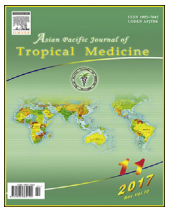
HOSTED BY
ELSEVIER

Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage: http://ees.elsevier.com/apjtm



Original research https://doi.org/10.1016/j.apjtm.2017.10.014

Effect of taurine on immune function in mice with T-cell lymphoma during chemotherapy

Jin-Feng Dong, Xiao-Qiang Zheng✉, Hong-Bing Rui

Department of Hematology and Rheumatology, the First Affiliated Hospital of Fujian Medical University, Fuzhou, Fujian, 350000, China

ARTICLE INFO

Article history:
Received 15 Sep 2017
Received in revised form 25 Sep 2017
Accepted 28 Sep 2017
Available online 28 Oct 2017

Keywords:
Taurine
T-cell lymphoma
Gemcitabine
Immune function

ABSTRACT

Objective: To observe the effect of taurine on immune function in mice with T-cell lymphoma during chemotherapy.

Methods: A total of 40 C57BL/6 mice were selected and randomly divided into 4 groups, namely model group, chemotherapy group, taurine group and chemotherapy + taurine group, each containing 10 mice. Hypodermic injection was adopted to inoculate EL-4 cells in order to establish model of T-cell lymphoma. When the tumor achieved the size of 1 cm^3, intervention treatments were given to the groups respectively. Mice in model group received 0.2 mL of normal saline which was intraperitoneally injected on Days 1, 8 and 15 with 3 weeks as a cycle; mice in chemotherapy group were administered with 80 mg/kg body weight of gemcitabine which was also intraperitoneally injected on Days 1, 8 and 15 with 3 weeks as a cycle; mice in taurine group were administered with 80 mg/kg body weight of taurine intraperitoneally injected daily for consecutive 8 d; mice in chemotherapy + taurine group were treated in the same manner as the mice in taurine group and chemotherapy group. Five mice were sacrificed at 2 and 3 weeks after intervention respectively, and the tumor tissues were collected and weighted after removal of auxiliary tissue, then the tumor inhibition rate was calculated. The thymus and spleen of mice sacrificed at 3 weeks after intervention were collected and weighted, and thymus and spleen indexes were calculated. Enzyme linked immunosorbent assay was used to detect the serum levels of IL-4, IL-10, IL-12 and IFN-γ in mice of each group.

Results: The tumor weights in chemotherapy group, taurine group and chemotherapy + taurine group after 2 and 3 weeks of treatment were significantly lower than that in model group ($P < 0.05$); the tumor weight in chemotherapy + taurine group after 2 and 3 weeks of treatment was significantly lower than that in chemotherapy group ($P < 0.05$); the tumor inhibition rate in chemotherapy + taurine group was significantly higher than that in chemotherapy group and taurine group ($P < 0.05$); the thymus and spleen indexes in taurine group and chemotherapy + taurine group were significantly higher than those in chemotherapy group and model group ($P < 0.05$); the thymus and spleen indexes in chemotherapy group were significantly lower than those in model group ($P < 0.05$); after 3 weeks of treatment, the serum levels of IL-4, IL-12 and IFN-γ in chemotherapy group, taurine group and chemotherapy + taurine group were significantly lower than those in model group ($P < 0.05$); the IL-4 level in taurine group and chemotherapy + taurine group was significantly lower than that in chemotherapy group ($P < 0.05$); the serum level of IL-10 in chemotherapy group and chemotherapy + taurine group was significantly higher than that in model group and taurine group ($P < 0.05$); the serum level of IFN-γ in taurine group and chemotherapy + taurine group was significantly lower than that in model group and chemotherapy group ($P < 0.05$); after treatment of 3 weeks, the serum levels of IL-4 and IL-10 in chemotherapy group, taurine group and chemotherapy + taurine group were significantly lower than those in model group

First author: Jin-Feng Dong, Department of Hematology and Rheumatology, the First Affiliated Hospital of Fujian Medical University, China.
Tel: +86 18650060686
E-mail: 390705086@qq.com
✉Corresponding author: Xiao-Qiang Zheng, Department of Hematology and Rheumatology, the First Affiliated Hospital of Fujian Medical University, China.
Tel: +86 15980273107
E-mail: 119222900@qq.com

Peer review under responsibility of Hainan Medical University.
Foundation project: This work was supported by Youth Scientific Research Project of Fujian Provincial Health and Family Planning Commission (No. 2017-1-57).

($P < 0.05$), and IL-12 level was significantly higher than that in model group ($P < 0.05$); the level of IFN-γ in taurine group and chemotherapy + taurine group was significantly higher than that in model group ($P < 0.05$), while the level of IFN-γ in chemotherapy group was significantly lower than that in the other 3 groups ($P < 0.05$).
Conclusions: Taurine can effectively enhance the immune function of mice with T-cell lymphoma during chemotherapy, reduce the toxicity of chemotherapy.

1. Introduction

Malignant lymphoma frequently occurs in the lymph nodes or extranodal tissue, with pathological type as the main type and high degree of malignancy, and the average survival time of patients is shorter [1]. Hodgkin's lymphoma and non-Hodgkin's lymphoma are two major types of malignant lymphoma. Non-Hodgkin's lymphoma patients account for 90% patients with malignant lymphoma, and non-Hodgkin's lymphoma is the fastest-growing tumor with higher incidence in male than female [2,3]. The incidence of peripheral T-cell lymphoma is relatively lower; its incidence in adults is 5%–10% of non-Hodgkin's lymphoma incidence, seriously threatening the life and health of patients [4,5]. At present, the clinical treatments of T-cell lymphoma mainly include radiotherapy and chemotherapy, biological targeted therapy, immunotherapy, hematopoietic stem cells and traditional Chinese medicine treatments. However, in the modern medicine, the treatment of the disease is mainly based on chemotherapy. Although the chemotherapy drug can effectively kill tumor cells, it exhibits more inhibition on the strongly proliferated bone marrow hematopoietic cells and immune system, severely affecting the chemotherapy efficacy and leading to poor prognosis [5–8]. Therefore, it is urgently needed to effectively enhance the immune function of patients during chemotherapy treatment to improve the efficacy of chemotherapy. Taurine is a necessary amino acid for human body and involved in the processes of stabilizing the body internal environment, which has a positive effect on the digestion, endocrine and immune systems within the body [9–12]. The present study was conducted to observe the effect of taurine on the immune function of mice with T-cell lymphoma after chemotherapy. C57BL/6 mice were used for T-cell lymphoma modeling, and taurine was administered while using gemcitabine for chemotherapy, in order to observe its effect on immune function in mice, and to provide theoretical basis for clinical application.

2. Materials and methods

2.1. Experimental animals

A total of 40 healthy female C57BL/6 mice with SPF level, weighting (18–22 g), were provided by Beijing Vital River Laboratory Animal Technology Co., Ltd., and fed with SPF level of dedicated mice feedstuff formulated by the experimental animal center, at feeding temperature of 20–26 °C and humidity of 40%–60%. The experiments were performed in the laboratory center of Fujian Medical University. The handling of animals complied with the relevant regulations in Regulations for the Administration of Affairs Concerning Experimental Animals and was approved by the Ethics Committee of our hospital.

2.2. Apparatus and reagents

T lymphoma cell line of EL-4 mice was provided by Shanghai Institutes for Biological Sciences; taurine was purchased from Tianjin Ruijinte Chemicals Co., Ltd.; gemcitabine hydrochloride injection was purchased from Jiangsu Hansoh Pharma Co., Ltd.; lipopolysaccharide, concanavalin A, dimethyl sulfoxide and methyl thiazolyl tetrazolium were purchased from Sigma, fetal bovine serum from Giboc, enzyme linked immunosorbent assay kits from Dingguo Biotechnology Co., Ltd. Leica DMI4000B smart inverted biologic microscope (Leica), LEICA-2235 paraffin slicer (Shandon Varistain Gemini company), desktop high speed centrifuge, inverted phase contrast microscope and image acquisition system from Leica were used.

2.3. Grouping and modeling

Forty C57BL/6 mice were randomly divided into 4 groups, namely model group, chemotherapy group, taurine group and chemotherapy + taurine group, each containing 10 mice. Hypodermic injection was adopted to establish model of T-cell lymphoma in the 4 groups [13,14]. The suspension of EL-5 cell (0.2 mL) after steady passage was inoculated at the right armpit of each group of mice to prepare T-cell lymphoma model. When the tumor achieved the size of 1 cm^3, intervention treatments were given to the groups respectively. Mice in model group received 0.2 mL of normal saline which was intraperitoneally injected on Days 1, 8 and 15 with 3 weeks as a cycle; mice in chemotherapy group were administered with 80 mg/kg body weight of gemcitabine which was intraperitoneally injected on Days 1, 8 and 15 with 3 weeks as a cycle; mice in taurine group were administered with 80 mg/kg body weight of taurine which was intraperitoneally injected daily for consecutive 8 d; mice in chemotherapy + taurine group were treated in the same manner as the mice in taurine group and chemotherapy group.

2.4. Indexes observation

Five mice were sacrificed by cervical dislocation at 2 and 3 weeks after intervention respectively, and the tumor tissue was collected and weighted after removal of auxiliary tissue, then the tumor inhibition rate after 3 weeks of treatment was calculated by the following formula: tumor inhibition rate = (average tumor weight of model group – average tumor weight of treatment group)/average tumor weight of model group × 100%. The thymus and spleen of mice sacrificed at 3 weeks after intervention were collected and weighted, and thymus and spleen indexes were calculated by the following formula: thymus index = thymus weight/body weight; spleen index = spleen weight/body weight. The venous blood from the tail of mice in each group was collected, and serum was separated. Enzyme

linked immunosorbent assay was then used to detect the serum levels of IL-4, IL-10, IL-12 and IFN-γ in mice of each group.

2.5. Statistical analysis

All the data were checked and input into the SPSS 19.0 software for analysis. The measurement data with the approximate normal distribution were expressed as mean ± SD, and the variance test and *SNK-q* test were used. $P < 0.05$ indicated statistically significant difference.

3. Results

3.1. Comparison of tumor weight and tumor inhibition rate in mice

The tumor weights in chemotherapy group, taurine group and chemotherapy + taurine group after 2 and 3 weeks of treatment were significantly lower than that in model group ($P < 0.05$); the tumor weight in chemotherapy + taurine group after 2 and 3 weeks of treatment was significantly lower than that in chemotherapy group ($P < 0.05$); the tumor inhibition rate in chemotherapy + taurine group was significantly higher than that both in chemotherapy group and taurine group ($P < 0.05$) (Table 1).

Table 1
Comparison of tumor weight in mice (g) ($n = 5$).

Groups	Tumor weight		Tumor inhibition rate (%)
	2 weeks after treatment	3 weeks after treatment	
Model group	4.6 ± 0.2	4.7 ± 0.3	–
Chemotherapy group	2.2 ± 0.2*	2.4 ± 0.8*	52.9
Taurine group	3.0 ± 0.3$^{*\#}$	3.4 ± 0.5$^{*\#}$	20.6
Chemotherapy + taurine group	1.2 ± 0.3$^{*\#\Delta}$	1.5 ± 0.1$^{*\#\Delta}$	72.8
F	158.717 9	38.114 5	
P	<0.01	<0.01	

*: $P < 0.05$ compared with model group; #: $P < 0.05$ compared with chemotherapy group; Δ: $P < 0.05$ compared with taurine group.

3.2. Comparison of thymus and spleen indexes after treatment in different groups

After 3 weeks of treatment, the thymus and spleen indexes in taurine group and chemotherapy + taurine group were all significantly higher than those in chemotherapy and model groups ($P < 0.05$). The thymus and spleen indexes in chemotherapy group after 3 weeks of treatment were significantly lower than those in model group ($P < 0.05$). The thymus and spleen indexes in taurine group and chemotherapy + taurine group after 3 weeks of treatment had no significant difference ($P > 0.05$). Results were shown in Table 2.

Table 2
Comparison of thymus and spleen indexes in different groups after treatment ($n = 5$).

Groups	Thymus index	Spleen index
Model group	2.0 ± 0.5	10.4 ± 1.8
Chemotherapy group	0.8 ± 0.4*	8.1 ± 1.3
Taurine group	4.0 ± 0.5$^{*\#}$	13.0 ± 2.9$^{\#}$
Chemotherapy + taurine group	3.9 ± 0.3$^{*\#}$	12.9 ± 0.4$^{*\#}$
F	62.244 4	8.069 1
P	0.000 0	0.001 7

Compared with model group, *: $P < 0.05$; compared with chemotherapy group, #: $P < 0.05$.

3.3. Comparison of Th1/Th2 cytokine level after the treatment of 2 and 3 weeks

After 2 weeks of treatment, the serum levels of IL-12 and IFN-γ in chemotherapy group, taurine group and chemotherapy + taurine group were significantly lower than those in model group ($P < 0.05$); the IL-4 level in taurine group and chemotherapy + taurine group was significantly lower than that in chemotherapy group ($P < 0.05$); the serum level of IL-10 in chemotherapy group and chemotherapy + taurine group was significantly higher than that in model group and taurine group ($P < 0.05$); the serum level of IFN-γ in taurine group and chemotherapy + taurine group was significantly lower than that in model group and chemotherapy group ($P < 0.05$); after treatment of 3 weeks, the serum levels of IL-4 and IL-10 in chemotherapy group, taurine group and chemotherapy + taurine group were significantly lower than those in model group ($P < 0.05$), and IL-12 level was significantly higher than that in model group ($P < 0.05$); the level of IFN-γ in taurine group and chemotherapy + taurine group was significantly higher than that in model group ($P < 0.05$), while the level of IFN-γ in chemotherapy group was significantly lower than that in the other three groups ($P < 0.05$) (Table 3).

Table 3
Comparison of Th1/Th2 cytokine level after the treatment of 2 and 3 weeks ($n = 5$).

Groups	2 weeks after treatment				3 weeks after treatment			
	IL-4 (pg/mL)	IL-10 (pg/mL)	IL-12 (ng/mL)	IFN-γ(ng/mL)	IL-4 (pg/mL)	IL-10 (pg/mL)	IL-12 (ng/mL)	IFN-γ(ng/mL)
Model group	121.6 ± 1.4	441.6 ± 20.0	31.4 ± 0.9	884.2 ± 2.0	104.1 ± 2.6	536.1 ± 3.2	22.2 ± 0.3	836.0 ± 12.2
Chemotherapy group	137.8 ± 0.3*	472.3 ± 17.1*	26.3 ± 1.4*	835.5 ± 5.3*	67.3 ± 0.9*	375.5 ± 2.7*#	32.0 ± 0.5*#	192.4 ± 9.7*#
Taurine group	123.8 ± 0.3$^{*\#}$	453.1 ± 2.4$^{\#}$	26.1 ± 0.7*	761.9 ± 12.1*$^{\Delta}$	84.1 ± 3.4$^{*\#}$	474.0 ± 6.4*	27.9 ± 0.3*	957.5 ± 5.8*
Chemotherapy + taurine group	117.6 ± 0.8$^{*\#\Delta}$	498.5 ± 15.5$^{*\#\Delta}$	27.0 ± 0.6*	776.5 ± 22.4*$^{\Delta}$	22.9 ± 3.4$^{*\#\Delta}$	219.1 ± 8.7*#$^{\Delta}$	38.4 ± 0.6*#$^{\Delta}$	1 169.5 ± 2.9*#$^{\Delta}$
F	555.012 0	13.193 4	34.438 3	93.198 2	779.120 2	287.853 5	1 179.303 8	12 429.245 8
P	0.000 0	0.000 1	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0

Compared with model group, *: $P < 0.05$; compared with chemotherapy group, #: $P < 0.05$; compared with taurine group, Δ: $P < 0.05$.

4. Discussion

T-cell lymphoma is a malignant tumor of abnormal proliferation of tissue cells and precursors with a rare incidence. The high incidence of T-cell lymphoma in the Asian countries is characterized by high fever, splenomegaly and whole blood cell reduction. Cell phenotype is determined by immune assay, expressing immune surface marker of T-cell, commonly in the majority of extranodal lesion [15,16]. T-cell lymphoma is highly malignant, and currently there is still a lack of effective treatment. The prognosis is worse than B-cell lymphoma, and the improvement of its efficacy depends on the emergence of new drugs or gene targeting therapy for T-cell lymphoma [17]. The main measure used in T-cell lymphoma is the combination of anti-cancer drug chemotherapy, which has a certain effect, but with poor long-term follow-up result on patients.

Gemcitabine hydrochloride is a pyrimidine nucleotide. Nucleotide reductase inhibitor is a new anti-metabolic tumor drug, which can have an effect on the tumor cells in the synthesis phrase, with the tumor treatment mechanisms similar to cytarabine [18]. Currently, gemcitabine + cisplatin is a good treatment for peripheral T-cell lymphoma, and its safety and drug resistance are superior to the traditional MVAC treatment. Gemcitabine plays an active role in tumor suppression, but it also has adverse reactions in the course of chemotherapy including bone marrow resistance and function injuries of liver, kidney and nervous system. As the main adverse reaction, bone marrow resistance can lead to bleeding and infection, even cause death in the severe case [19]. Therefore, combined chemotherapy is usually used in clinical application to alleviate the suffering of patients, reduce the incidence of adverse reactions and ensure the smooth progress of treatment [20–23]. But whatever chemotherapy treatments we use, the effect on the immune function of the body will be inevitably caused; the combined infection during chemotherapy will further inhibit the immune function of patients, affecting the treatment result. In the present study, after 2 weeks of treatment, the anti-tumor rate of the chemotherapy group was 52.9%, but the thymus and spleen indexes were significantly lower than those in the other three groups ($P < 0.05$), and Th1/Th2 cytokines in mice were significantly disturbed, which also showed that it had significant anti-tumor effect, but with more toxic reactions, so treatment should be a reasonable combination of drugs to reduce the toxicity of chemotherapy.

Taurine, also known as β-amino ethanesulfonic acid, was first isolated from bezoar, which is a sulfur-containing non-protein amino acid and exists *in vivo* in a free state, with chemical stability and no involvement in the body protein biosynthesis. In the human body, taurine has a close metabolic relation with the cystine and cysteine, and the CSAD of taurine synthesis in the human is low, mainly relying on feeding to supplement the taurine needs of the body [24,25]. It is proved in some experiments [26,27] that taurine has the effects of promoting infant brain tissue and mental development, improving nerve conduction and visual function, preventing cardiovascular disease, improving endocrine status and enhancing immune function. In addition, taurine can also promote the secretion of pituitary hormones and activate pancreatic function so as to regulate the body metabolism, thus improving the body immunity and anti-fatigue effect. Some studies [28] reported that taurine has a certain anti-tumor effect. In the present study, after 3 weeks treatment, the anti-tumor rate of mice in taurine group was lower than chemotherapy group and chemotherapy + taurine group ($P < 0.05$), indicating that taurine has a certain anti-tumor effect, but the effect is less than routine chemotherapy. Some researches [14,29] believed that taurine is an effective immune adjuvant, which can play a role in chemotherapy drugs, and has a multi-directional advantages. In the present study, after the intervention treatment of chemotherapy and taurine, the tumor mass was significantly lower than the other three groups ($P < 0.05$), and the anti-tumor rate was obviously higher than those of chemotherapy group and taurine group ($P < 0.05$), which showed that using taurine adjuvant therapy in the conventional chemotherapy process can significantly improve the anti-tumor effect. Moreover, after 3 weeks of treatment in chemotherapy + taurine group, the thymus and spleen indexes of mice were significantly higher than those in model group and chemotherapy group ($P < 0.05$), and Th1/Th2 cytokine levels were better than those in the chemotherapy and model groups ($P < 0.05$), which also indicated that taurine can enhance the immune function of mice with T-cell lymphoma during chemotherapy, reduce the toxicity of chemotherapy and improve the curative effect. The results of this study confirm enhancement and toxicity reduction effect of taurine.

Conflict of interest statement

The authors declare that there is no conflict of interest.

References

[1] Yu MW, Yang L, Luo XQ. Impact of Heijiang Dan on the expression of wound cell apoptosis related protein of rats with radiodermatitis. *J Tradit Chin Med* 2017; **58**(13): 1145-1149.
[2] Yan H, Huang H. Should taurine act as nutritional supplement? *Electron J Metab Nutr Cancer* 2015; **11**(1): 67-70.
[3] Liu M, Feng LX, Hu LH, Liu X, Gao DA. Advancement in research of anti-cancer effects of toad venom (ChanSu) and perspectives. *World J Tradit Chin Med (English edition)* 2015; **1**(2): 12-23.
[4] Efferth T. Artemisinin-second career as anticancer drug? *World J Tradit Chin Med (English edition)* 2015; **1**(4): 2-25.
[5] Li W. Clinical effect of rituximab combined with CHOP regimen in treatment of non-Hodgkin's lymphoma. *Chin Foreign Med Res* 2017; **15**(13): 11-13.
[6] Bouckenooghe T, Remacle C, Reusens B. Is taurine a functional nutrient. *Curr Opin Clin Nutr Metab Care* 2006; **9**(6): 728-733.
[7] Duan YJ. Clinical application of chimeric antigen receptor T cells. *Cancer Res Clin* 2017; **29**(7): 498-500.
[8] Argiles JM, Busquets S, Lopezsoriano FJ. Cytokines as mediators and targets for cancer cachexia. *Cancer Treat Res* 2006; **130**(130): 199-217.
[9] Feng J, Wu MW. Effects of isoflurane on human breast cancer MDA-MB-231 cells and discussion on its relevant mechanism. *China Mod Doct* 2017; **55**(5): 8-11.
[10] Dong XL, Zhang SJ. Curative effect analysis of CD 20 monoclonal antibody in treatment of adult patients with invasive B-cell non-Hodgkin's lymphoma. *Anti-tumor Pharm* 2017; **7**(3): 332-335.
[11] Zheng YY, Xu YT, Wang J, Qiu MT, Yin R, Xu L, et al. Expression and function of long-chain non-coding RNA taurine upregulated gene 1 in esophageal squamous cell. *Chin J Exp Surg* 2015; **32**(12): 3216.
[12] Guo S, Tschammer N, Mohammed S, Guo P. Specific delivery of therapeutic RNAs to cancer cells via the dimerization mechanism of phi29 motor pRNA. *Hum Gene Ther* 2005; **16**(1): 1097-1109.
[13] Zhang XD, Zhao SY, Li YL, Zhu DL, Zhang R, Sheng JJ, et al. Taurine affects expression of ICAM-1, VCAM-1 by p38 pathway

in hypoxic endothelial cells. *China J Chin Mater Med* 2017; **42**(12): 2350-2354.

[14] Han YY, Shen P. Expression of long noncoding RNA TUG1 and its role in proliferation and apoptosis of lung adenocarcinoma. *China J Mod Med* 2017; **27**(7): 41-45.

[15] Schuller-Leris Georgia B. Taurine: new implications for an old amino acid. *FEMS Microbiol Lett* 2003; **226**(2): 195-202.

[16] Lu ZL, Liu J, Li F, Li XW, Wang Y. Antenatal taurine supplementation improves neural axon development in fetal rats with intrauterine growth restriction by inhibiting the activity of Rho-ROCK signaling pathway. *Chin J Perinat Med* 2017; **20**(1): 38-44.

[17] Zhang Z, Gui W, Zheng YP, Wang Ly, Su LP. Primary and secondary renal lymphoma: report of six cases and review of literature. *Cancer Res Clin* 2017; **29**(5): 346-348.

[18] Azzam EI, de Toledo SM, Little JB. Stress signaling from irradiated to non-irradiated cells. *Curr Cancer Drug Targets* 2004; **4**(1): 52-64.

[19] Guo K, Huang Y, Li YB. 18F-FDG PET/CT imaging features in different pathological types of malignant lymphoma. *J Chin Oncol* 2017; **23**(6): 479-482.

[20] Chen JP, Zhou XC, Huang CX. Clinicopathological analysis of 17 cases of primary MALT lymphoma. *Zhejiang Med J* 2017; **39**(10): 841-843.

[21] Diaz-Rubio E. New chemotherapeutic advances in pancreatic, colorectal, and gastric cancer. *Oncologist* 2004; **9**(4): 282-294.

[22] Wu LP, Hu XF, Wan HP. Cod skin peptide alleviates chemotherapeutic toxic reactions in patients with Hodgkin's lymphoma. *Zhejiang Med J* 2017; **39**(10): 779-781.

[23] Li H, Zheng W, Guo HW, Du J, Zhang XF, Shu SY. Influence of exogenous taurine addition in amino acid content in brains of hypoxic-ischemic brain injury rats during lactation. *Chin J Neuromed* 2015; **14**(12): 1240-1244.

[24] Chen F, Liu XL, Li PW. Extranodal marginal zone lymphoma of mucosa-associated lymphoid tissue in the brain parenchyma:a case report. *Chin J Oncol* 2017; **39**(3): 239-240.

[25] Lu EY, Zhang C, Wang JQ. Correlation between EBV infections and classification of non-Hodgkin lymphoma of pharyngeal and nasal cavity. *Chin J Nosocomiol* 2017; **27**(3): 639-641.

[26] Huang J, Wu J, Sun Y, Gong B, Liu HY. Inhibitory effect of taurine on inflammatory pain in rats and its mechanism. *Chin J Mod Drugs Appl* 2016; **10**(14): 283-284.

[27] Wang Y, Fu W, Liu J. Taurine improves neuronal stem cell proliferation in fetal rats with growth restriction. *Chin J Perinat Med* 2017; **20**(7): 530-537.

[28] Simmons TL, Andrianasolo E, Mcphail K, Flatt P, Gerwick WH. Marine natural products as anticancer drugs. *Mol Cancer Ther* 2005; **4**(2): 333-342.

[29] Jiang XM, Wang ZD, Li JL. Regulatory effects of taurine up-regulated gene 1 on tumorigenesis. *Chin J Pathophysiol* 2017; **33**(7): 1332-1337.