfang) were searched (up to October 2022) for randomized controlled trials (RCTs) comparing intraoperative inhalation anesthesia and propofol intravenous anesthesia in breast cancer patients, with the outcome of T-lymphocyte subsets. The meta-analysis was performed by STATA 14.0. **Results:** Six RCTs with 352 patients were included in the study. Compared with inhalation anesthesia, there was no difference in T-lymphocyte subsets between the two groups immediately after surgery, but the activities of $CD4^+$ T cells in patients with propofol anesthesia were higher (standard mean difference [SMD] = 0.234, 95% confidence interval [CI]: 0.003–0.466, $P = 0.047$, $I^2 = 44.1\%$) than those under inhalation anesthesia 1 day after surgery, and $CD4^+/CD8^+$ activities in patients with propofol anesthesia were higher (SMD = 304, 95% CI: 0.072–0.537, $P = 0.010$, $I^2 = 48.0\%$) than those under inhalation anesthesia 1 day after surgery. **Conclusion:** There were no differences in the effects of propofol and inhalation anesthetics on T-lymphocytes immediately after surgery, but the inhibitory effects of inhalation anesthetics on $CD4^+$ and $CD4^+/CD8^+$ cells were stronger 1 day after surgery.

Key words: Anesthesia, breast cancer, propofol, T-lymphocytes

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INTRODUCTION

Breast cancer has the highest incidence in women, accounting for 30% of all cancers in the female population, and the incidence of infectious breast cancer in women increased slightly from 2007 to 2016, increasing by 0.3% per year.[1] Surgical removal of solid tumors is the most common and effective form of treatment, and the usual anesthesia for breast surgery is general anesthesia, including intravenous propofol anesthesia and inhalation anesthesia. However, surgery and anesthesia also pose several side risks to patients, which can produce intense stress responses, induce immunosuppression, and cause cancer to recur or metastasize. Immunocompromise has no benefits to the recovery of the disease and long-term survival in breast cancer patients, whereas anesthesia and surgery will lead to a 3–4 times increase in the rate of tumor metastasis in tumor patients.[2] Therefore, it is very important to explore how to choose a reasonable anesthesia method to appropriately reduce the immune suppression caused by surgery and anesthesia.

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A controversial view is that propofol-based anesthesia seems to reduce perioperative immunosuppression compared to general anesthesia with volatile anesthetics.[3] The results of existing clinical trials studying propofol, including laboratory studies, are inconsistent. More research supports that the beneficial effects of propofol on the immune system are largely restricted to NK cells.[4] Among the immune cells, helper $CD4^+$ Th1 cells and $CD8^+$ cytotoxic T-lymphocytes (CTLs) are the major antitumor effector cells, which are implicated in postoperative cancer recurrence and metastasis.[5] Some studies have proven that propofol can alleviate immunosuppression in breast cancer patients, preserve the activity of T-lymphocytes, and induce apoptosis of tumor cells, whereas inhalation anesthesia significantly reduces T-lymphocyte subsets, increasing tumor proliferation, migration, and invasion.[6-10] Some studies also believe that the effect of propofol-based anesthesia on cancer cell and CTL functions does not differ from that of sevoflurane-based anesthesia in breast cancer surgery.[11]

Therefore, in this meta-analysis, we pooled the results of prospective randomized controlled trials (RCTs) and attempted to determine the effect of propofol intravenous anesthesia and inhalation anesthesia on the activity of T-lymphocytes in patients immediately after breast cancer surgery and 1 day after surgery.

METHODS

This meta-analysis was conducted in accordance with the recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines. There was no registered protocol.

Inclusion and exclusion criteria

The inclusion criteria were as follows: RCTs of elective surgical inhalation anesthesia versus propofol-based intravenous anesthesia in adult female patients with primary breast cancer published at home and abroad and included the outcome measures in the trials. The exclusion criteria were as follows: Patients with a history of chronic pain or oral analgesia before surgery, patients with immune system disorders and other significant complications, and studies comparing propofol combined with paravertebral or epidural block with inhalation anesthesia.

Literature search

The Embase, PubMed, Cochrane Library, CBM, CNKI, and Wanfang databases were searched. The searched terms were breast cancer, breast neoplasm, breast tumors, propofol, disoprofol, diprivan, RCT, randomized controlled, prognosis, and diagnosed. Clinical trial registries were searched for any further potentially eligible trials. The published languages included were English and Chinese. Search for articles from databases to October 2022.

Data extraction and quality assessment

Data were extracted by two researchers according to preset criteria, and if there were any differences and disagreements, it was again decided by the third researcher. The primary outcomes were as follows: activities of $CD3^+$, $CD4^+$, and $CD8^+$ T-lymphocytes and $CD4^+/CD8^+$ T-lymphocytes before anesthesia (T0), at the end of the operation (T1), and 1 day after surgery (T2). The results of the data extraction are shown in Table 1. The quality of the literature was assessed with reference to the Cochrane Manual for Systematic Reviewers, version 5.0 of the risk of bias assessment, which included the following seven evaluation indicators: (1) Random sequence generation (selection bias); (2) Allocation concealment (selection bias); (3) Blinding of participants and personnel (performance bias); (4) Blinding of outcome assessment (detection bias); (5) Incomplete outcome data (attrition bias); (6) Selective reporting (reporting bias); and (7) Other bias. For each study result, the above seven indicators were judged as "high risk," "low risk" and "unclear." Quality assessment was performed using Rev Man 5.4 (The cochrane collaboration, United kingdom).

Statistical analysis

Meta-analysis was performed using STATA 14.0 (Stata, United States). Pooled effect sizes for total T-lymphocytes ($CD3^+$) and subgroups ($CD4^+$, $CD8^+$, $CD4^+/CD8^+$) included in the study were estimated using a fixed-effect or random-effect model. Standard mean differences (SMDs) and 95% confidence intervals (95% CIs) were used as pooled effect statistics. First, the pooled effect sizes of the preoperative

Table 1: Basic information and data extraction results of the included studies

Study	Number of examples/*n*		Interventions		Outcomes
	Experimental group	Control group	Experimental group	Control group	
Chen Ling 2018[14]	20	20	Propofal	Sevoflurane	$CD3^+$ $CD4^+$ $CD8^+$ $CD4^+/CD8^+$ (T0, T1, T2)
Pihong Wei 2011[13]	16	16	Propofal	Isoflurane	$CD3^+$ $CD4^+$ $CD8^+$ $CD4^+/CD8^+$ (T0, T1, T2)
Jianlong Du 2017[15]	60	60	Propofal	Isoflurane	$CD3^+$ $CD4^+$ $CD8^+$ $CD4^+/CD8^+$ (T0, T1, T2)
Yue Cao 2021[16]	30	30	Propofal	Desflurane	$CD3^+$ $CD4^+$ $CD8^+$ $CD4^+/CD8^+$ (T0, T1, T2)
Woo, JH 2015[17]	20	20	Propofal	Desflurane	$CD4^+$ $CD8^+$ $CD4^+/CD8^+$(T0, T1, T2)
Qiaoyan Zhou 2016[2]	30	30	Propofal	Sevoflurane	$CD3^+$ $CD4^+$ $CD8^+$ $CD4^+/CD8^+$ (T0, T1)

T_0=The measurements before anesthesia; T_1=The measurements at the end of the operation; T_2=The measurements 1 day after surgery

baseline (T0) were calculated for each group, and if there was no difference between baselines, the pooled effect sizes for each subgroup were estimated for comparison immediately after surgery (T1) and 1 day after surgery (T2). The χ^2 test and the I^2 value were used to determine the level of heterogeneity. If $P > 0.1$ and $I^2 < 50\%$, no heterogeneity was considered, and data were pooled for meta-analysis using a fixed-effect model; if $P < 0.1$ and $I^2 > 50\%$ were considered heterogeneous, data were pooled using a random-effect model for meta-analysis.[12] Pooled effect sizes were estimated by meta-analysis, and significance levels were determined at $P < 0.05$. Sensitivity analyses were performed for subgroups of high heterogeneity ($P < 0.1$ and $I^2 > 50\%$), and if there were data that had a clear impact on the results, they were excluded from the meta-analysis, and forest maps were drawn for each study. The pooled effect size is shown by the forest plot. Egger's test was performed, and $P > 0.05$ was considered free of publication bias.

RESULTS

Basic information from the included studies

According to the corresponding search formula, a total of 1221 articles were detected, 766 articles were excluded after removing duplicate articles, 651 articles were removed from the study by reading the titles, 38 articles were left after reading the abstracts, and the full text was read according to the inclusion criteria. Finally, six articles were included,[2,13-17] with a total of 352 patients. Two of the studies compared propofol with sevoflurane, two compared propofol with desflurane, and two compared propofol with isoflurane. The literature screening procedure is shown in Figure 1, and the basic information of the included studies is shown in Table 2.

Quality assessment of the included studies

All six studies used a random allocation regimen and did not explicitly state allocation concealment or blinding, and all six studies had complete outcome measures. The results of the literature quality evaluation are shown in Figure 2.

Meta-analysis results

CD3⁺

Five studies (312 patients) reported CD3⁺ T-lymphocyte subsets with no statistical heterogeneity at T_0 between

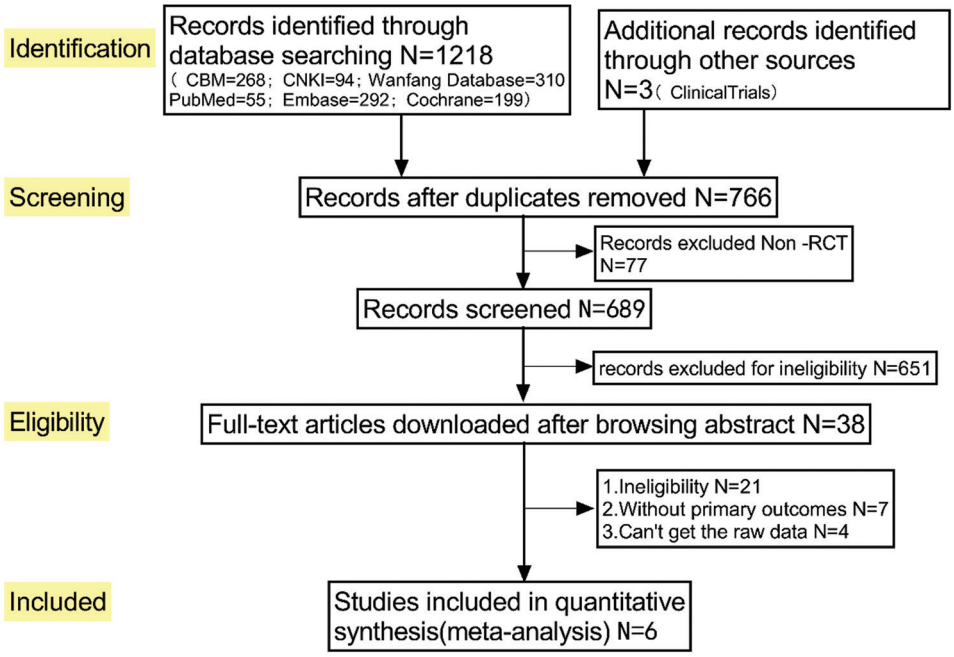

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-analysis flow diagram

Table 2: Results of meta-analysis

Indicators of immune function	Number of studies included	Number of examples/*n*	SMD (95% CI)		*P*	
			T_1	T_2	T_1	T_2
CD3⁺	5	312	0.202 (−0.303~0.707)	0.243 (−0.148~0.635)	>0.05	>0.05
CD4⁺	6	352	0.157 (−0.404~0.718)	0.234 (0.003~0.466)	>0.05	<0.05
CD8⁺	6	352	−0.079 (−0.440~0.283)	0.167 (−0.064~0.397)	>0.05	>0.05
CD4⁺/CD8⁺	6	352	0.389 (−0.176~0.954)	0.304 (0.072~0.537)	>0.05	<0.05

SMD=Standard mean difference; CI=Confidence interval

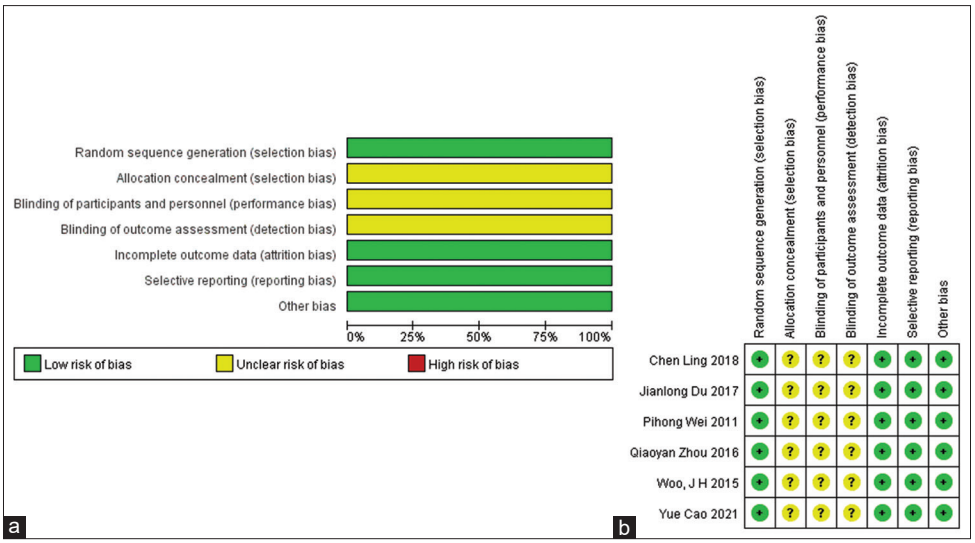

Figure 2: Literature quality evaluation (a) Risk of bias graph, (b) Risk of bias summary

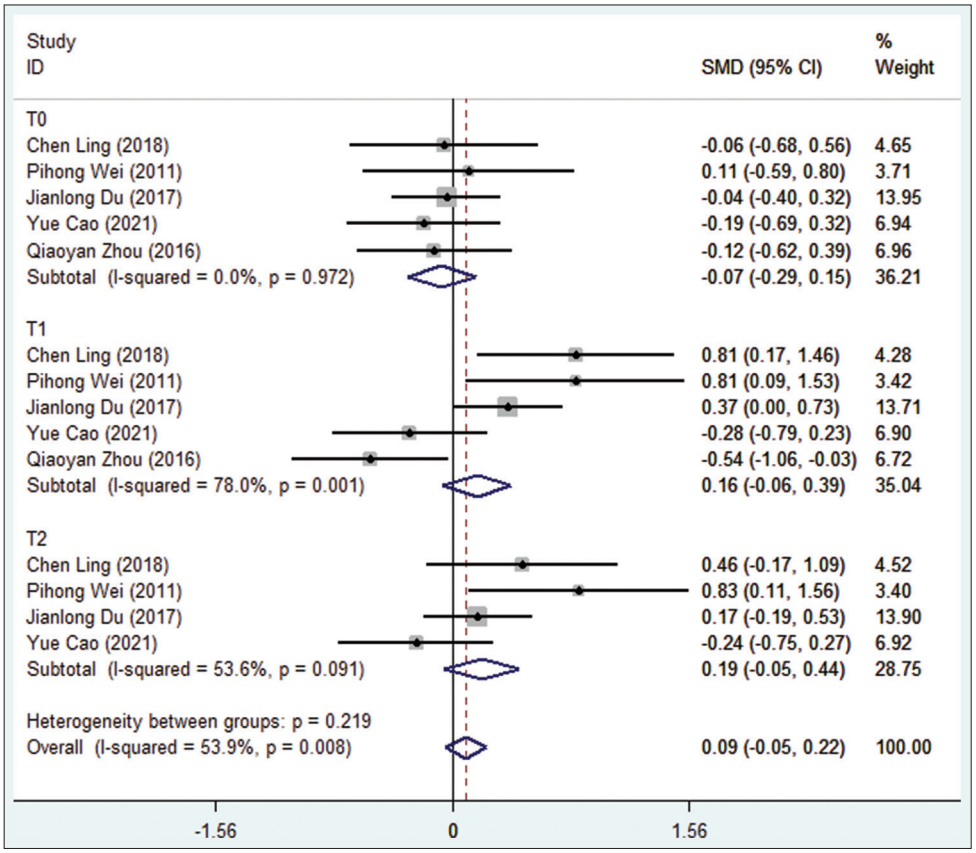

Figure 3: Meta-analysis forest plot of CD3⁺

groups (I^2 = 0.0%, P = 0.972), as shown in Figure 3. The difference in the use of fixed-effect pooled effect sizes was not statistically significant (SMD = −0.07, 95% CI: −0.29 ~ 0.15, Z = 0.61, P = 0.544); that is, there was no difference in CD3⁺ between the two groups at T_0, and subsequent meta-analysis could be performed. The effect size of T_1 was combined for heterogeneity testing, and there was some heterogeneity between the selected studies (I^2 = 78.0%, P = 0.001); the results are shown in Figure 3. A sensitivity analysis of the five studies in this study was carried out, as shown in Figure 4, and it was found that none of the studies had a strong impact on the results of the study. The selection of random-effect pooled effect sizes yielded a pooled effect size of 0.202 (95% CI: −0.303~0.707), with no statistically significant difference (Z = 0.79, P = 0.544) between the

$CD3^+$ and inhalation groups in the propofol group at the end of surgery. The effect size of T_2 was combined for heterogeneity testing, and there was some heterogeneity between the selected studies in this study (I^2 = 53.6%, P = 0.091); the results are shown in Figure 3. The random-effect combined effect size was 0.243 (95% CI: −0.148 ~ 0.635), and the difference was not statistically significant (Z = 1.22, P = 0.223). There was no difference between the $CD3^+$ and inhalation groups in the propofol group 1 day after surgery. Egger's test was carried out to test the publication bias of the literature in this study, and the P values obtained were all >0.05 (P_T = 0.746, P_{T1} = 0.754, P_{T2} = 0.460). Therefore, it can be judged that the literature in this study is free of the publication bias.

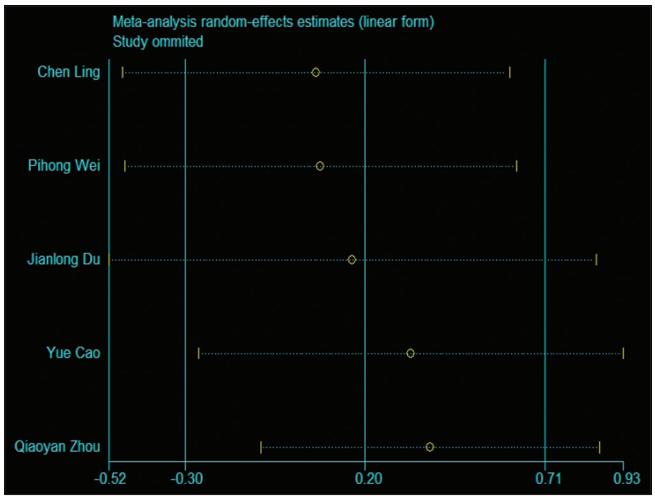

Figure 4: Sensitivity analysis of $CD3^+$ (T_1)

$CD4^+$

Six studies (352 patients) reported $CD4^+$ T-lymphocyte subsets with no statistical heterogeneity at T_0 (I^2 = 0.0%, P = 0.474), as shown in Figure 5. The difference in the use of fixed-effect pooled effect sizes was not statistically significant (SMD = −0.10, 95% CI: −0.31 ~ 0.11, Z = 0.78, P = 0.335); that is, there was no difference in $CD4^+$ between the two groups at T_0. The effect size of T_1 was combined for heterogeneity testing, and there was some heterogeneity between the selected studies (I^2 = 84.3%, P = 0.000), and the results are shown in Figure 5. A sensitivity analysis of the six studies in this study was carried out, and the results are shown in Figure 6. It was found that none of the studies had a strong impact on the study results. The random-effect pooled effect size was 0.157 (95% CI: −0.404 ~ 0.718), the difference was not statistically significant (Z = 0.55, P = 0.584), and there was no difference between the $CD4^+$ and inhalation groups in the propofol group at the

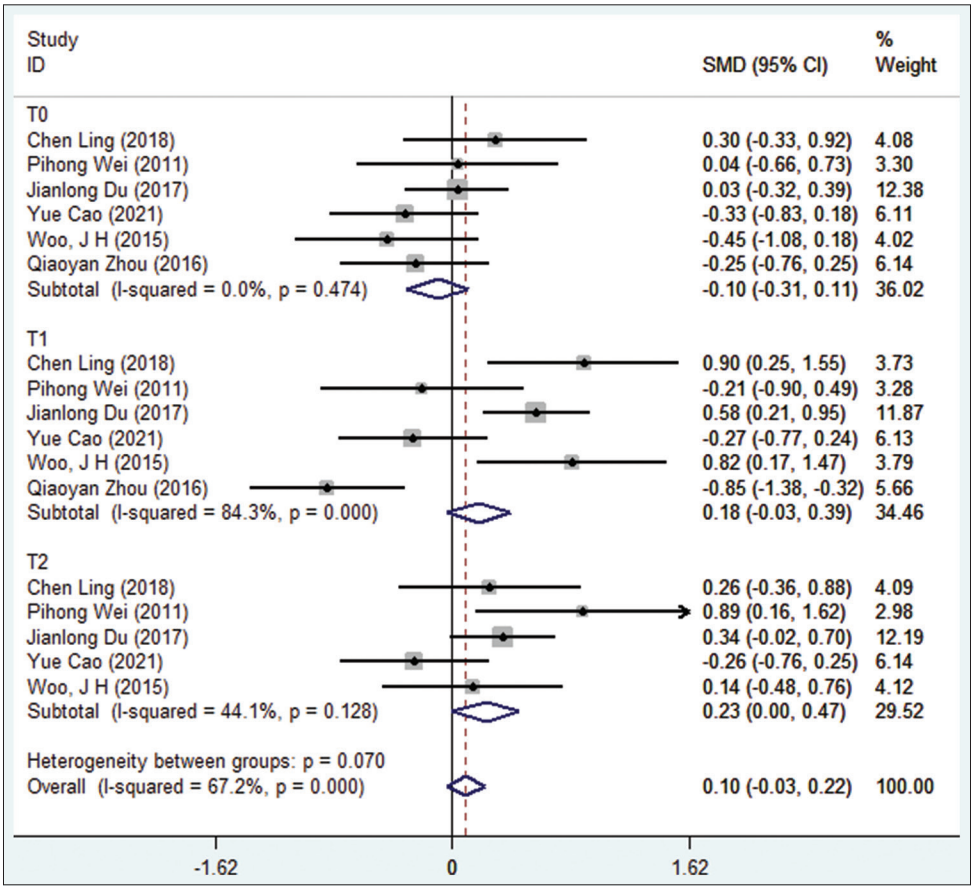

Figure 5: Meta-analysis forest plot of $CD4^+$

end of surgery. The effect size of T_2 was combined for heterogeneity testing, and there was no heterogeneity between the selected studies ($I^2 = 44.1\%$, $P = 0.128$), and the result is shown in Figure 5. The fixed-effect combined effect amount was 0.234 (95% CI: 0.003 ~ 0.466), the effect was significant ($Z = 1.98$, $P = 0.047$), and the $CD4^+$ in the propofol group was significantly higher than that in the inhalation group by 0.234 1 day after surgery. The *P* values obtained by Egger's test were all > 0.05 ($P_{T0} = 0.769$, $P_{T1} = 0.817$, $P_{T2} = 0.789$), so there was no publication bias in the literature in this study.

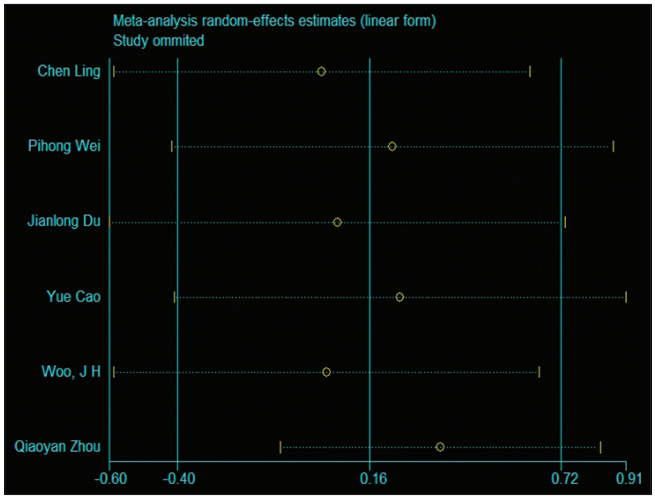

Figure 6: Sensitivity analysis of $CD4^+$ (T_1)

$CD8^+$

Six studies (352 patients) reported $CD8^+$ T-lymphocyte subsets with no statistical heterogeneity at T_0 ($I^2 = 0.0\%$, $P = 0.565$), as shown in Figure 7. The difference in the use of fixed-effect pooled effect sizes was not statistically significant (SMD = −0.08, 95% CI: −0.29 ~ 0.13, $Z = 0.77$, $P = 0.439$); that is, there was no difference in $CD8^+$ between the two groups at T_0. The effect size of T_1 was combined for heterogeneity testing, and there was some heterogeneity between the selected studies ($I^2 = 63.0\%$, $P = 0.019$); the results are shown in Figure 7. A sensitivity analysis of the six studies in this study was carried out, and the results are shown in Figure 8. It was found that none of the studies had a strong impact on the study results. The random-effect pooled effect size was −0.079 (95% CI: −0.440 ~ 0.283), the difference was not statistically significant ($Z = 0.43$, $P = 0.670$), and there was no difference between the $CD8^+$ and inhalation groups in the propofol group at the end of surgery. The effect size of T_2 was combined for heterogeneity testing, and there was no heterogeneity between the selected studies ($I^2 = 18.0\%$, $P = 0.300$); the results are

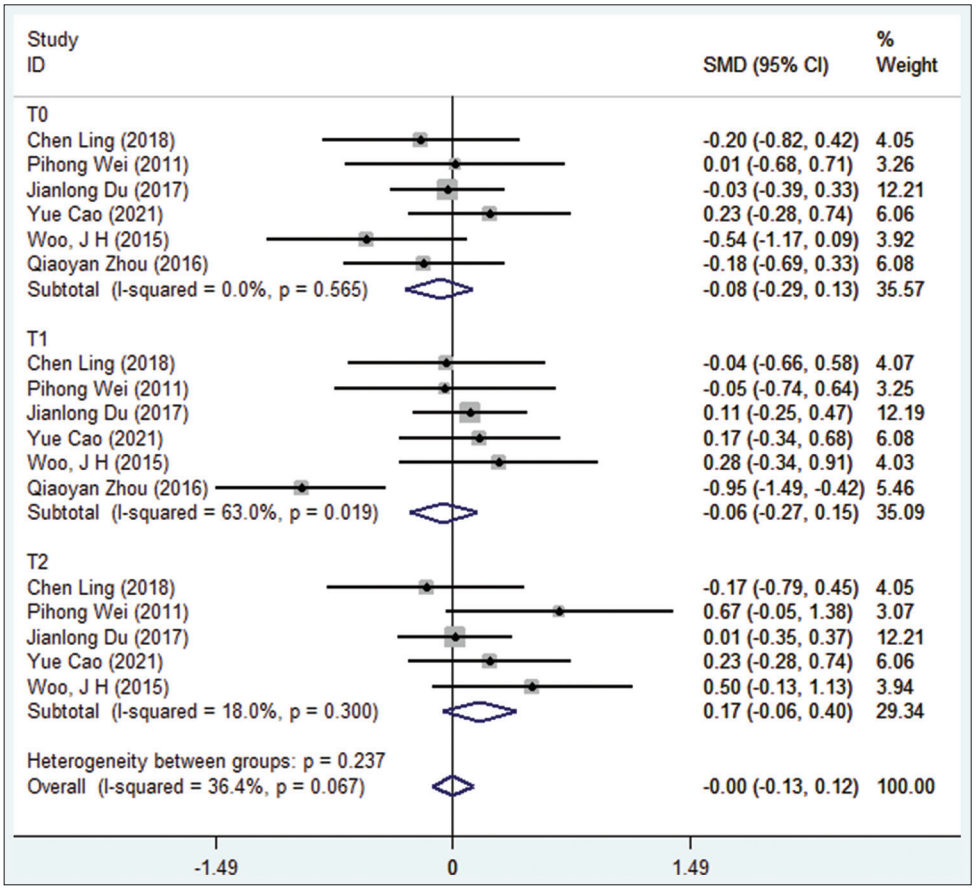

Figure 7: Meta-analysis forest plot of $CD8^+$

shown in Figure 7. The fixed-effect combined effect size was 0.167 (95% CI: −0.064 ~ 0.397), and the difference was not statistically significant (Z = 1.41, P = 0.157). There was no difference between the $CD8^+$ and inhalation groups in the propofol group 1 day after surgery. The P values obtained by Egger's test were all > 0.05 (P_{T0}=0.496, P_{T1}=0.761, P_{T2}=0.283), so there was no publication bias in the literature of this study.

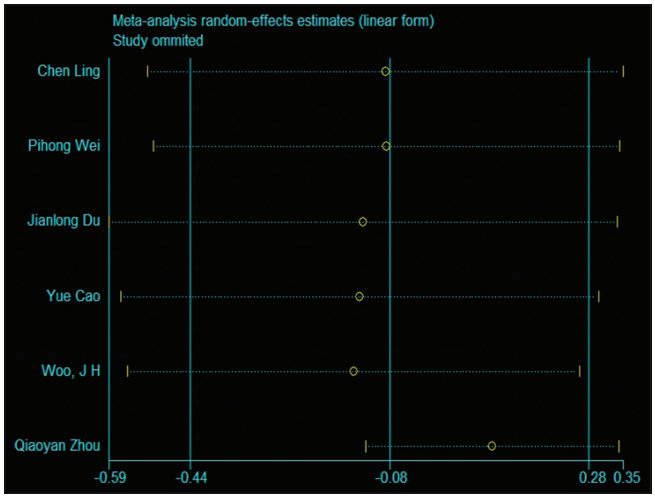

Figure 8: Sensitivity analysis of $CD8^+$ (T_1)

$CD4^+/CD8^+$

Six studies (352 patients) reported the $CD4^+/CD8^+$ ratio with no statistically significant heterogeneity between groups at T_0 (I^2 = 23.3%, P = 0.259), as shown in Figure 9. The difference in the use of fixed-effect pooled effect sizes was not statistically significant (SMD = −0.04, 95% CI: −0.25 ~ 0.17, Z = 0.37, P = 0.709), so there was no difference in the ratio between the two groups at T_0, and subsequent meta-analysis could be performed. The effect size of T_1 was combined for heterogeneity testing, and there was some heterogeneity between the selected studies (I^2 = 84.2%, P = 0.000), and the result is shown in Figure 9. A sensitivity analysis of the six articles in this study is shown in Figure 10, and it was found that none of the studies had a strong impact on the study results. The random-effect pooled effect size was 0.389 (95% CI: −0.176 ~ 0.954), and the difference was not statistically significant (Z = 1.35, P = 0.177). There was no difference between $CD4^+/CD8^+$ in the propofol group and the inhalation group at the end of surgery. The effect size of T_2 was combined for heterogeneity testing, and there was no heterogeneity between the selected studies (I^2 = 48.0%, P = 0.103); the results are shown in Figure 9. The fixed-effect combined effect amount was 0.304 (95% CI: 0.072 ~ 0.537), and the effect was significant (Z = 2.56, P = 0.010). The ratio in the propofol group was significantly higher than that

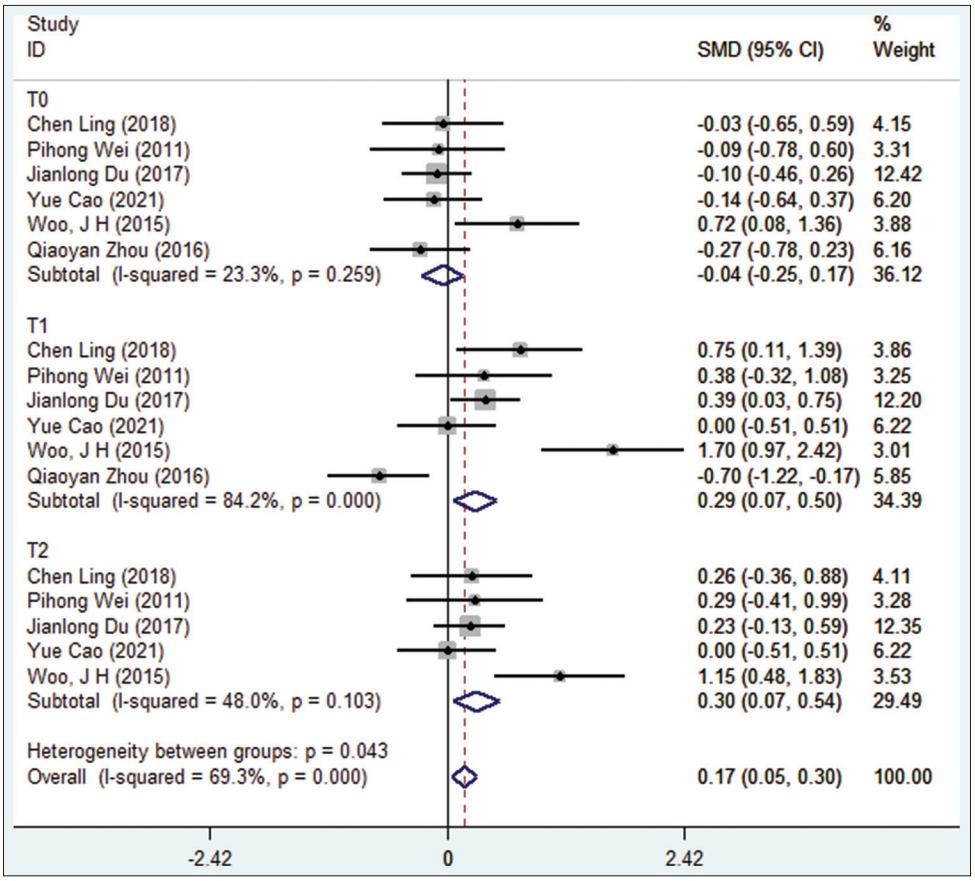

Figure 9: Meta-analysis forest plot of $CD4^+/CD8^+$

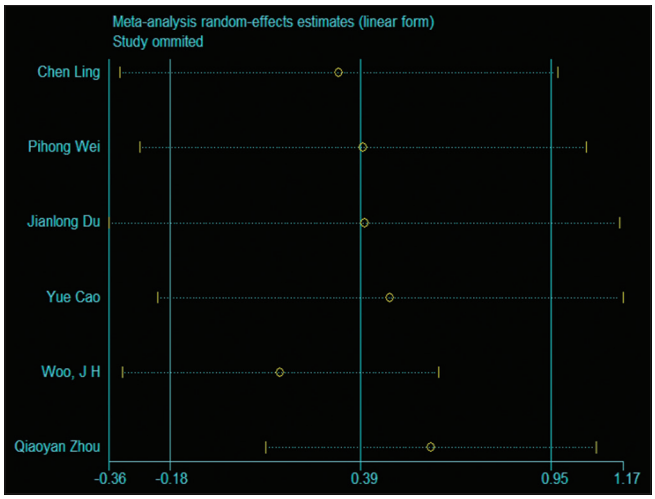

Figure 10: Sensitivity analysis of $CD4^+/CD8^+$ (T_1)

in the inhalation group by 0.348 1 day after surgery. The *P* values obtained by Egger's test were all >0.05 (P_{T0} = 0.422, P_{T1} = 0.504, P_{T2} = 0.442), so there was no publication bias in the literature of this study.

DISCUSSION

This meta-analysis included six randomized controlled trials comparing the effects of propofol anesthesia and inhalation anesthesia on postoperative immune function in breast cancer patients, with selected indicators of immune function limited to the cellular level. The results showed that there was no difference in the effects on T-lymphocytes between propofol anesthesia and inhalation anesthesia at the end of surgery and 1 day after surgery, but on the postoperative day, patients with propofol anesthesia had higher activities of $CD4^+$ cells and $CD4^+/CD8^+$ than those with inhalation anesthesia.

Perioperative immunosuppression predisposes individuals to tumor recurrence and metastasis.[18] Cellular immunity plays an important role in antitumor effects, and T-lymphocytes are the most important cell population and an important indicator reflecting the level of immunity. $CD3^+$, $CD4^+$, and $CD8^+$ are the main effector cells of T-lymphocytes. $CD3^+$ is a characteristic marker representing T-lymphocytes. Peripherally mature T-lymphocytes have $CD3^+$ distribution on the surface, and the decrease in the ratio of $CD3^+$ is related to impaired cellular immune function. Peripheral mature T-lymphocytes are divided into two cell subsets, $CD4^+$ and $CD8^+$, according to the difference in CD differentiation antigens on the cell surface. $CD4^+$ T cells can secrete some cytokines, which play a role in assisting the body's immune function, promoting the immune response, and inducing Type IV hypersensitivity reactions. $CD8^+$ T cells detect and specifically kill cancer cells,[19] which are key to cellular immunity associated with the prognosis of cancer. The $CD4^+/CD8^+$ ratio is considered to be positively correlated with the function of cellular immunity,[20] and a decrease in the ratio indicates that the body's immunity may be in a state of suppression or disorder, which is an indicator of disease severity and poor prognosis.

Propofol can enhance antitumor immunity by enhancing the activity of $CD8^+$ T cells,[10] which can preserve the activity of lymphocytes. Inhalation anesthetics have been shown to reduce circulating lymphocytes and induce apoptosis of T-lymphocytes.[3,4,8,18,21,22] This may be related to the fact that propofol does not increase the damage to DNA in white blood cells.[23] Although the precise mechanisms by which volatile anesthetics inhibit lymphocyte functions remain elusive, the induction of apoptosis, the decrease in mitochondrial membrane potential, the release of cytochrome C from mitochondria, interference with the MAPK cascade, the induction of mitochondrial reactive oxygen species, and abnormal calcium release from the endoplasmic reticulum suggest possible mechanisms for the volatile anesthetic-induced inhibitory effects on lymphocytes.[18] The results of the effects of propofol and inhalation anesthetics on T-lymphocyte subsets suggest that propofol may have potentially beneficial effects on long-term prognosis after breast cancer surgery.

Limitations of the study

There are some limitations in the review. First, the number of included RCTs was small, with only six RCTs participating in this meta-analysis, five of which (312 patients) were from Asia. Different populations have different sensitivities to propofol and inhalation anesthetics, and the results may also be influenced by genetics, environment, and lifestyle. Second, some of the results are heterogeneous, and there are nonnegligible biases in the meta-analyses.

CONCLUSION

There was no difference in the effects of propofol and inhalation anesthetics on T-lymphocytes immediately after surgery, but the inhibitory effects of inhalation anesthetics on $CD4^+$ and $CD4^+/CD8^+$ ratios were stronger 1 day after surgery.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Viale PH. The American cancer society's facts and figures: 2020 edition. J Adv Pract Oncol 2020;11:135-6.
2. Zhou Q. The Effection of Inhalation Anesthesia and Total

Intravenous Anesthesia on Perioperative Cellular Immune Function in Patients with Breast Cance. Inner Mongolia Medical University; 2016.
3. Kim R. Effects of surgery and anesthetic choice on immunosuppression and cancer recurrence. J Transl Med 2018;16:8.
4. Li R, Liu H, Dilger JP, Lin J. Effect of propofol on breast cancer cell, the immune system, and patient outcome. BMC Anesthesiol 2018;18:77.
5. Vallejo R, Hord ED, Barna SA, Santiago-Palma J, Ahmed S. Perioperative immunosuppression in cancer patients. J Environ Pathol Toxicol Oncol 2003;22:139-46.
6. Ecimovic P, McHugh B, Murray D, Doran P, Buggy DJ. Effects of sevoflurane on breast cancer cell function *in vitro*. Anticancer Res 2013;33:4255-60.
7. Yu B, Gao W, Zhou H, Miao X, Chang Y, Wang L, *et al.* Propofol induces apoptosis of breast cancer cells by downregulation of miR-24 signal pathway. Cancer Biomark 2018;21:513-9.
8. Pirbudak Cocelli L, Ugur MG, Karadasli H. Comparison of effects of low-flow sevoflurane and desflurane anesthesia on neutrophil and T-cell populations. Curr Ther Res Clin Exp 2012;73:41-51.
9. Melamed R, Bar-Yosef S, Shakhar G, Shakhar K, Ben-Eliyahu S. Suppression of natural killer cell activity and promotion of tumor metastasis by ketamine, thiopental, and halothane, but not by propofol: Mediating mechanisms and prophylactic measures. Anesth Analg 2003;97:1331-9.
10. Kushida A, Inada T, Shingu K. Enhancement of antitumor immunity after propofol treatment in mice. Immunopharmacol Immunotoxicol 2007;29:477-86.
11. Lim JA, Oh CS, Yoon TG, Lee JY, Lee SH, Yoo YB, *et al.* The effect of propofol and sevoflurane on cancer cell, natural killer cell, and cytotoxic T lymphocyte function in patients undergoing breast cancer surgery: An *in vitro* analysis. BMC Cancer 2018;18:159.
12. Pang QY, Duan LP, Jiang Y, Liu HL. Comparison of outcomes after breast cancer surgery between inhalational and propofol-based intravenous anaesthesia: A systematic review and meta-analysis. J Pain Res 2021;14:2165-77.
13. Pi-Hong W. The influence of different general anesthesia technique on immune function in patients undergoing radical mammotomy (astoctomy). J Taishan Med Coll 2011;32:664-6.
14. Ling C, Hu X, Liu X, Zou L, Zhou S, Chen W, *et al.* The effects of total intravenous anesthesia or combined intravenous – Inhalation anesthesia use for patients on postoperative cellular immune function and inflamatory mediator undergoing radical mastectomy under the same depth of anesthetic. Mod Hosp 2018;18:906-9, 912.
15. Du J, Lu Y, Jiang L. Effects of inhalation anesthesia and total intravenous anesthesia on immune level of postoperative breast cancer. Med J NDFNC 2017;38:805-8.
16. Cao Y. Effect of Desflurane on Perioperative Cellular Immune Function in Patients Undergoing Modified Radical Mastectomy for Breast Cancer. NanChang University; 2021.
17. Woo JH, Baik HJ, Kim CH, Chung RK, Kim DY, Lee GY, *et al.* Effect of propofol and desflurane on immune cell populations in breast cancer patients: A randomized trial. J Korean Med Sci 2015;30:1503-8.
18. Kurosawa S. Anesthesia in patients with cancer disorders. Curr Opin Anaesthesiol 2012;25:376-84.
19. Poschke I, Mougiakakos D, Kiessling R. Camouflage and sabotage: Tumor escape from the immune system. Cancer Immunol Immunother 2011;60:1161-71.
20. Wang K, Wu M, Xu J, Wu C, Zhang B, Wang G, *et al.* Effects of dexmedetomidine on perioperative stress, inflammation, and immune function: Systematic review and meta-analysis. Br J Anaesth 2019;123:777-94.
21. Cho JS, Lee MH, Kim SI, Park S, Park HS, Oh E, *et al.* The effects of perioperative anesthesia and analgesia on immune function in patients undergoing breast cancer resection: A prospective randomized study. Int J Med Sci 2017;14:970-6.
22. Deegan CA, Murray D, Doran P, Moriarty DC, Sessler DI, Mascha E, *et al*. Anesthetic technique and the cytokine and matrix metalloproteinase response to primary breast cancer surgery. Reg Anesth Pain Med 2010;35:490-5.
23. Braz MG, Magalhães MR, Salvadori DM, Ferreira AL, Braz LG, Sakai E, *et al.* Evaluation of DNA damage and lipoperoxidation of propofol in patients undergoing elective surgery. Eur J Anaesthesiol 2009;26:654-60.