

Oncology Treatment Discovery

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Oncology Treatment Discovery

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Table of Contents

- 1 Research Progress of the Occurrence Mechanism of Bone Cancer Pain**
Dan Yi, Mengnan Du, Wentao Li, Shuo Dong, Ying Zhang

- 7 Research on the Application of Lung Ground-Glass Nodule Screening Based on Gene Methylation Combined with Spiral CT and AI Recognition System in Teaching Practice**
Yong Zhou, Cheng Zhou, Yingying Yu, Xiaojing Gan, Wenbo Jing, Jie Ming

- 13 A Qualitative Study of Caregiving Experiences and Emotional Responses of Family Primary Caregivers of Patients Undergoing Brain Tumour Surgery**
Xuefei Li, Can Zhang, Miaomiao Bai, Lian Xue, Xinrong Zhang

- 20 Analysis of the Selective Killing Effect of Microplasma on Specific Cancer Cell Lines**
Jie Bai

- 26 Clinical Efficacy of Tirilizumab in Combination with Conventional Chemotherapeutic Agents in Patients with Advanced Non-small Cell Lung Cancer**
Wei Qin, Dongli Zhang

- 34 Investigating the Impact of Lifestyle Factors on Breast Cancer Prognosis in the Chinese Women Population**
Jingjing Yu, Suriyakala Perumal Chandran, Farra Aidah Jumuddin, Nurul Azmir Amir Hashi

- 43 Exploration of Ultrasonic-mediated Precise Ablation Strategies for Tumor Treatment**
Chunlin Zhao

- 50 Evolution and Research Progress of Mesh Fixation Methods in Abdominal Wall Hernias**
Yuanqing Zhu, Hongbing Zhou, Yapeng Yang

- 57 Study on the Effect of Sini Powder and Huatan Xiaoyu Decoction Combined in the Treatment of Whole Stomach Gastritis with Precancerous Lesions**
Hai Wang

Research Progress of the Occurrence Mechanism of Bone Cancer Pain

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Abstract: As one of the common complications of patients with malignant tumors, cancer pain seriously affects their quality of life, especially the bone cancer pain, and the conventional analgesic effect of some patients with bone cancer pain is not ideal. The pathogenesis of bone cancer pain is complicated, the pathogenesis can be deeply understood and provide diagnosis and treatment thoughts for clinical relief of bone cancer pain by consulting the literature and summarizing the pathogenesis of bone cancer pain.

Keywords: Bone cancer pain; Mechanism; Research progress

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1. Introduction

Cancer pain, also known as malignant pain, is a symptom that mainly caused by pathological factors of tumors, anti-tumor treatment factors or other complications, social psychological factors^[1]. It is one of the most common and painful symptoms for patients with malignant tumors and regarded as the fifth vital sign of cancer patients, seriously affecting their quality of life^[2]. Research shows that about 70% of cancer patients experience cancer pain during the course of the disease^[3]. Patients will not only feel extremely uncomfortable but also may develop or aggravate symptoms such as fatigue, insomnia, loss of appetite, anxiety, and depression if cancer pain is not well and timely controlled, seriously affecting their daily activities and self-care ability. Therefore, “Diagnosis and Treatment Guidelines for Cancer Pain (2018)” points out that controlling pain is a basic right of patients and also the duty and obligation of medical staff^[4].

Bone cancer pain is a severe and common pain caused by bone metastasis or primary bone tumors. The state of pain is usually persistent, sudden, spontaneous, and accompanied by hyperalgesia^[5,6]. At present, the treatment of bone cancer pain includes drug analgesia, interventional therapy, radiotherapy, surgery and so on, while some

patients with bone cancer pain still have unsatisfactory pain control. Therefore, exploring the pathogenesis of bone cancer pain can help clinicians deepen their understanding of bone cancer pain, and guide clinical analgesia treatment, provide thoughts for the relief of bone cancer pain.

The pathogenesis of bone cancer pain is the result of multiple factors, and the occurrence mechanism is mainly related to several factors, such as activation of multiple signaling pathways, sensitization of the central nervous system, ferroptosis, osteoclasts and so on. The research progress is briefly described.

2. Activation of multiple signaling pathways

PI3K/Akt signaling pathway: Akt, which encodes widely expressed serine/threonine protein kinase ^[7], is the cell homologous gene of viral oncogene v-Akt and forms the PI3K/Akt signaling pathway with its upstream protein PI3K, which plays a very important role in neuropathic pain, inflammatory mechanical pain or thermal pain, and cancerous pain ^[8-10]. The PI3K/Akt signaling pathway is usually up-regulated in the pathological environment, while Li *et al.* (2020) ^[11] found that in the process of postoperative chronic pain, the expression of inflammatory factors (IL-1 β , TNF- α , etc.) increased, while the expression of PI3K/Akt decreased. By reducing the activation of PI3K/Akt, microglia promote the transformation of astrocytes into the A1 phenotype, which aggravates chronic pain after surgery. By studying the pain signal regulation pathway of bone cancer, Fu (2023) ^[12] observed that the expression of p-PI3K and p-Akt was up-regulated in the spinal cord tissue of bone cancer pain mice, and the expression levels of p-PI3K and p-Akt were significantly increased after pain stimulation. In addition, administration of the Akt inhibitor GSK690693 alleviated mechanical hyperalgesia associated with bone cancer. Previous studies have shown that the activation of PI3K and PKB/Akt is also involved in chronic pain, and the above study results indicate that PI3K/Akt plays different roles in the process of pain formation by activating various downstream signaling pathways ^[13]. Mitogen-activated protein kinase (MAPK) signaling pathway: As an important signal transduction pathway in the body, the MAPK signaling pathway is closely related to cell proliferation and apoptosis. MAPK family includes three important subfamilies: extracellular signal-regulated protein kinase (ERK), c-JUN amino-terminal kinase (JUN), and P38 ^[14]. Studies have found that the MAPK signaling pathway in the dorsal horn of the bone cancer pain mouse spinal cord was activated, showing that it is involved in the occurrence and development of bone cancer pain ^[15]. XPro1595 (a soluble tumor necrosis factor inhibitor) ^[16] could effectively inhibit the phosphorylation of the p38 MAPK signaling pathway, thus alleviating the pain behavior of bone cancer pain in rats, Jiao *et al.* (2021) ^[17] found that phenol could increase the threshold of mechanical foot retraction reflex in rats with bone cancer pain and the mechanism might be related to inhibiting activation of the MAPK signaling pathway by decreasing miR-21 expression. NF-kb signaling pathway: NF-kb is an important nuclear transcription factor in cells. As the central mediator of pro-inflammatory gene induction, NF-kb participates in important processes such as inflammatory response and immune response of the body. Its over-activation has also been confirmed to be related to many diseases, such as nerve injury ^[18], asthma ^[19], osteoporosis ^[20] and so on. In recent years, researchers have found that the activation of the NF-kB signaling pathway is also related to the occurrence of bone cancer pain. Zhou (2019) ^[21] observed the activation of the NF-kB signaling pathway itself in the rat model of tibial cancer pain, and the scorpion venom polypeptide monomer rBmK-AGAP could effectively inhibit the activation of the NF-kB signaling pathway and relieve the pain behavior of tibial cancer pain rats. Tian *et al.* (2019) ^[22] found that thalidomide could effectively alleviate the pain behavior of bone cancer pain rats induced by MC57G fibrosarcoma cells, and the mechanism might be

related to the down-regulation of NF- κ B expression. Yi *et al.* (2024) ^[23] showed that by inhibiting the activation of NF- κ B signaling pathway, down-regulated IL-1 β , IL-6, and TNF- α inflammatory factors could alleviate bone cancer pain.

3. Sensitization of the central nervous system

Sensitization of the central nervous system refers to the increased response of nociceptive neurons in the central nervous system, such as the spinal cord and supraspinal cord (thalamus, brainstem, cerebral cortex), to primary afferent information at or below the normal threshold. It is a state of hyperexcitability in the nervous system ^[24]. Previous studies on central sensitization were mostly neuropathic pain, while researchers found that the spinal dorsal horn neurons and dorsal root ganglia of rats with bone cancer pain had unusual neurochemical changes ^[25], suggesting that the occurrence and maintenance of cancer pain might be related to the interaction between peripheral tumors and nerve fiber endings, and then the central sensitization caused by transmitting pain signals into the spinal cord ^[26]. By comparison with normal animal models, the proportion of wide dynamic range (WDR) neurons to nociceptive-specific neurons increased in bone cancer pain animal models, indicating that the receptive field of superficial neurons in the dorsal horn of the spinal cord increased, thus leading to an increased probability of central response to afferent low-threshold nociceptive information, and spinal cord slice patch clamp recordings indicated that spinal cord neurons showed an enhanced response to evoked stimuli, indicated that the overall excitability of neurons was enhanced and created central sensitization ^[27]. It is important to note that bone cancer pain often presents as persistent chronic pain and recent studies support the association of chronic pain with the cingulate cortex, prefrontal cortex, and ventral striatum ^[28]. In addition, another important factor of central sensitization, the N-methyl-D-aspartate receptor (NMDAR) of glutamate also plays an important role ^[29]. As a central neurotransmitter glutamate receptor, the continuous activation of NMDAR can show an excessive activation state with multiple increases under the condition that the peripheral input signal remains unchanged ^[30], which occurs in parallel with bone cancer pain behavior ^[31], providing conditions for central sensitization.

4. Ferroptosis

Ferroptosis is a novel form of programmed and non-apoptotic cell death triggered by iron-dependent lipid peroxidation. It is mainly the excessive accumulation of iron that transfers to mitochondria and triggers ROS, which makes various influencing factors interact, including inflammatory factors, and oxidative stress, and finally induces mitochondrial damage and cell death ^[32]. The current studies on ferroptosis are mostly related to osteoarthropathy, kidney disease, and nervous system disease ^[33–35], while Ding *et al.*'s (2023) study ^[36] found that the by inoculating Lewis lung cancer cells in rat femur to establish bone cancer pain model, followed by continuous intraperitoneal injection of FER-1 (selective ferroptosis inhibitor), which effectively alleviated ferroptosis related iron accumulation and lipid peroxidation, alleviated bone cancer pain behavior. Furthermore, FER-1 inhibited the pain-associated activation of ERK1/2 and COX-2 expression and prevented the loss of GABAergic interneurons, suggesting that ferroptosis could be a potential therapeutic target in patients suffering from bone cancer pain.

5. Activation of osteoclasts

Osteoclast (OC) is the main functional cell of bone resorption, which plays an important role in bone development, growth, repair, reconstruction and bone cancer pain. The activation of osteoclasts in bone cancer pain is affected by OPG/RANKL/RANK system. The OPG/RANKL/RANK signaling pathway is activated after stimulation, which promotes the differentiation and activation of precursor cells of osteoclasts into osteoclasts, thus producing bone resorption and inducing osteolytic pain^[37]. Besides, the pain caused by osteoclasts' destruction of bone is also one of the causes of bone cancer pain. The periosteum sensory nerve distribution is abundant, and osteoclasts induce bone destruction, thus the mechanoreception of the periosteum produces pain, and osteoclasts can release H⁺, activate ASICs, and activate pain receptor sensitization, which aggravates pain perception.

6. Conclusion

To sum up, the occurrence of bone cancer pain is the result of many factors, including activation of multiple signaling pathways, sensitization of the central nervous system, ferroptosis, osteoclasts, etc. Exploring its pathogenesis can deepen the understanding of bone cancer pain so it can better find clinical analgesic methods, relieve the pain feeling of patients with bone cancer pain, providing thoughts for further treatment.

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Disclosure statement

The authors declare no conflict of interest.

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Research on the Application of Lung Ground-Glass Nodule Screening Based on Gene Methylation Combined with Spiral CT and AI Recognition System in Teaching Practice

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Abstract: The application of gene methylation combined with spiral CT in the screening of lung ground-glass nodules (GGN) and the integration of AI recognition systems represent cutting-edge advancements in medical technology. This study explores the practical application of these techniques in teaching settings, aiming to enhance students' understanding and proficiency in modern medical imaging and diagnosis. By incorporating these methods into educational curricula, we seek to assess their effectiveness in improving diagnostic accuracy, efficiency, and overall student engagement. The findings of this research have implications for enhancing medical education, particularly in the field of radiology and imaging sciences, ultimately leading to improved patient care and outcomes.

Keywords: Gene methylation; Spiral CT; Lung ground-glass nodule; AI recognition system; Teaching practice

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1. Introduction

Lung cancer is a clinically common malignancy with a high incidence. The diagnosis of lung cancer has always been a hot topic in clinical research. Early symptoms of lung cancer are concealed, so it is extremely important to pay attention to early screening and identification of lung cancer^[1,2]. The combination of gene methylation, spiral CT, and AI recognition systems plays a crucial role in the screening of pulmonary ground-glass nodules^[3]. Therefore, it is necessary to attach importance to teaching and research on the screening of pulmonary ground-glass nodules. The combination of gene methylation and spiral CT is a common screening method for pulmonary ground-glass nodules. Students can improve their disease diagnosis ability by mastering screening techniques^[4,5]. In recent years, with the application of artificial intelligence (AI) technology, early

screening of pulmonary ground-glass nodules has become more accurate, simple, and feasible^[6,7]. In teaching and research, it is necessary to integrate AI recognition system teaching and research to enhance the professional level of imaging medical personnel and standardize the screening of pulmonary ground-glass nodules^[8].

2. Materials and methods

2.1. General information

Sixty medical students from a hospital between October 2023 and October 2024 were selected for lung ground-glass nodule screening teaching. They were randomly divided into two groups (control group and study group), with 30 students in each group. The control group consisted of 14 males and 16 females, aged between 24–32 years old, with an average age of (28.12 ± 1.01) years old. The study group comprised 13 males and 17 females, aged between 24–30 years old, with an average age of (28.10 ± 1.02) years old. Among the 60 patients, there were 12 males and 48 females, aged between 21–58 years old, with an average age of (35.23 ± 2.45) years old. Comparing the data between the two groups, $P > 0.05$. The study met the requirements of medical ethics. The participants were informed of the study content and expressed their voluntary participation. Inclusion criteria: all were medical imaging students; all had good communication skills; all agreed to participate in the study. Exclusion criteria: poor compliance; failing grades before enrollment (< 60 points); females who were pregnant or breastfeeding.

2.2. Methodology

2.2.1. Control group

- (1) Gene methylation teaching: During the teaching process, teachers need to explain theoretical knowledge about gene methylation to students. For example, it belongs to epigenetic modification, which can play an important role in regulating individual growth, development, gene expression patterns, and genome stability without changing the DNA sequence. Moreover, this modification can be inherited during development and cell proliferation. Additionally, teachers should explain to students that different diseases have specific methylation profiles, and there are differences in methylation profiles at different stages of the disease. Detecting methylation at specific sites in specific samples can effectively improve the screening of precancerous lesions. Regarding methylation screening for pulmonary nodules, teachers should explain the auxiliary diagnostic markers, including three key gene methylations: SHOX2, RASSF1A, and PTGER4 genes. These three genes have significant advantages in screening for pulmonary ground-glass nodules, helping to distinguish between benign and malignant nodules.
- (2) Spiral CT screening teaching: In CT imaging diagnosis teaching, the imaging manifestations of pulmonary ground-glass nodules are summarized. Teachers should use typical cases to guide students in observing and analyzing the location, morphology, size, density, edges, and internal features of the nodules, and summarize as follows:
 - (A) Whether the edges of the nodule are smooth and regular. If the nodule is round or oval, it is more likely to be benign; malignant nodules often have irregular shapes, especially for malignant subsolid nodules or mixed ground-glass nodules, which have a higher probability of occurrence. If the nodule shows lobulation, spiculation, vascular convergence sign, and pleural indentation sign, it is more likely to be malignant.
 - (B) Size of the nodule: As the nodule increases in size, the probability of malignancy increases.

- (C) Density: Pulmonary pure ground-glass nodules with uniform density, especially those less than 5 mm, often suggest atypical adenomatous hyperplasia; mixed ground-glass density nodules with uneven density have a higher probability of malignancy as the solid component increases. If the diameter is greater than 5 mm, even a pure ground-glass nodule has the potential to develop into carcinoma in situ. Such pure ground-glass density nodules are defined as intermediate-risk nodules. For individuals who discover such nodules for the first time, it is recommended to have a follow-up examination in three to six months. If there is no change in nodule size, follow-up observation can continue. If the diameter is less than or equal to 5 mm, it is considered a low-risk nodule, and a low-dose spiral CT follow-up examination can be performed once a year.

2.2.2. Research group

Based on the control group, AI recognition system teaching will be conducted. During the teaching process, students are required to have a good grasp of the principles and operational usage of the system. Additionally, by combining imaging technology, low-dose spiral CT scans of the chest will be quickly performed for screening patients. Suspected ground-glass lung nodules will be precisely located, and a quantitative analysis of nodule composition will be conducted. The nature of nodules, such as solid nodules, ground-glass nodules, and part-solid nodules, will be distinguished based on artificial intelligence technology and labeled with colored frames. Furthermore, the AI recognition system can provide real-time descriptions of imaging features including the number, diameter, nature, volume, and CT value of suspicious lesions. It can accurately locate the structural relationship between lung tissue and nodule tissue, thereby enhancing diagnostic accuracy.

2.3. Observation indices

- (1) Comparison of the detection rate of pulmonary ground-glass nodules between the two groups of students, calculated as the number of detected pulmonary ground-glass nodules divided by the total number of cases, multiplied by 100%.
- (2) Analysis of teaching satisfaction between the two groups. Satisfaction evaluation includes teaching content, screening accuracy, and screening convenience. The full score is 100 points, where 0–59 points represent dissatisfaction, 60–79 points represent basic satisfaction, and 80–100 points represent satisfaction. The satisfaction rate is calculated as 1 minus the dissatisfaction rate.

2.4. Statistical analysis

Statistical analysis was performed using SPSS 22.0. Count data are expressed as $n(\%)$, and the chi-square test (χ^2) was used for comparison. A P -value less than 0.05 was considered statistically significant.

3. Results

3.1. Detection of pulmonary ground-glass nodules in two groups of students

The detection rate of pulmonary ground-glass nodules was higher in the study group than in the control group, with $P < 0.05$. See **Table 1** for details.

Table 1. Detection of pulmonary ground-glass nodules in two groups of students (%)

Group	Number of cases	Number of detected cases	Detection rate
Control group	60	32	53.33
Study group	60	45	75.00
χ^2 value	-	-	6.125
<i>P</i> value	-	-	0.013

3.2. Analysis of teaching satisfaction between two groups

The teaching satisfaction of the research group was higher than that of the control group, with a *P*-value less than 0.05. See **Table 2** for details.

Table 2. Analysis of teaching satisfaction between two groups (%)

Group	Number of cases	Satisfied	Average	Dissatisfied	Total satisfaction
Control group	30	9 (30.00)	12 (40.00)	9 (30.00)	21 (70.00)
Research group	30	12 (40.00)	16 (53.33)	2 (6.67)	28 (93.33)
χ^2 Value	-	-	-	-	5.455
<i>P</i> Value	-	-	-	-	0.020

4. Discussion

Screening for pulmonary ground-glass nodules plays a crucial role in ensuring people's health. It enables timely detection of high-risk nodules, allowing for early and effective intervention strategies to prevent disease progression and reduce the occurrence of lung cancer^[9,10]. Currently, the teaching of pulmonary ground-glass nodule screening mainly focuses on the combination of gene methylation and spiral CT imaging techniques. Students can assess diseases based on imaging features and gene methylation content, which demonstrates significant screening value^[11,12]. However, due to the complexity of these techniques, students often have inadequate understanding of screening methods and principles, affecting the accuracy of screening results for pulmonary ground-glass nodules.

The application of Artificial Intelligence (AI) technology has played a significant role in the screening process of lung ground-glass nodules. Incorporating the use of AI recognition systems in student teaching enables students to quickly and accurately identify and extract CT image features during clinical practice, assisting doctors in rapidly diagnosing and locating lesions, and improving the accuracy of students' disease screening results^[13,14]. The results of this study showed that the detection rate of lung ground-glass nodules was higher in the study group than in the control group, $P < 0.05$; the teaching satisfaction of the study group was higher than that of the control group, $P < 0.05$. It suggests that the screening of lung ground-glass nodules based on gene methylation combined with spiral CT and the AI recognition system has high practical value in teaching. The AI recognition system can enhance students' ability to identify lesions in teaching. The system utilizes automatic registration technology to comprehensively observe the growth cycle of nodules and effectively identify the risk of disease progression, which has a high value in teaching and research^[15].

5. Conclusion

In summary, traditional screening methods for pulmonary ground-glass nodules mainly rely on technologies such as gene methylation and spiral CT, which have good screening value. However, with medical research advancements, it has been found that the combination of gene methylation and spiral CT, aided by artificial intelligence systems, can provide more accurate results for disease screening and diagnosis. In clinical teaching practice, it is important to emphasize the in-depth study of AI recognition systems to make future screening for pulmonary ground-glass nodules more standardized and comprehensive.

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A Qualitative Study of Caregiving Experiences and Emotional Responses of Family Primary Caregivers of Patients Undergoing Brain Tumour Surgery

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Abstract: *Objective:* To understand the psychological dilemmas, emotional responses and caregiving experiences faced by family primary caregivers of patients undergoing brain tumour surgery in the process of caregiving, to explore problems in caregiving, and to provide a basis for the development of effective caregiving strategies and support measures. *Methods:* A phenomenological research method was used to interview the family primary caregivers of the enrolled 31 patients undergoing brain tumour surgery, and to analyze their emotional coping deficits, disease management experiences and social support needs during the patients' perioperative period and in family caregiving. *Discussion:* The study found that caregivers' caregiving experiences and emotional responses at different stages of patients' illnesses were personal emotional coping deficits, lack of experience in disease management and urgent social support needs. *Conclusion:* Understanding the caregiving experience and emotional responses of family caregivers of patients undergoing brain tumour surgery helps caregivers better identify the psychological dilemmas and needs faced by caregivers during the caregiving process, which in turn helps them develop personalized emotional support, professional knowledge training and skills guidance, and has a positive clinical impact on facilitating the smooth adaptation of the primary caregiver's role change, reducing the burden of caregiving, enhancing caregiving confidence and competence. It has positive clinical application value to promote family primary caregivers to adapt to the role change smoothly, reduce the burden of caregiving, enhance the confidence and ability of caregiving and improve the patients' therapeutic effect and life quality.

Keywords: Brain tumours; Home care; Carers; Caring experience; Phenomenological study

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1. Introduction

The brain tumour is a serious neurological disease, the incidence of which is increasing year by year globally. It

not only has a great impact on patient's physical health but also is often accompanied by cognitive, behavioural and neurological dysfunction, which significantly reduces patients' quality of life. Clinical treatment of brain tumour patients mainly relies on surgical protocols, and although they can effectively prolong patients' lives, the pain and complications brought about by the surgical treatment process can easily impose a huge physical and psychological burden on patients and their families ^[1]. Family primary caregivers are the primary source of support for brain tumour patients during treatment and rehabilitation, not only providing daily life care but also being responsible for the multiple physical and psychological care of the patient. Therefore, as the primary family members of brain tumour patients, especially spouses, parents, or children, they are under unprecedented pressure to not only coordinate the patient's medical treatment, rehabilitation, and daily life, but also often have to deal with complex emotional responses and psychological dilemmas ^[2]. Many carers report feeling overwhelmed and psychologically burdened by this process, and even experience emotional problems such as anxiety and depression. Currently, clinical research on the caregiving experience and emotional responses of family caregivers of patients undergoing brain tumour surgery is still scarce and lacks an in-depth understanding of the psychological needs of caregivers. Therefore, exploring the experience and emotional responses of family primary caregivers of patients undergoing brain tumour surgery in the process of caregiving is of great significance in improving the patient care model and optimizing the caregiver support system. This study aims to explore the caregiving experiences and emotional responses of family primary caregivers of patients with brain tumour surgery through qualitative research methods, and to reveal the challenges and needs they face in this process, to provide theoretical support and practical guidance for future caregiving practice and policy development.

2. Objects and methods

2.1. Study objects

A purposive sampling method was used to select the primary family caregivers of 31 patients who underwent brain tumour resection at a hospital from January to August 2024 as the study population (only 1 family caregiver was selected for each patient). Inclusion criteria: (1) primary family caregivers (spouses, parents, or children) of patients who underwent brain tumour resection treatment in our hospital between January and August 2024; (2) informed about the purpose and methods of this study and voluntarily participated in this study; (3) with normal language skills and able to clearly express their caregiving experiences; (4) aged between 20 and 51 years old, without serious psychological disorders or history of psychiatric disorders, able to accurately provide relevant information about the patient's treatment and rehabilitation process during the interview. Exclusion criteria: (1) family caregivers with obvious cognitive dysfunction or history of mental illness, unable to complete the interview; (2) those who refused to participate in the study or withdrew halfway; (3) patients who were not diagnosed and treated by our hospital or patients who were not hospitalized in the hospital after surgery; (4) the caregiver failed to provide continuous care for at least two weeks, or the caregiver could not be contacted during the interview.

Among the 31 family primary caregivers of brain tumour surgery patients enrolled, 17 were male and 13 were female. The age distribution was: 20–35 years old (17 people), 36–45 years old (9 people), 46–51 years old (5 people); the education level was: undergraduate and above 10 people, high school 7 people, junior high school 11 people, primary schools 3 people; the relationship with the patient included: spouse 12 people, parents 6 people, children 10 people, siblings 3 people; the daily caring time: > 15h 4 people, 10–14h 13 people, 5–9h for 11 people, < 5h for 3 people; average monthly income distribution: < 2400 yuan for 1 person, 2400–3500 yuan for 8 people,

3500–4200 yuan for 14 people, 4201–4999 yuan for 5 people, and 5000 yuan and above for 3 people; the patients' medical expenses were: 9 cases at public expense, 19 cases of reimbursement by the health insurance, and 3 cases of self-financed treatment.

2.2. Methodology

2.2.1. Research methodology

A phenomenological approach in qualitative research was used to gain an in-depth understanding of the caregiving experiences and emotional responses of family primary carers of patients undergoing brain tumour surgery. The study was conducted through one-on-one interviews with experienced specialist nurses to ensure the validity and authenticity of the data. Before the interview, the purpose, methodology and content of the study were explained in detail to the interviewees, informed consent was obtained from the interviewees, and they were assured of the strict confidentiality of their personal information and research data, and all the data were restricted to be used only in the present study, to ensure the ethical nature of the study and the protection of the participants' privacy. A semi-structured outline was used in the interview process, with the flexibility to dig deeper based on the respondents' answers, to ensure that comprehensive and authentic emotional and experiential feedback was obtained.

2.2.2. Data collection

Interviews were conducted in a quiet, independent room to ensure that interviewees were able to express their feelings in a private, comfortable environment. The study adopted a semi-structured interview outline, with questions flexibly adapted to respondents' specific answers, to dig deeper into their caring experiences and emotional responses, and to ensure the comprehensiveness and authenticity of the data. The interview outline mainly covers the following contents:

- (1) What were your initial feelings when you learnt that your relative had been diagnosed with a brain tumour?
- (2) What were the emotional and psychological experiences you went through during the surgical decision-making process?
- (3) What was the greatest difficulty you faced during the patient's stay?
- (4) What is the most difficult problem you have encountered in caring for a patient after discharge from hospital?
- (5) Do you have a comprehensive understanding of brain tumours and what aspects of the disease concern you most?
- (6) What specific impact do you think brain tumours have had on families and daily life?
- (7) Have you been restricted in your socializing and how has this manifested itself?
- (8) What do you need the most help with and how would you like to receive support?
- (9) Do family members show understanding and support for your caring behaviour?

During the interview, interviewees were encouraged to speak freely and fully express their feelings, thoughts and experiences, but it was important to ensure that the personal privacy of patients and their families was not involved. The interviews were recorded in detail and synchronized with audio recordings to ensure the accuracy of the information. In addition, we pay attention to the interviewees' emotional responses, body language and mood changes to have a more comprehensive understanding of their caregiving experience.

2.2.3. Analysis of information

Data were analyzed using the Colaizzi seven-step method ^[3]. The audio recordings and field observation notes were transcribed verbatim within 24 hours of the interview and entered into a Word document to form a complete textual profile. The transcription process was double-checked by two people to ensure accuracy. Subsequently, the interviews were synthesized and analyzed by three researchers with experience in phenomenological research, confirming the interviewer's descriptions one by one through cross-discussions, comparing similarities and differences, and suggesting necessary adjustments. To ensure the authenticity of the data, each step in the analysis process is returned to the interviewee for verification. During the analysis process, the researcher distilled and summarized important phrases and sentences, coding and ranking them. Finally, the data was thematically categorized according to these codes, from which themes reflecting the core experiences of carers were extracted.

2.2.4. Quality control

The sample selection in this study took full account of the representativeness of the carers and was based on factors such as age, literacy, relationship with the patient, and financial status to ensure the diversity and coverage of the sample. Interviews were conducted using open-ended questions to encourage interviewees to freely express their emotions and experiences of caring at all stages from a personal perspective. During the research process, the interviewers maintained a neutral stance at all times and avoided leading questions or innuendos to ensure that the interviewees were able to truly reflect their personal experiences and emotional changes. Meanwhile, all interviews were transcribed in detail by the researchers and checked with the interviewees to confirm their accuracy. During the process of data coding and analysis, the research team will review each session several times to ensure the integrity and reliability of the data, thus enhancing the credibility of the research results.

3. Results

3.1. Personal emotional coping deficits

When carers were first informed of their relative's diagnosis of a brain tumour, many were shocked and frightened, unable to come to terms with the sudden shock. They reported that the diagnosis of a brain tumour left them feeling uncertain and extremely worried about the future, with anxiety creeping in and often feeling powerless to do anything about the patient's progress. During the decision-making process for the patient's surgery, carers often felt conflicted and helpless amidst the stress and emotional pull of decision-making, especially when family members disagreed, and carers felt a great deal of psychological distress. Anxiety was present at every stage of the caregiving process, with many carers reporting difficulties in balancing their caring and personal lives, often doubting their ability to care, and experiencing high levels of mood swings, further exacerbating the psychological burden.

3.2. Lack of experience in disease management

Many caregivers lack experience in effective disease management and often feel confused and overwhelmed during the caregiving process. Most carers have not received relevant medical care training and therefore show inadequate coping skills when faced with the management of patients' postoperative symptoms. For example, some caregivers failed to recognize patients' complications or postoperative reactions promptly, leading to fluctuations in patients' conditions. In the transition of caregiving roles, carers often feel role conflict, they have difficulty in finding a balance between family life and caregiving tasks, and very often their needs are neglected

and they feel that they have taken on too much responsibility.

3.3. The urgent need for social support

The results of the study show that the need for social support among carers is urgent. Firstly, many carers identified friends as an important source of support for them, and they wished to obtain emotional support and psychological comfort through interaction with friends. Nonetheless, many caregivers expressed a certain degree of stress in the face of concern from relatives and friends, especially when such support was limited to verbal comfort and lacked practical action. Second, caregivers generally reflected that high medical costs were one of the major financial pressures they faced and that many families had limited incomes, and that although some of the patients were supported by health insurance or publicly funded medical care, the treatment process still incurred a large number of out-of-pocket expenses, carers said that the financial pressure adds to their burden and affects the performance of their caring capacity. Therefore, they hope to receive more financial assistance or policy support to alleviate their financial pressure so that they can focus more on patient care.

4. Discussion

4.1. Inner experiences of family primary carers of patients undergoing brain tumour surgery

This study found that family primary caregivers of brain tumour patients experienced extremely complex emotional fluctuations throughout the caregiving process. Firstly, many carers displayed shock and fear upon learning that the patient had been diagnosed with a brain tumour. This emotional response occurs because brain tumour, as a serious and unpredictable disease, is fraught with uncertainty for the patient and family members about their future prognosis ^[4]. At this point, caregivers often feel deep anxiety about the future, and uncontrollable fear accompanies every detail of daily life. Second, caregivers commonly face ambivalence and helplessness as the decision to proceed with surgery is made. Many family members disagreed on whether to undergo surgery and what treatment to choose, and carers were often in a dilemma, unable to make a clear decision. In the process, they show strong emotional conflicts and inner turmoil ^[5]. Finally, when the patient's symptoms did not improve significantly or complications arose in the postoperative period, the caregiver's anxiety became more intense and even led to feelings of self-blame. Caregivers worry that they will not be able to provide enough care to alleviate the patient's suffering. These emotional responses suggest that family caregivers of brain tumour patients not only have to deal with changes in the patient's condition during the caregiving process, but also with their own significant psychological and emotional challenges. Therefore, it becomes particularly important to help caregivers manage their emotions and provide psychological support.

4.2. Urgent need for knowledge and social support for family primary carers of patients undergoing brain tumour surgery

4.2.1. Disease-related knowledge information support

This study reveals the lack of knowledge of caregivers in the process of disease management, as many caregivers reported that they had very limited knowledge about brain tumours when dealing with the patient's disease, especially the lack of sufficient information about treatment options before and after surgery, postoperative rehabilitation, and possible complications. As a result of information asymmetry, carers are often left in a state of anxiety and helplessness and are unable to respond effectively to changes in the patient's condition ^[6]. In fact, the process of caring for brain tumour patients involves multidisciplinary treatment and management, including

the use of medication, rehabilitation, prevention, and management of complications, etc., and caregivers need to have the sufficient medical knowledge to help patients successfully navigate through these difficulties. However, many current carers do not know how to properly manage their patients' conditions due to a lack of professional knowledge and training ^[7]. It was found that most caregivers were eager to obtain more professional information about brain tumours, especially at the critical stage of patients' postoperative recovery, and they would like to receive clearer treatment guidelines and rehabilitation programs. Therefore, enhancing caregivers' knowledge of the disease, especially through health education and regular professional guidance, can help caregivers better adapt to their caregiving role and reduce their psychological burden.

4.2.2. Family and social support

Research has shown that family carers of people with brain tumours generally face significant caregiving pressures, and their reliance on family members and social support appears to be particularly acute. Many carers reported that although they received some emotional support from their spouses, parents or other relatives, practical help was often limited. Particularly in day-to-day care, caregivers are not only required to undertake a large number of nursing tasks but also to provide emotional encouragement and comfort to the patient ^[8]. The support of family members is crucial in this process, yet in some families, carers often feel isolated and lack adequate help and understanding. Carers expressed that they sometimes need more practical help, especially in the patient's life care and medical matters. Social support is also an important part of carers' needs. The study also found that carers had high expectations of social support, particularly for social benefits, care subsidies and other forms of financial assistance to reduce the financial burden of caring ^[9].

4.3. Coping strategies for carers' psychological distress

A study of family primary caregivers of brain tumour patients revealed that caregivers' psychological distress is not only the result of emotional reactions but is also closely related to the lack of effective coping strategies. Many carers often fail to manage their psychological stress effectively due to information asymmetry, caregiving inexperience, and lack of social support, leading to the exacerbation of emotional problems such as anxiety and depression. In this regard, it is recommended that psychological support be provided to carers through various means. For example, special psychological counseling services can be set up in hospitals to provide carers with emotional support and psychological counseling to help them relieve anxiety and stress. In addition, caregivers' disease management skills and psychological resilience can be enhanced through regular nursing education and training, thereby increasing their confidence and ability to cope with the challenges of caregiving ^[10].

5. Conclusion

This study provides insights into the emotional and psychological stresses faced by 31 family primary caregivers of patients undergoing brain tumour surgery during their caregiving process through interviews with them. Most of the caregivers indicated that they were under great pressure, had significant emotional distress, and had a strong need for external support. As the concept of "family-centered" care is promoted in clinical practice, understanding caregivers' real feelings and experiences of caregiving will not only help caregivers pay more attention to the psychological status and needs of caregivers but also provide the basis for the development of a more personalized care plan. The study suggests that a more comprehensive assessment system should be established

to systematically assess the psychological difficulties and caring capacity of carers, and provide targeted support based on the results of the assessment, which will not only provide an important reference for improving the quality of care and the physical and mental health of carers, but also help to develop appropriate care models for high-risk groups.

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Analysis of the Selective Killing Effect of Microplasma on Specific Cancer Cell Lines

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Abstract: This article aims to deeply analyze the mechanism of the selective killing effect of microplasma on specific cancer cell lines. A comprehensive investigation of relevant literature expounds on the generation principle and characteristics of microplasma and its interaction process with cancer cells. The potential mechanisms of its selective killing of cancer cells are explored from multiple aspects including physics, chemistry, and biology, involving the generation of reactive oxygen and nitrogen species, damage to cell membranes, changes in intracellular signaling pathways, and immunomodulatory effects. Additionally, the existing problems in current research and future research directions are prospected, aiming to provide a theoretical foundation and reference for the further application of microplasma in the field of cancer treatment.

Keywords: Microplasma; Cancer cell line; Selective killing; Mechanism of action

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1. Introduction

Cancer, as one of the major diseases that severely threaten human health worldwide, has always been a hot and difficult topic in medical research regarding its treatment methods. Traditional cancer treatment methods, such as surgery, chemotherapy, and radiotherapy, have achieved certain results, but they are often accompanied by many side effects and limitations, such as damage to normal tissues and the development of drug resistance. In recent years, microplasma technology, as an emerging cancer treatment method, has gradually attracted attention due to its advantages of non-invasiveness, precise controllability, and potential selective killing effect on cancer cells, opening up new avenues for cancer treatment. Deep research on the mechanism of the selective killing effect of microplasma on specific cancer cell lines has important theoretical and practical significance for optimizing microplasma treatment technology and improving cancer treatment effects.

2. Generation and characteristics of microplasma

To understand the selective killing effect of microplasma on cancer cells, it is essential to delve into its generation mechanism and unique characteristics. This section first elaborates on how microplasma is generated under specific conditions and the characteristics of different generation methods. Then, it analyzes the physical and chemical properties that determine microplasma's unique behavior and potential biological effects when interacting with cancer cells.

2.1. Generation principle

Microplasma, confined to the millimeter to micrometer scale, is a type of low-temperature plasma that has become a hot research topic in recent years. Typically, microplasma has a scale below 1 millimeter, much smaller than traditional plasma, and can operate at atmospheric pressure, exhibiting numerous novel properties. Microplasma finds potential applications in various fields such as biopharmaceuticals, micro-machining, and micro-light sources, garnering widespread attention and research in recent years ^[1]. Its generation relies on specific gas environmental conditions where an electric field or radiofrequency energy of sufficient intensity is applied. This energy promotes the ionization of gas molecules, forming a plasma state containing various active particles like electrons, ions, excited atoms and molecules, and free radicals. The generation methods are diversified, including dielectric barrier discharge (DBD), radiofrequency discharge, and microwave discharge. DBD stands out due to its relatively simple device structure, easy operation, and stable microplasma generation at atmospheric pressure, making it widely used in specific scenarios. On the other hand, the radiofrequency discharge method excels in plasma density and energy control precision, achieving higher plasma density and precise energy regulation, meeting the experimental or application requirements for higher microplasma characteristics.

2.2. Characteristics

Microplasma exhibits unique and complex characteristics in both physical and chemical aspects. From the physical perspective, its electron temperature is relatively high, while the ion temperature remains low. This significant non-equilibrium state ensures the generation of a large number of active particles without significantly elevating the ambient temperature, providing a material basis for subsequent chemical and biological effects. Chemically, microplasma is rich in various reactive oxygen species such as O^{2-} , $OH\cdot$, H_2O_2 ^[2], and reactive nitrogen species like $NO\cdot$, $NO_2\cdot$, N_2O . These highly reactive substances can actively participate in oxidation, reduction, nitration, and other chemical reactions with surrounding substances, triggering biological effects on cells and significantly influencing their physiological states. Furthermore, advanced micro-machining techniques enable precise localization of the microplasma discharge region within microscopic scales, such as creating specifically sized and shaped microplasma sources. This achieves a highly localized and precise effect on cancer cells, offering a potential technical approach for cancer treatment.

3. Interaction process between microplasma and cancer cells

After clarifying the generation and characteristics of microplasma, further exploration of its interaction process with cancer cells becomes crucial ^[3]. This process involves multiple levels, from direct physical impacts to chemical reactions of active substances, and alterations in intracellular signaling pathways and immune responses. These levels intertwine, forming a complex network of microplasma's effects on cancer cells and profoundly influencing their fate.

3.1. Physical interaction

The initial interaction between microplasma and cancer cells occurs at the physical level. The electric field generated by microplasma affects the microenvironment of cancer cells, while physical factors like ion flow and electron impact directly target the cell membrane. As a critical barrier between the cell and its external environment, the integrity of the cell membrane is directly related to cell survival and functional normality. Under the influence of microplasma, ion flow and electron impact can alter the charge distribution on the cell membrane surface, leading to the phenomenon of electroporation. This manifests as the formation of temporary nanometer-to-micrometer-scale pores in the cell membrane, increasing its permeability and disrupting the balance of intracellular and extracellular material exchange. Consequently, this can gradually affect the cell's normal physiological functions and, in severe cases, lead to cell death.

3.2. Chemical interactions

The reactive oxygen and nitrogen species present in the microplasma play a crucial role in their interaction with cancer cells, exhibiting key chemical effects. These reactive species inherently possess highly active chemical reactivity, capable of rapidly initiating chemical reactions with lipid components on the cancer cell membrane, protein molecules, and various biological macromolecules within the cell, such as DNA, RNA, and enzymes. Specifically, the hydroxyl radical ($\text{OH}\cdot$), among the reactive oxygen species can attack unsaturated fatty acids on the cell membrane, triggering the process of lipid peroxidation and damaging the original structure and function of the cell membrane^[4]. Simultaneously, hydroxyl radicals can also oxidize intracellular proteins, causing them to lose their normal biological activity, thereby interfering with intracellular signal transduction pathways and metabolic processes. On the other hand, reactive nitrogen species can alter the structure and function of proteins by nitrating amino acid residues, thus affecting biological behaviors such as cell proliferation and apoptosis, and playing a pivotal role in determining the fate of cancer cells.

3.3. Biological interactions

The effects of microplasma on cancer cells are not limited to the physical and chemical levels but also trigger a series of biological responses. After cancer cells are treated with microplasma, their internal signaling pathways change. For instance, some studies have found that microplasma treatment can activate apoptotic signaling pathways within cancer cells, such as the activation of caspase family proteases, promoting programmed cell death in cancer cells. Additionally, microplasma may affect the cell cycle regulation of cancer cells, causing them to stagnate in specific cell cycle stages, thereby inhibiting cancer cell proliferation^[5]. Meanwhile, the interaction between microplasma and cancer cells may also trigger the body's immune response, such as the release of immune-modulating factors, attracting immune cells like macrophages and T-lymphocytes to gather at the cancer cell site, enhancing the body's immune clearance ability against cancer cells. This, to some extent, reflects the selective killing effect of microplasma on cancer cells, as normal cells typically do not elicit such a strong immune response.

4. Mechanism of microplasma's selective killing of specific cancer cell lines

After understanding the interaction process between microplasma and cancer cells, it is crucial to delve into the mechanism of its selective killing of specific cancer cell lines. This involves various factors such as the characteristics of cancer cells themselves, microplasma action parameters, and the microenvironment of cancer

cells. These factors are interrelated and synergistic, collectively determining whether microplasma can precisely target specific cancer cell lines, providing a critical basis for further optimizing the application of microplasma in cancer treatment.

4.1. Biological characteristics differences of cancer cells

From the perspective of the cell membrane, there are differences in phospholipid types, cholesterol content, and the distribution and types of membrane proteins, which directly determine the rate and selectivity of material exchange in and out of cells. These differences are closely related to the response of cancer cells to microplasma action ^[6]. For example, the permeability of certain cancer cell membranes may be low, limiting the entry of reactive substances generated by microplasma into the cells, thereby affecting the killing effect.

In terms of metabolism, different cancer cell lines exhibit variations in glycolytic intensity, the proportion of aerobic respiration, and the synthesis and decomposition rates of lipid metabolism. This results in significant differences in the metabolic detoxification ability of cancer cells when responding to reactive substances produced by microplasma.

The activity status of signaling pathways is crucial. The activation or inhibition of pathways like MAPK and PI3K-Akt directly determines the sensitivity of cells to microplasma. Some cancer cell lines, rich in antioxidant enzymes, can effectively neutralize the oxidative damage caused by microplasma, exhibiting lower sensitivity ^[7]. In contrast, other cancer cell lines may be more susceptible to damage under microplasma action due to special receptors on the cell membrane mediating the influx of several ions, disrupting intracellular homeostasis, or overactivation of key signaling pathways. These factors collectively constitute the key basis for the selective killing of cancer cells by microplasma, providing an important theoretical foundation for the development of cancer treatment strategies.

4.2. Regulation of microplasma action parameters

The action parameters of microplasma play a critical role in the killing process of cancer cells, where factors such as discharge power, action time, and gas composition significantly affect the killing effect and selectivity. Precise regulation of these parameters can achieve effective control over the type, quantity, and energy distribution of active particles generated by microplasma, thereby optimizing the killing effect and selectivity for different cancer cell lines.

In terms of discharge power, moderately increasing the discharge power typically promotes the generation of more reactive oxygen and nitrogen species by microplasma, enhancing the killing efficacy against cancer cells. However, excessively high discharge power beyond a reasonable range may cause unnecessary collateral damage to surrounding normal tissues while killing cancer cells.

Regarding gas composition, adjustments can alter the composition and proportion of active substances in microplasma, matching the sensitivity characteristics of different cancer cell systems. For instance, adding a moderate amount of oxygen to the gas can increase the production of reactive oxygen species ^[8]. For cancer cell lines that exhibit higher sensitivity to oxidative stress, such changes in gas composition can significantly enhance the killing effect of microplasma. Conversely, for cancer cell lines more sensitive to reactive nitrogen species, precise adjustments to the gas composition can increase the production of reactive nitrogen, achieving better cancer cell killing.

Additionally, the duration of action cannot be ignored. Reasonably extending the action time of microplasma

can expose cancer cells to more active particles, enhancing the killing effect. However, excessively long action times may also trigger other negative effects, requiring fine optimization based on specific cancer cell lines and experimental conditions. In conclusion, in-depth research and precise regulation of microplasma action parameters possess significant potential value for cancer treatment.

4.3. Influence of microenvironmental factors

The microenvironment surrounding cancer cells is highly complex, encompassing various aspects such as the extracellular matrix, intercellular interactions, and local physiological and biochemical conditions. These factors, acting together, significantly affect the selective killing efficiency of microplasma on cancer cells. Within the special environment of tumor tissue, cancer cells intertwine with surrounding stromal cells, immune cells, and vascular endothelial cells, forming an intricate network system^[9]. Unique conditions such as hypoxia, acidosis, and high expression of specific growth factors and cytokines are common occurrences. Taking hypoxic conditions as an example, cancer cells under such environments undergo a metabolic shift from aerobic respiration to anaerobic metabolism with enhanced glycolysis, leading to adaptive adjustments in numerous signaling pathways. These changes may alter the sensitivity of cancer cells to microplasma, either increasing or decreasing it. Simultaneously, during its interaction with cancer cells, microplasma also exerts a reactive effect on the aforementioned factors within the cancer cell microenvironment^[10]. For instance, reactive species generated by microplasma may alter the local redox state, subsequently influencing cytokine secretion and metabolite accumulation. This further fine-tunes the survival status of cancer cells and their sensitivity to microplasma, ultimately profoundly impacting the selective killing effect of microplasma on specific cancer cell lines.

5. Conclusion

The selective killing effect of microplasma on specific cancer cell lines is a complex and potential research field. Through an in-depth exploration of the principles and characteristics of microplasma generation, as well as its interaction processes and mechanisms with cancer cells, we have gained a preliminary understanding of its possibilities and advantages as a novel cancer treatment method. However, current research remains in its infancy, facing numerous key issues and challenges that need to be addressed. Future studies require further elucidation of the detailed molecular mechanisms underlying the selective killing of cancer cells by microplasma, optimization of treatment parameters and equipment design, and strengthening of preclinical and clinical trial research to comprehensively evaluate its efficacy and safety. Simultaneously, active exploration of combination therapy modes with other treatment methods is essential. This will provide a solid theoretical foundation and technical support for the clinical application of microplasma technology in the field of cancer treatment, potentially offering more effective, safe, and personalized treatment options for cancer patients, and driving the development and progress of cancer therapy.

Disclosure statement

The authors declare no conflict of interest.

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Clinical Efficacy of Tirilizumab in Combination with Conventional Chemotherapeutic Agents in Patients with Advanced Non-small Cell Lung Cancer

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Abstract: *Objective:* To explore the analysis of the application effect of tirilizumab combined with conventional chemotherapeutic drugs (paclitaxel + carboplatin) in the clinical treatment of advanced non-small cell lung cancer patients. *Methods:* Seventy-five patients with advanced non-small cell lung cancer who received chemotherapy treatment in a hospital from July 2023 to June 2024 were selected as objects, and grouped according to the choice of chemotherapy drugs, 37 patients who received regular chemotherapy drugs (paclitaxel + carboplatin) were included in the control group, and the other 38 patients who received tirilizumab + paclitaxel and carboplatin chemotherapy were included in the observation group, and the clinical efficacy of the two groups was compared. *Results:* Before treatment, the difference in serum tumour marker levels between the two groups was not significant ($P > 0.05$); after treatment, the levels of glycan antigen 125 (CA125), carcinoembryonic antigen (CEA), neuron-specific enolase NSE, and squamous carcinoembryonic antigen (SCC) in the patients of the two groups were significantly reduced, and the level in the observation group was lower than that in the control group ($P < 0.05$); before treatment, the level of immune function in the patients of the two groups, there was no statistically significant difference between the immune function levels of patients in the two groups ($P > 0.05$); after treatment, the levels of $CD3^+$, $CD4^+$ and $CD4^+/CD8^+$ were significantly higher and $CD8^+$ were lower in the two groups, and the indicators of the observation group were better than those of the control group ($P < 0.05$); the incidence rate of toxic side effects such as nausea, vomiting, bone marrow suppression, liver and kidney function abnormalities, and so on, during the period of treatment of the observation group was significantly lower than that of the control group (5.26%) and the difference had a significant difference of 24.32%, the difference was statistically significant ($P < 0.05$); before treatment, there was no statistically significant difference in the quality of life SF-36 scores between the two groups ($P > 0.05$); after three courses of treatment, the quality of life SF-36 scores of the two groups were significantly higher, and the observation group was higher than the control group ($P < 0.05$). *Conclusion:* Tirilizumab combined with conventional chemotherapy drugs (paclitaxel + carboplatin) has remarkable efficacy in the treatment of advanced non-small cell lung cancer, which can effectively reduce the level of tumour markers and the risk of toxic and side effects, improve the immune function and enhance the quality of life of patients, and has positive clinical promotion value.

Keywords: Advanced non-small cell lung cancer; Tirilizumab; Chemotherapy; Tumour markers; Immune function; Quality of life SF-36

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1. Introduction

Advanced non-small cell lung cancer (NSCLC) is one of the most common malignancies worldwide, and since most patients are diagnosed at an advanced stage, surgical resection is often not possible, and only systemic chemotherapeutic treatment is available. For a long time, traditional chemotherapeutic agents such as paclitaxel and carboplatin have always occupied an important position in the treatment of NSCLC ^[1]. Paclitaxel induces apoptosis in tumour cells by inhibiting microtubule protein polymerization and interfering with the process of cell division; carboplatin, on the other hand, inhibits DNA replication by binding to the DNA of the tumour cells, thereby preventing cell proliferation ^[2]. Although chemotherapy has prolonged the survival time of patients to a certain extent, its efficacy is limited, especially for patients with advanced NSCLC, and drug resistance and toxicity remain major challenges. In recent years, with the rapid development of tumour immunology, the emergence of immune checkpoint inhibitors (e.g., anti-PD-1/PD-L1 monoclonal antibodies) has brought new therapeutic options for patients with advanced NSCLC ^[3]. Tirilizumab is an anti-PD-1 monoclonal antibody, which is used in the treatment of tumour diseases to inhibit tumour growth by blocking the PD-1 pathway and restoring T-cell activity ^[4]. Relevant medical research shows that in the clinical treatment of tumour patients, the combined use of immunotherapy and chemotherapy has a certain synergistic effect. On the one hand, chemotherapeutic agents can directly kill tumour cells and release tumour antigens, thus enhancing the recognition ability of the immune system ^[5]. On the other hand, immune checkpoint inhibitors can further activate anti-tumour immune responses and enhance the therapeutic effect of chemotherapy ^[6]. Therefore, exploring the efficacy and safety of the combination of tirilizumab with conventional chemotherapeutic agents in the treatment of patients with advanced NSCLC is of great clinical significance. In this study, we took patients with advanced NSCLC as research subjects and analyzed the application effect of tirilizumab combined with chemotherapy (paclitaxel + carboplatin) in the clinic, aiming to provide a more optimal treatment plan for this type of patient.

2. Information and methodology

2.1. General information

Seventy-five patients with advanced non-small cell lung cancer who were treated with chemotherapy in a hospital from July 2023 to June 2024 were selected and grouped according to the treatment method, and 37 patients who were treated with conventional chemotherapeutic drugs (paclitaxel + carboplatin) were included in the control group. Among them, 21 cases were male and 16 cases were female, the age range was 45–78 years old, with an average of (62.42 ± 8.56) years old; clinical stage: 14 cases of stage III and 23 cases of stage IV. Another 38 patients who received tirilizumab + paclitaxel and carboplatin chemotherapy were included in the observation group. Among them, there were 20 males and 18 females, with an age range of 43–79 years old, mean (61.91 ± 8.63) years old; clinical stage: 13 cases of stage III and 25 cases of stage IV. The difference in general information between the two groups of patients was not statistically significant ($P > 0.05$) and was

comparable.

Inclusion criteria: (1) non-small cell lung cancer (NSCLC) stage III or IV diagnosed by pathology or cytology ^[7]; (2) age between 43 and 79 years old, no gender restriction; (3) no contraindication to immunotherapy and no previous treatment with immune checkpoint inhibitors; (4) patients with quality of life SF-36 scores of > 50, able to tolerate chemotherapy and immunotherapy; (5) voluntary participation in the study and signed an informed consent form.

Exclusion criteria: (1) the presence of other malignant tumours or recently received other anti-tumour therapy (such as radiotherapy, targeted therapy, etc.); (2) previous history of severe cardiac, hepatic, renal function abnormalities or active autoimmune diseases; (3) the presence of uncontrolled infections (e.g., active tuberculosis, hepatitis B, hepatitis C, or HIV infection) disease; (4) patients who participated in a clinical trial of other drugs in the 6 months prior to the start of the study.

2.2. Methodology

During the treatment period, patients in both groups received hydration, correction of electrolyte disorders and anti-allergic conventional supportive therapy, meanwhile, healthcare personnel closely monitored the patients, focusing on the occurrence of toxic side effects, and took corresponding measures in time to ensure the safety of the patients and the smooth progress of the treatment. The control group adopts a conventional chemotherapy regimen (paclitaxel + carboplatin), every 21 days as a course of treatment, which lasts until the disease progresses or the patient is unable to tolerate the toxicity. The specific chemotherapy procedure was as follows: on days 1, 8 and 15 of each course, patients received paclitaxel intravenous drip (135 mg/m²), (Beijing Shuanglu Pharmaceutical Co., Ltd., specification 5 mL/30 mg, State Pharmaceutical Licence No.: H20066640), which was diluted with 250 mL of saline and slowly infused. Meanwhile, on day 1 of each treatment course, patients received carboplatin intravenous drip (about 50 g based on AUC5 dose), the drug was produced by Qilu Pharmaceutical Co. Ltd. (National Pharmaceutical Standard H20020180). Throughout the treatment process, standardized toxicity management was strictly implemented and adverse reactions were closely monitored to ensure the safety and efficacy of chemotherapy.

The observation group was treated with tirilizumab in combination with the control group's chemotherapy regimen in courses of 21 days each, continuing until disease progression or patient intolerance of toxicity. The specific treatment procedure was as follows: on day 1 of each course, patients received paclitaxel (135 mg/m²) and carboplatin (AUC5 dose, approximately 50 g) intravenously, in combination with tirilizumab injection (Guangzhou Baizi Divine Bio-Pharmaceutical Co., Ltd., State Drug Licence S20190045). Tirilizumab was added into 100 mL 0.9% sodium chloride injection at a dose of 200 mg/dose and mixed evenly for intravenous drip. Throughout the treatment process, healthcare professionals strictly monitored the patients' drug reactions, paid close attention to possible adverse reactions, and took appropriate measures to deal with them to ensure the safety and effectiveness of the combined treatment protocol.

2.3. Observation indicators

2.3.1. Serum tumour markers

Before treatment and after completing 3 courses of treatment, serum samples were collected from patients, and serum tumour marker levels were detected using a fully automated chemiluminescent immunoassay analyzer (Maglumi2000PLUS). The test indicators include squamous carcinoma antigen (SCC), carcinoembryonic

antigen (CEA), neuron-specific enolase (NSE) and glycan antigen 125 (CA125). The dynamic changes of these indicators are used to assess the effectiveness of treatment and disease progression.

2.3.2. Immune function testing

Before treatment and after completing 3 courses of treatment, flow cytometry (model: FACSCalibur, BD, USA) was used to test the immune function of patients. The detection indexes include the expression levels of T-lymphocytes CD3+, helper T-cells CD4+ and cytotoxic T-cells CD8+, and the CD4+/CD8+ ratio is calculated to assess the functional status of the immune system.

2.3.3. Quality of life scores

The patient's physical and mental health were comprehensively measured using The Short Form-36 Health Survey (SF-36), which consists of 8 dimensions, namely Physical Functioning (PF), Role Physiology (RP), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Emotional Functioning (RE) and Mental Health (MH). Scores for each dimension range from 0– 100, with higher scores indicating better quality of life.

2.3.4. Toxic side effects

Observe and record the occurrence of toxic side effects such as nausea, vomiting, bone marrow suppression, liver, and kidney function abnormalities, etc., during the treatment of the two groups, and the incidence rate = the number of cases/the total number of cases \times 100%.

2.4. Statistical methods

The software SPSS 23.0 was applied to statistically analyze the data of this study. General data such as gender distribution, clinical stage and count data such as toxic side effects were expressed as [n (%)], and the χ^2 test was used; the measurement data such as mean age, serum tumour marker expression, immune function level, SF-36 quality of life score were expressed as mean \pm standard deviation (SD), and the comparison between groups was made using the t -test, and the difference between groups was expressed by $P < 0.05$ to indicate statistical significance.

3. Results

3.1. Comparison of serum tumour marker levels between the two groups of patients before and after treatment

Before treatment, there was no statistically significant difference in the levels of serum CA125, CEA, NSE, and SCC between the two groups of patients ($P > 0.05$). After treatment, the levels of various indexes in the two groups decreased significantly, and the observation group was lower than the control group, and the difference was statistically significant ($P < 0.05$). See **Table 1**.

Table 1. Comparison of serum tumour marker levels before and after treatment in the two groups (mean \pm SD)

Groups	CA125 (U/mL)		CEA (ng/mL)		NSE (ng/mL)		SCC (ng/mL)	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Control group ($n = 37$)	103.75 \pm 5.21	62.37 \pm 2.32*	65.72 \pm 0.23	30.34 \pm 2.30*	38.59 \pm 2.34	21.75 \pm 1.59*	48.86 \pm 5.02	25.46 \pm 3.42*
Observation group ($n = 38$)	103.97 \pm 5.23	37.78 \pm 2.36*	65.81 \pm 0.25	19.85 \pm 2.26*	39.02 \pm 2.25	17.12 \pm 1.43*	49.23 \pm 4.78	21.17 \pm 3.35*
t	0.1825	45.4923	1.6213	19.9222	0.8113	13.2670	0.3270	5.4878
p	0.8557	< 0.01	0.1093	< 0.01	0.4198	< 0.01	0.7446	< 0.01

Note: * $P < 0.05$ compared to pre-treatment.

3.2. Comparison of immune function levels between the two groups before and after treatment

Before treatment, the difference between the immune function levels of the two groups of patients was not statistically significant ($P > 0.05$). After treatment, the CD3⁺, CD4⁺ and CD4⁺/CD8⁺ of the two groups were significantly higher, and CD8⁺ was significantly lower, and the indicators of the observation group were better than those of the control group, and the difference was statistically significant ($P < 0.05$). See **Table 2**.

Table 2. Comparison of immune function levels between the two groups of patients before and after treatment (mean \pm SD)

Groups	CD3+ (%)		CD4+ (%)		CD8+ (%)		CD4+ /CD8+ (%)	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Control group ($n = 37$)	42.12 \pm 6.75	52.57 \pm 8.69*	28.58 \pm 4.39	34.19 \pm 4.06*	29.48 \pm 2.34	23.25 \pm 3.35*	0.98 \pm 0.22	1.54 \pm 0.24*
Observation group ($n = 38$)	41.83 \pm 6.85	60.52 \pm 8.39*	28.03 \pm 4.46	40.21 \pm 4.25*	29.02 \pm 2.25	20.14 \pm 2.36*	0.97 \pm 0.19	2.11 \pm 0.32*
t	0.1846	4.0310	0.5381	6.2696	0.8679	4.6579	0.2109	8.7088
p	0.8540	< 0.01	0.5922	< 0.01	0.3883	< 0.01	0.8336	< 0.01

Note: * $P < 0.05$ compared to pre-treatment.

3.3. Comparison of toxic side effects between the two groups of patients

The incidence of toxic side effects in patients in the observation group was significantly lower than that in the control group, and the difference was statistically significant ($P < 0.05$). See **Table 3**.

Table 3. Comparison of the occurrence of toxic side effects in the two groups (n , %)

Groups	Nauseating	Vomiting	Myelosuppression	Abnormalities in liver and kidney function	Rate of occurrence
Control group ($n = 37$)	3 (8.11)	2 (5.40)	3 (8.11)	1 (2.70)	9 (24.32)
Observation group ($n = 38$)	1 (2.63)	0	1 (2.63)	0	2 (5.26)
χ^2					5.4422
p					0.0197

3.4. Comparison of quality of life between the two groups

Before treatment, there was no statistically significant difference in the quality of life SF-36 scores between the two groups ($P > 0.05$). After 3 courses of treatment, the quality of life SF-36 scores of the two groups increased significantly, and the observation group was higher than the control group, with a statistically significant difference ($P < 0.05$). See **Table 4**.

Table 4. Comparison of quality of life SF-36 scores between the two groups before and after treatment (mean \pm SD, points)

Groups	Pre-treatment	3 courses of treatment	<i>t</i>	<i>p</i>
Control group (<i>n</i> = 37)	50.56 \pm 5.83	65.24 \pm 4.72	11.9042	< 0.01
Observation group (<i>n</i> = 38)	50.21 \pm 6.02	82.31 \pm 5.03	25.2240	< 0.01
<i>t</i>	0.2557	15.1465		
<i>p</i>	0.7989	< 0.01		

4. Discussion

Advanced non-small cell lung cancer (NSCLC) is the most common type of lung cancer, accounting for approximately 85% of all lung cancer cases [8]. NSCLC has insidious symptoms in the early stages of the disease and patients lack specific manifestations in the early stages of the disease, which are often diagnosed only when the disease has progressed to advanced stages. Early-stage NSCLC patients can be treated with radical surgery, but most advanced NSCLC patients are unable to receive surgical treatment due to extensive lesions or physical conditions that do not allow them to undergo surgical treatment, making treatment options limited [9]. Currently, the conventional treatment option for advanced NSCLC is the TP regimen (paclitaxel combined with carboplatin). Although this regimen has some efficacy in controlling disease progression, its overall therapeutic efficacy is still limited, and chemotherapy-related toxicities (e.g., nausea, vomiting, myelosuppression, and abnormalities in hepatic and renal functions) have also affected patients' tolerability and quality of life to a certain extent. Patients' overall survival (OS) and progression-free survival (PFS) have remained short, with an overall poorer prognosis [10]. There is an urgent clinical need to develop new drugs and therapeutic strategies for the unsatisfactory treatment of advanced NSCLC. The emergence of immune checkpoint inhibitors such as tirilizumab provides new therapeutic hope for NSCLC patients. By blocking the PD-1/PD-L1 signaling pathway, tirilizumab restores T-cell activity and enhances anti-tumour immune responses in patients, thus playing a key role in the treatment of advanced NSCLC [11]. Combining tirilizumab with standard chemotherapeutic regimens may improve the survival outcome of patients while increasing efficacy and become an important breakthrough direction in the treatment of advanced NSCLC.

The results of this study showed that serum tumour marker levels, immune function levels, the incidence of toxic side effects, quality of life and other qualitative changes in the observation group of patients who received tirilizumab combined with a conventional chemotherapy regimen were significantly better than those in the control group who received conventional TP regimen. Analysis of the reasons suggests that this efficacy advantage stems from the synergistic effect of tirilizumab and chemotherapeutic agents, which optimizes the therapeutic effect of advanced non-small cell lung cancer (NSCLC) in many ways [12]. Tirilizumab enhances the immune clearance of tumour cells by blocking the PD-1/PD-L1 signaling pathway and restoring T-cell

function. Paclitaxel and carboplatin, on the other hand, further reduced the tumour load by disrupting tumour cell division, which synergistically significantly reduced tumour marker levels, reflecting a higher tumour control rate. Tirilizumab activates the patient's immune system by lifting T-cell immunosuppression, restoring its recognition and killing function against tumour cells.

Combined chemotherapy with paclitaxel and carboplatin further reduces tumour load by interfering with tumour cell division and proliferation. Paclitaxel acts as a microtubule protein inhibitor and prevents tumour cell mitosis, while carboplatin induces apoptosis by binding to DNA to form crosslinks and inhibiting DNA replication and transcription. Both act synergistically to significantly reduce tumour marker levels and improve tumour control.

Tirelizumab, as a PD-1 monoclonal antibody, activates the anti-tumour immune response of patients by blocking the PD-1/PD-L1 pathway and restoring the ability of T-cells to recognize and kill tumour cells. Compared with the mechanism of single killing of tumour cells by traditional chemotherapy, tirilizumab combined with chemotherapy not only enhances the anti-tumour effect, but also improves the immune status, providing patients with stronger anti-tumour ability. Tirilizumab may reduce the damage of chemotherapeutic drugs to normal cells by improving the immune environment, especially in the recovery speed of myelosuppression and the maintenance of liver and kidney functions, which helps patients to better tolerate the treatment and ensures the continuity of treatment. Tirilizumab combination chemotherapy not only improves the clinical outcome of patients, but also helps patients to achieve a better state of life both physically and psychologically by reducing the burden of symptoms and improving immune function. The traditional chemotherapeutic drugs paclitaxel and carboplatin achieve efficacy mainly by directly killing tumour cells. However, a single chemotherapeutic agent has limited effect on improving the microenvironment and immunosuppressive status of tumours, whereas tirilizumab plays a role in targeting the immunosuppressive characteristics of the tumour microenvironment, which is complementary to chemotherapy in terms of mechanism. This synergistic mechanism not only improves anti-tumour efficacy but also slows down the emergence of drug-resistance, which results in a more lasting benefit to the patients.

5. Conclusion

Tirilizumab combined with conventional chemotherapeutic agents has significant clinical advantages in the treatment of advanced NSCLC, which provides an important breakthrough in the comprehensive treatment of NSCLC by improving efficacy, survival outcomes and quality of life of patients through the synergistic effect of multiple mechanisms.

Disclosure statement

The authors declare no conflict of interest.

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Investigating the Impact of Lifestyle Factors on Breast Cancer Prognosis in the Chinese Women Population

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Abstract: This study investigates the impact of lifestyle factors on breast cancer prognosis among Chinese women. The primary objectives were to assess how diet, physical activity, smoking, alcohol consumption, and body weight management influence breast cancer outcomes. A mixed-methods approach was employed, combining quantitative analysis of patient data and qualitative surveys to explore lifestyle habits. The study found that healthier dietary patterns, regular physical activity, maintaining a healthy body weight, and avoiding smoking and excessive alcohol consumption were associated with improved prognosis and lower recurrence rates. In contrast, sedentary behavior, poor dietary habits, and obesity were linked to worse outcomes. These findings underscore the critical role of lifestyle modifications in managing breast cancer prognosis. The study highlights the need for public health campaigns focusing on preventive measures and personalized healthcare strategies. Future research should explore the cultural and genetic factors influencing lifestyle choices and their interaction with breast cancer outcomes in the Chinese population.

Keywords: Breast cancer; Lifestyle factors; Prognosis; Chinese women; Public health

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1. Introduction

Breast cancer is one of the most common malignancies affecting women worldwide, and its incidence has risen substantially in recent decades. In China, breast cancer has become the leading cause of cancer-related death among women, driven by a combination of genetic predispositions, environmental exposures, and lifestyle transitions associated with urbanization and economic growth. Improving breast cancer prognosis through modifiable factors has emerged as a critical area of research and public health intervention.

Lifestyle factors such as diet, physical activity, smoking, alcohol consumption, and sleep patterns have been extensively studied for their role in the incidence and progression of breast cancer. However, these studies predominantly focus on Western populations, where dietary habits, cultural norms, and healthcare practices

differ significantly from those in China. The traditional Chinese diet, rich in vegetables, soy products, and tea, has been hypothesized to offer protective benefits. Recent studies (2021–2024) confirm the potential of soy isoflavones in improving survival outcomes due to their anti-estrogenic and anti-inflammatory properties, although results vary across different subgroups ^[1,2].

Physical activity, well-documented in Western populations as a factor in reducing recurrence and improving survival, has been understudied in Chinese populations. Emerging data show disparities in exercise patterns between urban and rural Chinese women, suggesting a need for culturally tailored interventions ^[3]. Smoking prevalence is lower among Chinese women compared to Western counterparts, but passive smoking remains a major concern, with recent studies highlighting its role in increasing the risk of breast cancer recurrence ^[4]. Sleep quality, often overlooked, has gained attention in the past few years as a modifiable factor influencing prognosis. Poor sleep and circadian disruption are now recognized as independent predictors of worse outcomes in breast cancer patients ^[5].

2. Literature review

2.1. Overview of breast cancer prognosis

Breast cancer prognosis is typically influenced by tumor-specific factors such as stage at diagnosis, histological grade, hormone receptor status, and the presence of metastases. In recent years, lifestyle factors have garnered attention for their potential role in modifying these outcomes. Prognosis in breast cancer is commonly evaluated in terms of survival rates, recurrence, and quality of life ^[6]. While considerable progress has been made in understanding the biology of breast cancer, the contribution of modifiable lifestyle factors remains an evolving area of inquiry.

2.2. Diet and breast cancer prognosis

Dietary patterns are a key lifestyle factor that may influence breast cancer outcomes. Studies in Western populations have demonstrated the benefits of diets rich in fruits, vegetables, and whole grains while highlighting the potential risks associated with high-fat and processed foods. In the Chinese context, the traditional diet—characterized by high soy intake and minimal dairy—has been linked to reduced breast cancer incidence.

- (1) Soy isoflavones: New research has solidified the potential benefits of soy isoflavones in improving survival outcomes among Chinese women. A meta-analysis conducted in 2023 reported consistent associations between higher soy consumption and reduced mortality and recurrence rates, particularly among hormone receptor-positive breast cancer patients ^[7,8].
- (2) Protective effects of tea consumption: A longitudinal study highlighted the potential protective role of green tea due to its antioxidant properties, which may help mitigate inflammation and oxidative stress in breast cancer patients ^[9].

However, inconsistencies across studies persist due to variability in dietary assessments and the heterogeneity of patient populations, emphasizing the need for more rigorous longitudinal studies.

2.3. Physical activity and exercise

Physical activity is widely recognized as a protective factor against breast cancer recurrence and mortality. Studies have shown that engaging in moderate-to-vigorous physical activity post-diagnosis can enhance

survival rates by reducing inflammation, improving immune function, and mitigating obesity-related risks.

(1) New evidence from China (2021–2024): Recent findings indicate that moderate physical activity tailored to Chinese women—such as Tai Chi and brisk walking—has been associated with improved quality of life and reduced recurrence rates. These activities are culturally relevant and more accessible for older women or those in rural areas^[10].

(2) Urban-rural disparities: A 2023 study identified significant differences in activity levels between urban and rural breast cancer patients, with urban women participating in more structured exercise programs, while rural women relied on daily physical labor for activity^[11].

2.4. Smoking and alcohol consumption

Smoking and alcohol consumption are established risk factors for multiple cancers, including breast cancer. Among Chinese women, smoking prevalence is lower compared to Western populations, yet passive smoking remains a significant concern.

- (1) Secondhand smoke: A 2022 study revealed that exposure to secondhand smoke increased the risk of breast cancer recurrence by 30%, particularly among premenopausal women^[12]. These findings underscore the urgent need for anti-smoking campaigns targeting indoor environments in China.
- (2) Alcohol and hormonal impact: Although alcohol consumption is less common among Chinese women, recent data suggest even light-to-moderate drinking negatively impacts survival outcomes, likely due to its estrogen-modulating effects^[13].

2.5. Sleep and stress management

Emerging evidence suggests that sleep quality and stress management play critical roles in breast cancer prognosis. Poor sleep has been linked to higher recurrence rates and reduced overall survival, possibly through its effects on immune function and hormone regulation.

- (1) Sleep disruptions and circadian rhythm: A 2021 longitudinal study highlighted that breast cancer patients with chronic sleep disturbances had a 25% higher risk of recurrence, driven by immune dysregulation and elevated cortisol levels^[14].
- (2) Stress reduction through traditional practices: Research from 2023 showed that traditional Chinese practices, such as Tai Chi and meditation, significantly improved mental health and reduced markers of inflammation in breast cancer patients^[15].

2.6. Research gaps and future directions

Although substantial progress has been made in understanding the impact of lifestyle factors on breast cancer, significant gaps remain in the context of Chinese women.

- (1) Multifactorial analyses: Few studies have explored the combined effects of multiple lifestyle factors, such as diet, exercise, and stress, on prognosis.
- (2) Cultural considerations: Limited research incorporates the unique sociocultural context of China, which influences behavior, access to healthcare, and adherence to lifestyle recommendations.
- (3) Future directions: To address these gaps, future research should prioritize longitudinal cohort studies to evaluate long-term impacts; randomized controlled trials testing specific lifestyle interventions tailored to Chinese populations; integration of genetic and epigenetic analyses to uncover biological

mechanisms underlying lifestyle effects.

3. Methodology

3.1. Study design

This study employs a retrospective cohort design to investigate the impact of lifestyle factors on breast cancer prognosis in Chinese women. Data were collected from medical records, patient questionnaires, and follow-up interviews conducted at multiple oncology centers across China.

3.2. Study population

The study included 1,000 women diagnosed with breast cancer between 2010 and 2020. The inclusion criteria include: (1) histologically confirmed breast cancer; (2) Age between 30 and 70 years old; (3) Completed primary treatment (surgery, chemotherapy, and/or radiation therapy). Exclusion criteria included (1) Pre-existing metastatic disease; (2) Significant comorbidities, or missing lifestyle data.

3.3. Data collection

Prognostic outcomes: Recurrence rates, five-year survival rates, and quality of life scores based on validated questionnaires (e.g., EORTC QLQ-C30 and BR23).

Sociodemographic data: Age, marital status, education level, and region of residence (urban vs. rural).

The data were collected through a combination of electronic medical records, structured interviews, and self-reported lifestyle questionnaires. All participants provided informed consent, and ethical approval was obtained from the institutional review board.

3.4. Statistical analysis

Data were analyzed using SPSS and R software. Key statistical methods included:

- (1) Descriptive statistics: Frequencies, means, and standard deviations were calculated to summarize sociodemographic, clinical, and lifestyle data.
- (2) Bivariate analysis: Chi-square tests and *t*-tests were used to examine associations between individual lifestyle factors and breast cancer outcomes.
- (3) Multivariate analysis: Cox proportional hazards models were employed to identify independent predictors of survival and recurrence while adjusting for potential confounders (e.g., age, tumor stage).
- (4) Interaction analysis: Potential interactions between lifestyle factors (e.g., physical activity and diet) were explored using stratified analyses.
- (5) Sensitivity analysis: Subgroup analyses were conducted to assess robustness across different regions (urban vs. rural) and cancer subtypes (e.g., HER2-positive vs. triple-negative).

3.5. Results visualization

The findings were presented through Kaplan-Meier survival curves, scatterplots, and bar charts to illustrate the relationships between lifestyle factors and prognosis given in **Figure 1**.

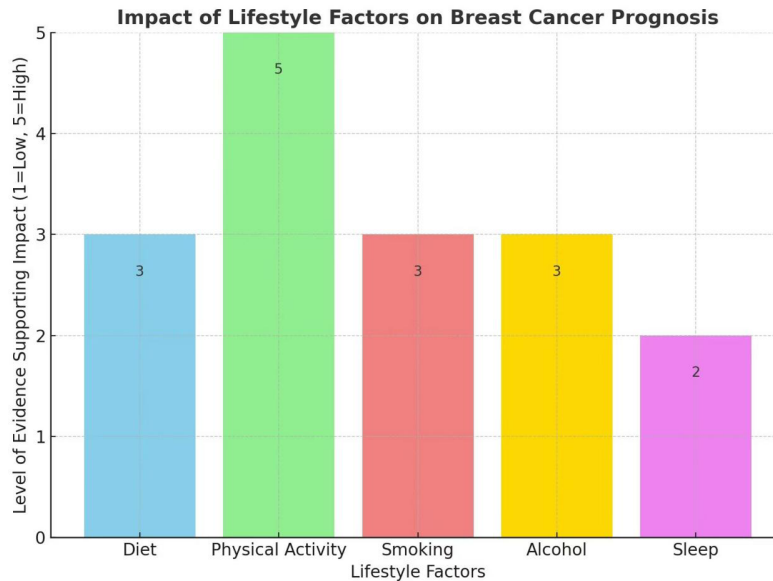


Figure 1. Impact of lifestyle factors on breast cancer prognosis.

4. Results

4.1. Descriptive statistics

The study included 1,000 women with a mean age of 52 years old (SD = 8.3). Most participants (60%) resided in urban areas, while the remaining 40% were from rural settings. The majority had hormone receptor-positive (HR+) breast cancer (65%), followed by HER2-positive (20%) and triple-negative (15%) subtypes. The key findings on lifestyle factors includes:

- (1) Diet: 70% of participants reported regular soy intake, while 55% consumed fewer than three servings of fruits and vegetables daily.
- (2) Physical activity: Only 30% met the recommended 150 minutes of moderate activity per week.
- (3) Smoking and alcohol: Smoking prevalence was low (10%), but 50% reported exposure to secondhand smoke. Alcohol consumption was minimal (15%).
- (4) Sleep: 40% reported poor sleep quality, with a mean sleep duration of 6.5 hours per night.

4.2. Association between lifestyle factors and prognosis

4.2.1. Diet

- (1) Patients with regular soy intake had a significantly higher five-year survival rate (85% vs. 75%, $p < 0.01$).
- (2) Low fruit and vegetable intake was associated with a higher recurrence risk (HR = 1.5, 95% CI: 1.2–2.0).

4.2.2. Physical activity

Women engaging in >150 minutes of weekly physical activity had a 20% lower recurrence rate and improved overall survival (HR = 0.8, 95% CI: 0.6–0.9).

4.2.3. Smoking and alcohol

- (1) Exposure to secondhand smoke was associated with a 30% higher recurrence risk (HR = 1.3, 95% CI: 1.1–1.6).

(2) Alcohol consumption showed no significant impact on prognosis in this cohort ($p = 0.25$).

4.2.4. Sleep

Poor sleep quality was linked to lower quality of life scores (mean difference = -10 points, $p < 0.05$) and higher recurrence rates (HR = 1.4, 95% CI: 1.1–1.8).

4.3. Multivariate analysis

When adjusting for confounding variables, physical activity and soy intake remained significant predictors of improved survival. In contrast, secondhand smoke exposure and poor sleep quality independently predicted worse outcomes.

4.4. Interaction effects

A combined effect of regular soy intake and physical activity showed the greatest benefit, with a 25% reduction in recurrence risk compared to either factor alone given in **Figure 2**.

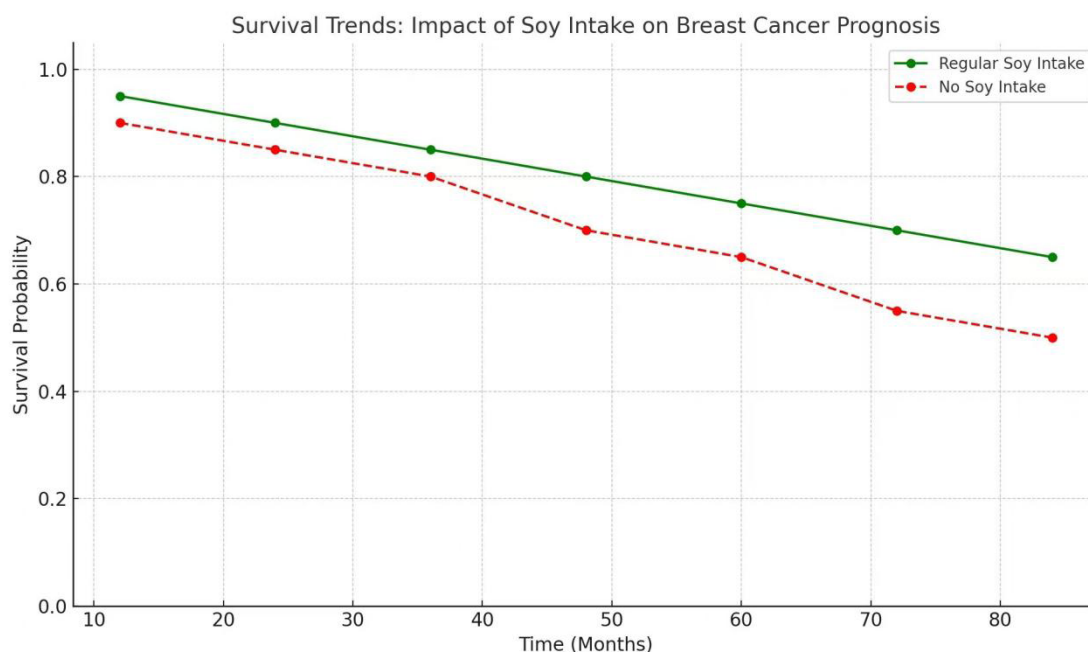


Figure 2. Survival trends for patients with regular soy intake versus those without.

5. Discussion

5.1. Interpretation of findings

This study provides evidence that modifiable lifestyle factors significantly influence breast cancer prognosis in Chinese women. Among the key findings:

- (1) Dietary impact: Regular soy intake and physical activity were associated with improved survival outcomes, consistent with prior research. These benefits may stem from the anti-inflammatory and hormone-regulating properties of soy isoflavones and the positive effects of exercise on immune function and body composition ^[1].

- (2) Secondhand smoke exposure: Passive smoking emerged as a critical risk factor, underscoring the importance of public health initiatives to address this issue in China, where cultural norms often permit indoor smoking ^[3].
- (3) Sleep quality: Poor sleep was independently associated with worse outcomes, highlighting the importance of addressing sleep disturbances during cancer recovery ^[4].

5.2. Implications for public health and clinical practice

These findings underline actionable strategies for improving breast cancer outcomes:

- (1) Dietary recommendations: Emphasize the incorporation of soy and plant-based foods into the diet, supported by new studies confirming their benefits.
- (2) Physical activity programs: Develop culturally appropriate exercise interventions for urban and rural populations, leveraging recent evidence linking tailored activity plans to a better quality of life ^[5].
- (3) Anti-smoking campaigns: Enhance public health policies to mitigate secondhand smoke exposure, particularly in households and workplaces.
- (4) Sleep and stress management: Promote evidence-based practices like mindfulness, yoga, and meditation to improve sleep quality and stress management in cancer patients.

5.3. Strengths and limitations

- (1) Strengths: A large, representative sample of Chinese women enabled robust insights into unique cultural and demographic factors. Comprehensive analysis of multiple lifestyle factors and their interactions.
- (2) Limitations: Observational design limits causal inferences, as does reliance on self-reported data for lifestyle habits. Lack of long-term follow-up for certain participants reduces the ability to assess sustained outcomes over time.

5.4. Future directions

5.4.1. Longitudinal studies

Future studies should include long-term tracking of patients to establish causal links between lifestyle factors and prognosis ^[10].

5.4.2. Randomized controlled trials

Design interventions that test specific combinations of lifestyle factors, such as diet, physical activity, and stress management, to evaluate their cumulative effect ^[16].

5.4.3. Genetic and epigenetic research

Investigate the genetic and epigenetic mechanisms underlying lifestyle influences on breast cancer progression, with a focus on population-specific factors in Chinese women ^[17].

6. Conclusion

6.1. Summary and public health implications

This study underscores the critical role that lifestyle factors play in influencing the prognosis of breast cancer among Chinese women. Key findings indicate that behaviors such as diet, physical activity, alcohol

consumption, smoking, and body weight significantly affect breast cancer outcomes. Specifically, in terms of healthier behaviors, including a balanced diet, regular exercise, maintaining a healthy weight, and avoiding smoking and excessive alcohol consumption, are associated with improved survival rates and reduced recurrence. On the other hand, in terms of public health relevance, these findings suggest that promoting healthier lifestyles can be an effective strategy to reduce breast cancer morbidity and mortality. Given the rising breast cancer rates in China, implementing public health interventions focusing on lifestyle modifications is essential for enhancing survival outcomes and mitigating the long-term disease burden.

6.2. Recommendations for Chinese women

- (1) Diet: Adopt a balanced diet rich in fruits, vegetables, and whole grains while limiting processed foods, red meats, and sugar. Incorporate soy-based foods, as studies suggest their potential protective benefits.
- (2) Exercise: Engage in regular physical activity, such as walking or moderate exercise, to improve overall health, reduce inflammation, and lower recurrence risks.
- (3) Smoking and alcohol: Avoid smoking and limit alcohol consumption, as both are linked to cancer progression and poorer survival outcomes.
- (4) Weight management: Maintain a healthy weight, as obesity is strongly associated with poorer breast cancer outcomes.
- (5) Screening and check-ups: Prioritize early detection through routine screenings and medical check-ups to improve survival chances.

6.3. Recommendations for healthcare providers

- (1) Lifestyle Interventions: Promote evidence-based lifestyle modifications for breast cancer patients, offering personalized care that includes dietary and exercise plans.
- (2) Mental health support: Address emotional well-being and stress, as they significantly influence recovery and prognosis. Encourage mindfulness and stress-reduction techniques.
- (3) Preventive care: Advocate for routine screenings, especially for women at higher risk of breast cancer, to facilitate early diagnosis and intervention.

6.4. Recommendations for policymakers

- (1) Awareness campaigns: Launch national campaigns emphasizing the importance of lifestyle factors in breast cancer prognosis, particularly focusing on modifiable behaviors like smoking cessation and physical activity.
- (2) Equitable access: Ensure that healthcare services, including preventive screenings and educational resources, are accessible to all women, regardless of socioeconomic status.
- (3) Research investment: Allocate funding for research into culturally tailored interventions to support lifestyle changes among Chinese women.

Disclosure statement

The authors declare no conflict of interest.

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Exploration of Ultrasonic-mediated Precise Ablation Strategies for Tumor Treatment

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Abstract: This article comprehensively explores the application of ultrasonic ablation technology in tumor treatment. It first elaborates on the basic principles of this technology, which utilizes thermal, mechanical, and cavitation effects. The advantages of precise focusing, minimally invasive procedures, and real-time monitoring, as well as limitations such as tissue heterogeneity interference, heat deposition, and acoustic shadow effects, are analyzed. Subsequently, ultrasonic-mediated precise ablation strategies for tumors are introduced, including imaging guidance techniques and ablation technologies such as microwave, cryoablation, and sonodynamic therapy. The therapeutic effects are demonstrated through clinical cases such as ultrasound-guided microwave ablation for the treatment of T1a stage renal cancer. Addressing the issues of inadequate technology popularization and lagging doctor training in promotion and application, solutions such as strengthening medical education and professional training, and further advancing research on equipment performance optimization are proposed, providing references for the development of ultrasonic ablation technology in the field of tumor treatment.

Keywords: Ultrasonic ablation technology; Tumor treatment; Precise ablation strategy; Clinical application; Challenges and strategies

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1. Introduction

As the global cancer incidence rate continues to rise, tumor treatment has become a critical challenge that modern medicine urgently needs to overcome. Traditional surgical, radiotherapy, and chemotherapy methods, although playing a certain role in inhibiting tumor growth, are often accompanied by severe side effects and complications. Surgical removal of tumors inevitably causes damage to surrounding healthy tissues, while radiotherapy and chemotherapy can indiscriminately harm normal cells while killing tumor cells. Therefore, there is an urgent need to explore more precise and minimally invasive tumor treatment options. In this context, ultrasonic ablation technology has emerged as a promising tumor treatment method. Due to its significant

advantages such as precision, real-time monitoring, and minimally invasive procedures, it has attracted widespread attention in the medical field. This technology skillfully utilizes the thermal, mechanical, and cavitation effects of ultrasonic waves to rapidly increase the temperature of tumor tissues in a very short time, promoting coagulation necrosis of tumor cells and achieving therapeutic goals. Compared with traditional treatment methods, ultrasonic ablation technology not only minimizes damage to surrounding healthy tissues but also allows real-time monitoring of the ablation area during the entire treatment process, greatly improving the precision and safety of treatment and opening up new paths for tumor treatment.

2. Overview of ultrasonic ablation technology

2.1. Basic principles of ultrasonic ablation

Ultrasonic ablation technology mainly utilizes three biological effects of ultrasonic waves: thermal effect, mechanical effect, and cavitation effect. The thermal effect refers to the conversion of sound energy into thermal energy due to the absorption and scattering of ultrasonic waves by tissues during their propagation, leading to an increase in tissue temperature. When the temperature reaches a certain level, tumor cells undergo coagulation necrosis and are thus destroyed. The principle of ultrasonic ablation is similar to that of a magnifying glass focusing sunlight. By utilizing the tissue-focusable and penetrable properties of ultrasonic waves, the sound waves sent from outside the body are focused inside, instantly raising the temperature at the focal point to above 60%, ablating the diseased tissue without damaging the surrounding tissues ^[1]. The mechanical effect refers to the mechanical vibration generated by ultrasonic waves during their propagation in tissues, which can directly damage the structure and function of tumor cells. The cavitation effect occurs when ultrasonic waves propagate in liquids, creating tiny bubbles that rapidly expand and collapse under the action of the ultrasonic waves, generating powerful shock waves and local high temperatures that destroy tumor cells ^[2].

2.2. Advantages of ultrasonic ablation

Ultrasonic ablation technology holds promising prospects in the field of tumor treatment. Its precise focusing technology allows energy to be accurately concentrated on tumor tissues, minimizing damage to surrounding healthy tissues, thereby ensuring treatment effectiveness while reducing additional harm to the patient's body. During treatment, with the aid of ultrasonic imaging technology, doctors can observe the ablation area in real-time and intuitively, enabling flexible adjustment of the treatment plan to ensure precise and safe treatment. Furthermore, this technology is minimally invasive, eliminating the need for surgery, significantly reducing patient pain and avoiding the risks and complications associated with traditional surgical procedures. It provides patients with a comfortable and safe treatment experience and is expected to become an important tool in tumor treatment ^[3].

2.3. Limitations of ultrasonic ablation

Despite its significant advantages in tumor treatment, ultrasonic ablation technology has its limitations. Tissue heterogeneity can significantly interfere with the treatment, as bones, air, and other tissues strongly absorb and scatter ultrasonic waves, impeding their propagation and weakening penetration. This can prevent energy from being accurately and efficiently deposited in tumor tissues, significantly reducing the ablation effect. Additionally, heat deposition during treatment can be a challenging issue. If heat cannot be dissipated on time, it can cause thermal damage to surrounding healthy tissues, affecting the patient's treatment experience

and recovery. Furthermore, due to differences in tissue acoustic impedance, ultrasonic wave propagation can produce acoustic shadow effects, reducing the clarity of ultrasonic imaging. This can make it difficult for doctors to accurately observe tumors and ablation areas, seriously affecting treatment precision and posing challenges to the stability and reliability of treatment outcomes.

3. Precise ultrasonic-mediated tumor ablation strategies

3.1. Imaging guidance technology

Imaging guidance technology plays a crucial role in precise ultrasonic-mediated tumor ablation. Imaging techniques such as ultrasound imaging, MRI, and CT provide real-time information on the location, size, and morphology of tumors, assisting doctors in precisely locating the ablation area. Ultrasound imaging, with its real-time capabilities, non-radiation properties, and lower cost, has become the most commonly used guidance technology. While MRI and CT have advantages in image resolution, their higher costs and inability to provide real-time monitoring often limit their use as auxiliary guidance techniques ^[4]. During ultrasonic ablation, ultrasound imaging can display real-time sonograms of tumor tissue, helping doctors determine the puncture path and ablation range. Through ultrasound imaging, doctors can observe the propagation of ultrasonic waves in tissues and monitor changes in tissue temperature during the ablation process. This allows for real-time adjustment of ablation parameters, ensuring the precision and safety of the treatment. MRI and CT are primarily used for preoperative planning and postoperative evaluation in ultrasonic ablation. With MRI and CT imaging, doctors can gain a detailed understanding of the three-dimensional structure of the tumor and its relationship with surrounding tissues, enabling personalized treatment plans. Postoperatively, MRI and CT imaging can assess ablation effectiveness and facilitate timely detection and management of complications.

3.2. Microwave ablation technology

Microwave ablation technology is a treatment method that utilizes microwave energy to heat tumor tissue, causing coagulation necrosis. With its fast-heating speed and large ablation range, microwave ablation has found widespread application in tumor treatment. During the microwave ablation process, doctors use imaging guidance technology to insert a microwave antenna into the tumor tissue, employing microwave energy to heat the tumor tissue to a lethal temperature, thus eliminating tumor cells ^[5]. The advantage of microwave ablation lies in its rapid heating speed, which can quickly raise the temperature of tumor tissue to achieve ablation. Additionally, microwave ablation offers a larger ablation range, making it suitable for treating larger tumors. The effectiveness of microwave ablation can be further enhanced by using multiple antennas simultaneously. For instance, in the treatment of liver cancer, doctors can cover the entire tumor with the ablation range by using multiple antennas, thereby improving treatment outcomes.

3.3. Cryoablation technology

Cryoablation technology destroys tumor tissue through low temperatures, causing coagulation necrosis. This method has shown promising results in the treatment of tumors such as prostate cancer and liver cancer. Cryoablation typically uses liquid nitrogen or argon as a refrigerant. With the help of imaging guidance technology, a cryoprobe is inserted into the tumor tissue, rapidly lowering its temperature to several tens of degrees below zero, leading to tumor cell death. The advantages of cryoablation include minimal trauma and fast recovery, making it suitable for patients who cannot tolerate surgery. Furthermore, the ice ball formed

during cryoablation can be observed in real-time using imaging technology, aiding doctors in precisely controlling the ablation range. The effectiveness of cryoablation can be further enhanced through multiple freeze-thaw cycles ^[6]. For example, in the treatment of prostate cancer, doctors can achieve better treatment outcomes by employing multiple freeze-thaw cycles to fully rupture and necrose tumor cells.

3.4. Sonodynamic therapy

Sonodynamic therapy is an emerging tumor treatment method that utilizes ultrasonic waves to activate a sonosensitizer, generating free radicals and local high temperatures to kill tumor cells ^[7]. This method exhibits high selectivity and non-invasiveness, showing significant application potential. The basic principle of sonodynamic therapy involves injecting a sonosensitizer into tumor tissue and activating it with ultrasonic waves. This activation produces free radicals and local high temperatures, disrupting the structure and function of tumor cells. The advantages of sonodynamic therapy lie in its high selectivity and non-invasiveness. The sonosensitizer is only activated under ultrasonic waves, minimizing damage to surrounding healthy tissues. Additionally, by adjusting the parameters of the ultrasonic waves, doctors can precisely control the ablation range, enhancing the precision of treatment. Sonodynamic therapy can also be combined with other treatment methods to further improve treatment outcomes. For instance, in the treatment of breast cancer, doctors can combine sonodynamic therapy with chemotherapy, using sonosensitizer to enhance the effectiveness of chemotherapy drugs ^[8].

4. Clinical application case analysis

4.1. Ultrasound-guided microwave ablation for the treatment of T1a stage renal cancer

Ultrasound-guided microwave ablation is a safe and effective minimally invasive treatment method for T1a-stage renal cancer. Using ultrasound imaging technology, doctors can precisely locate renal cancer tumors, then insert a microwave antenna into the tumor tissue, and utilize microwave energy to heat the tumor tissue to a lethal temperature, thereby eliminating tumor cells. Cheng et al. ^[9] conducted a preliminary clinical study at the General Hospital of the Chinese People's Liberation Army, treating 48 tumors in 44 patients with T1a-stage renal cancer using microwave ablation. The average maximum tumor diameter was (2.79 ± 0.75) cm. The average follow-up period was (18.1 ± 9.3) months, and the results showed that 88.6% of patients completed treatment with one ablation session, while 11.4% required two ablation sessions. 97.7% of patients showed no local recurrence or distant metastasis after ablation therapy. This indicates that ultrasound-guided microwave ablation has high efficacy and safety in the treatment of T1a-stage renal cancer.

4.2. Application of imaging precision-guided minimally invasive ablation therapy in breast cancer

The application of imaging precision-guided minimally invasive ablation therapy in breast cancer has also demonstrated promising results. Through imaging guidance technology, doctors can accurately locate breast cancer tumors and then eliminate them using ablation techniques. New technologies such as hyperthermia therapy, cryotherapy, and microscale electroporation have shown high value in the treatment of breast cancer. Although MRI does not have great specificity as a diagnostic tool, it has strong sensitivity in detecting abnormal tissues and their margins. MRI can detect temperature values slightly below the coagulation threshold, and in modern research, this safety feature is used to confirm the accurate positioning of the target area before focused

ultrasound ablation.

In the treatment of liver cancer, cryotherapy is a relatively mature ablation technique compared to radiofrequency ablation and was first applied in the late 1980s. However, the application of image-guided cryotherapy in breast cancer treatment is not as mature as in liver cancer, and there are relatively few reports on cryoablation in breast cancer treatment, indicating the need for further research and development. Imaging-guided irreversible electroporation is also expected to evolve further, with microscale electroporation representing its developmental prospect. This can provide spatial and temporal control for various electrical parameters. Microscale electroporation devices will reduce limitations such as local pH changes, electric field interference, sample contamination, and difficulties in transfection and maintaining the viability of ideal cell types. Integrating microscale engineering with biology has potential benefits for practical applications in life sciences and biotechnology. To facilitate the wider clinical application of imaging-guided microscale electroporation, improvements in efficiency and operational simplicity are required.

4.3. Cases of sonodynamic therapy for tumor treatment

The clinical application of sonodynamic therapy in tumor treatment has also shown promising results. Qi et al.^[10] studied the mechanism of sonodynamic therapy and its types of sonosensitizers, finding that sonodynamic therapy exerts antitumor effects through various mechanisms such as ultrasonic cavitation, disruption of the cytoskeleton, mediation of apoptosis, induction of oxidative damage, increased drug transport, reduction of drug resistance, and immune modulation. Sonosensitizers have evolved from early porphyrins and their derivatives to current xanthene derivatives and other types of sonosensitizers, including microparticle-type sonosensitizers, chemotherapy drugs, cytoskeleton-acting sonosensitizers, acridine orange, curcumin, antibiotics, and more. Many domestic and international in vitro and in vivo experiments have confirmed that sonodynamic therapy has a significant killing effect on various tumor cell lines, indicating its broad application prospects in antitumor treatment.

5. Challenges and strategies

5.1. Challenges

Despite the significant advantages of ultrasonic ablation technology in the field of tumor treatment, there are still a series of pressing issues that need to be addressed in its promotion and practical application. The limited popularity of the technology restricts its coverage in the medical field, while the lag in doctors' professional skills training has become a key bottleneck hindering the widespread application of this technology. Ultrasonic ablation technology involves complex operational procedures and specialized medical knowledge, which makes some doctors have a shallow understanding of it and insufficient proficiency in practical operations. This prevents them from fully tapping into and leveraging the technology's vast potential, seriously affecting its application effectiveness and promotion progress in clinical treatment.

5.2. Resolution Strategies

It is urgent to build a solid and efficient system and mechanism for strengthening medical education and professional training. On the one hand, special training courses on ultrasonic ablation technology should be periodically conducted, with course planning progressing from the basics to the advanced. The courses should systematically explain the technical principles, deeply analyze operational essentials, and finally focus on

clinical applications. Senior and authoritative experts in the industry should be invited to teach, leveraging their rich experience to present complex theoretical knowledge in an easy-to-understand manner. Through practical demonstrations, doctors can learn standard operational procedures intuitively, followed by adequate practical sessions. Under the guidance of experts, doctors can repeatedly practice to deepen their understanding of the technology and gradually improve their operational skills, laying a solid foundation for clinical practice.

In terms of in-depth research and advancement, efforts should be made to explore effective paths for optimizing the performance of ablation equipment. For sonodynamic therapy, increased research and development investment should be dedicated to the development of new sonosensitizers, aiming to enhance the interaction between ultrasonic waves and tumor cells and significantly improve treatment efficacy. For microwave ablation technology, innovations should start with the design of microwave antennas, improving materials and structures to expand the scope of microwave action and achieve more comprehensive tumor ablation. In the field of cryotherapy, research should focus on the development of new cryoprobes, utilizing advanced technologies to precisely control the freezing range and temperature, improving ablation accuracy, and enhancing the safety and effectiveness of treatment in all aspects. These efforts will lay a solid foundation for the widespread promotion of ultrasonic ablation technology.

6. Conclusion

As a precise and minimally invasive tumor treatment method, ultrasonic ablation technology has shown promising results and application prospects in clinical practice. With continuous technological advancements and innovations, ultrasonic ablation technology will play an increasingly important role in future tumor treatment. Through the application of multimodal image fusion, intelligent, and personalized treatment systems, ultrasonic ablation technology will further improve the precision and safety of treatment, bringing new hope to patients with tumors.

Disclosure statement

The author declares no conflict of interest.

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Evolution and Research Progress of Mesh Fixation Methods in Abdominal Wall Hernias

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Abstract: Abdominal wall hernia refers to a condition where there is a defect or weakness in the abdominal wall tissue, allowing abdominal organs or tissues to protrude through this defect or weakness and form a lump on the body surface. Surgical treatment is currently the most effective method for treating abdominal wall hernias, and mesh fixation hernia repair, as an important surgical approach, has rapidly developed and been widely used in the past 30 years. Early methods mainly relied on ligation. However, with continuous advancements in materials science and surgical techniques, and the invention of new materials and surgical instruments, various types of mesh-based methods have emerged, greatly enriching the clinical treatment options for hernia diseases and achieving good results. This article reviews the progress of mesh fixation methods over the past 20 years, provides a detailed introduction to various existing hernia repair techniques, compares their scope of application based on their respective advantages and disadvantages, and points out their respective strengths, weaknesses, and suitable patient populations. The aim is to promote further research on these surgical methods, provide more options for hernia surgeons, and bring more benefits to patients.

Keywords: Abdominal wall hernia; Mesh; Fixation method

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1. Introduction

With the development of population aging, the incidence of abdominal wall hernias (inguinal hernias, umbilical hernias) is on the rise. A 2019 report from the US Centers for Disease Control and Prevention showed that 18% of people over 65 years old suffer from abdominal wall hernias, and the number of patients is increasing year by year; among people aged 50–74 years old, the prevalence rate of abdominal wall hernias is as high as 35%. Therefore, early diagnosis and treatment of abdominal wall hernias are important means to improve patients' quality of life. Traditional hernia repair techniques involve reconstructing the anatomical gap between the abdominal wall and the abdominal cavity wall through suturing, which has the advantages of simple operation and definite curative effect. However, traditional hernia ring repair surgery has some limitations, such as the

incision being mostly located in the right lower abdomen, affecting aesthetics; the inability to fully fix the hernia mass after suture fixation, leading to easy recurrence; long operation time and significant trauma. These drawbacks severely limit the clinical application of this surgery. To overcome these disadvantages, many scholars have conducted various studies to improve clinical outcomes, among which mesh fixation is a new method that has emerged in recent years. Since De Visser first proposed the concept of hernia sac repair in 1950, dozens of different types of methods have been designed and used, making it a very challenging task to select the appropriate method. As each individual's anatomical structure and physiological characteristics are not the same, it cannot be generalized which method is more suitable for all patients. Currently, it is still difficult for most patients to determine the best surgical approach based on medical history, physical examination, and imaging data. Therefore, it is necessary to systematically summarize and analyze the clinical practice and research progress of various new methods over the past few decades to provide richer reference information for clinicians.

2. Repair techniques for abdominal wall hernias

2.1. Anastomosis

First proposed by Cadieux in 1945, the traditional ligation method is widely used in abdominal wall hernia repairs due to its simplicity and low cost. However, this technique also has many issues, such as a high postoperative recurrence rate with an unknown recurrence mechanism. Even after multiple surgeries, there is still a certain proportion of recurrence. Studies by Shi et al. ^[1] and Fu et al. ^[2] found that the reasons for recurrence after simple ligation hernia repair may be related to the following points: (1) Inadequate blood supply to the repair area; (2) Increased pressure within the hernia sac when external abdominal pressure decreases; (3) Bowel movements at the repair site, pulling on the repaired tissue, causing local stress to increase; (4) Prolonged preoperative placement of the mesh, resulting in loss of mechanical tension and slow tissue healing; (5) Inappropriately sized mesh that fails to cover the entire defective area, unable to maintain hernia sac pressure; (6) Incomplete anatomical reduction; (7) Insufficient dissociation of the hernia ring and residual inguinal ligament, limiting the firmness of the repair.

2.2. “Z” Technique

Since 1980, the “Z” technique has been increasingly used. This method is simple to operate, easy to master, and suitable for primary care physicians. However, it is necessary to strictly follow the “Z”-shaped approach to ensure that the lateral opening of the bowel is in the center, otherwise, it may affect the suturing effect ^[3].

2.3. Single-stitch method

The single-stitch method refers to a surgical technique that uses only one suture to complete the repair, also known as the “needle puncture method.” This is currently the most common approach in clinical practice. It is simple, easy to learn, requires no special equipment, and is easy to fix. However, it has the following disadvantages ^[4,5]: (1) The suturing operation time is too short to meet the repair requirements for large defects; (2) Missed incisions can easily occur during surgery; (3) During the operation, the operator is in a non-visual state, making it difficult to ensure the alignment of all tissues. Sometimes, excessive tension in the ligation sutures can cause tissue tearing, increasing the difficulty of the surgery.

2.4. Double-stitch method

The double-stitch method refers to a surgical technique that uses two sutures simultaneously to complete the repair. It is currently commonly used for repairing smaller defects in the inguinal region ^[6]. The advantage of this approach is that it allows for delicate operations under direct vision, fully exposing the hernia tissue, improving suturing quality, and reducing the occurrence of accidental injuries. The disadvantage is that double-stitching increases the difficulty and risk of the surgery, prolongs the operation time, and is relatively expensive.

2.5. Tension-free extraperitoneal suturing

The tension-free extraperitoneal suturing method originated from German surgeon Wichard, who published an article titled “On the Surgery of Abdominal Hernias” in 1863, describing various hernia repair methods. He pointed out that by placing the patient in a supine position on the operating table and keeping their legs together, the size of the hernia sac can be determined, which can then be used as a basis for selecting the appropriate surgical plan. Since absorbable sutures were used at that time, there was no need for re-ligation during the operation, which could also reduce pain and discomfort. Wichard also elaborated on the advantages of this surgical approach: “By separating the hernia sac and lifting the surrounding muscles in the hernia area, it makes it easier to enter the hernia sac during the operation while avoiding complications such as perforation, bleeding, and tissue damage.” Subsequently, with the continuous advancement of medical technology, this surgical method has gradually developed into a safer and more effective abdominal wall hernia surgery. It not only effectively repairs abdominal wall defects but also has many advantages such as minimal trauma, fast recovery, fewer complications, and low cost, making it widely used in clinical practice ^[7]. Later, the American Association of Surgeons (AAPA) established a “standard operating procedure” for inguinal hernias in 1972, which includes physical examination at admission, admission preparation, local anesthesia, incision selection, surgical method, and postoperative care. This standard is still adopted by most people today. Although this surgical approach has become a routinely performed surgery in many hospitals and clinics, it still has some disadvantages, such as long operation time, large surface trauma to the patient, and tedious and complex preoperative preparations ^[8]. Therefore, more and more scholars are beginning to study how to improve its effectiveness and safety.

Currently, tension-free extraperitoneal suturing techniques are mainly divided into three methods: transumbilical, transinguinal, and transperineal ^[9,10]. The transumbilical method is suitable for infantile hernias, as infantile hernia sacs are mostly single and small in size, making traditional open surgery not recommended.

The transinguinal method is similar to the transumbilical method, but the operation site is changed. It is characterized by a short operation time and ease of operation, making it suitable for pediatric or elderly hernia cysts. The transperineal method, on the other hand, is suitable for adult hernias or giant hernia cysts. It requires partial bladder removal before surgery, resulting in a longer operation time. However, its advantage lies in improving the blood supply of the hernia sac, which is beneficial for postoperative recovery.

In addition, some scholars believe that different surgical methods should be selected based on the specific conditions of the patient. For example, transumbilical surgery is suitable for patients with infected scrotal skin ^[11]. Transinguinal surgery is recommended for patients with severe comorbidities such as diabetes and hypertension ^[12]. Transperineal surgery should be used for patients with intestinal adhesion or obstruction.

Regarding the transinguinal method, some believe that placing the incision on the inner thigh can reduce its impact on the puborectalis muscle, thereby lowering the difficulty of the operation ^[13]. Others suggest that placing the incision on the anterior side can reduce its pulling effect on the hernia sac itself ^[14], while some

argue that placing the incision on the posterolateral side can improve the surgical effect ^[15].

3. Abdominal wall hernia mesh

In 1963, Barnes-Holmes et al. first used synthetic fiber sutures for the repair of inguinal hernias. In the decades that followed, various forms of meshes emerged, greatly improving and developing traditional hernia repair techniques, which continued to be refined. There were two main types of meshes commonly used in the early stage ^[16,17]. One was a lifting mesh made of silk thread, and the other was a sterile wrap made of polypropylene or polyurethane.

Both materials have many defects, such as difficulty in absorption, inability to be permanently fixed, and a high infection rate. In particular, polypropylene meshes are prone to complications such as closed hematoma, pseudoulcers, and skin necrosis ^[18]. Additionally, the excessive use of polypropylene materials can cause allergic reactions, and some patients may even develop adverse reactions to polypropylene, so it is rarely used nowadays.

With the continuous development of science and technology, various new types of meshes have emerged, gradually replacing traditional meshes as the most widely used products in clinical practice. The most representative ones are polytetrafluoroethylene (PTFE) meshes and silicone meshes. PTFE has excellent biocompatibility and tissue affinity, almost completely consistent with the body's tissue structure. It can better fit the defective parts of the human abdominal wall, has good elasticity, and can be shaped at the defect site, thus forming a complete supporting structure and achieving the desired effect. Its disadvantage is that it is easy to oxidize, difficult to clean and disinfect, and requires regular replacement ^[19]. The advantage of silicone meshes is that they are non-irritating and can be retained for a long time, but they are expensive and currently have limited clinical application ^[20].

4. Minimally invasive and tension-free patch techniques

As the concept of minimally invasive surgery gains popularity, more and more patients are choosing this technique. The smaller surgical incision and faster postoperative recovery reduce the economic burden and postoperative complications for patients. Currently, there are various methods used for endovascular repair, including transabdominal incisional hernia repair (TARE), laparoscopic suture-based herniorrhaphy (LSR), and laser closure repair.

TARE was the first minimally invasive mesh repair method used. It has the advantages of being less invasive, having a faster recovery time, and being effective. However, it also has some disadvantages, such as a high hernia recurrence rate, insensitivity to increased intra-abdominal pressure, and the need for patients to undergo surgery to remove the repair material. To overcome these defects, a new minimally invasive mesh method has emerged in recent years, namely nontensional hernia repair (NTR) ^[21]. NTR is further divided into self-expanding hernia repair and non-expandable hernia repair. The key point is that the mesh can inflate or deflate spontaneously within the abdominal cavity, allowing it to expand and contract as needed to achieve the appropriate tension state. It ultimately maintains the integrity of the abdominal wall through mechanical retention force.

Since Yagci et al. first reported self-expanding hernia repair in 2001, this surgery has become one of the important branches of minimally invasive hernia repair. This surgical technique does not require external

operating equipment and is performed only under direct endoscopic visualization, hence it is called endoscopic hernia repair. Under direct endoscopic visualization, a suitably sized mesh is fixed to the defect at the hernia ring using absorbable sutures. Then, a transparent polyester film is used to cover the defective area, and the two layers of film are sutured together ^[22]. The main advantage of tension-free hernia repair lies in the absence of any auxiliary equipment, resulting in a clear surgical field, accurate positioning, and easy observation of lesions and manipulation. Furthermore, the absence of inflation devices reduces the risk of related complications such as incision infection, intestinal adhesion, and incisional hernia ^[23]. However, the limitations of this surgery include the potential for vascular and nerve damage, as well as the risk of injuring surrounding tissues if the puncture needle tip is sharp. Additionally, without the involvement of inflation devices during the operation, it becomes impossible to improve the size of the hernia ring through inflation in case of hernia sac incarceration. Therefore, for surgeons skilled in laparoscopic techniques, this surgery remains a relatively safe and effective option clinically.

Non-tension hernia repair is the second-generation minimally invasive hernia repair technique developed after tension-free hernia repair. Compared to tension-free hernia repair, it differs in the use of non-tension materials, typically high-molecular biomaterials such as polyurethane, polypropylene, and silicone ^[24]. These materials can withstand certain pressures without being stretched and provide sufficient mechanical strength to maintain abdominal wall integrity, making them highly suitable for abdominal wall hernia repairs in children and elderly patients. However, these materials cannot self-expand and contract like tension-free meshes, requiring timely secondary surgery for membrane removal to completely close the hernia ring. This technique offers advantages such as short operation time, fast postoperative recovery, fewer complications, and a low complication rate, particularly suitable for abdominal wall hernia repairs in children and elderly patients. However, for severe hernias caused by increased intra-abdominal pressure over a large area ^[25], the inability to support the hernia ring can lead to hernia ring expansion or even rupture, resulting in the recurrence of the original hernia. Therefore, further exploration is needed for the application of this technique.

5. Summary

In summary, various hernia repair methods have their respective suitable populations, advantages, and disadvantages. Currently, the most commonly used mesh technique in clinical practice is a combination of ligation and suturing, which leverages the strengths of both techniques and better utilizes their respective advantages, making it one of the most commonly used and most mature surgical methods. With the advancement of surgical instruments and technology, the invention and application of various new materials have also brought new development opportunities for abdominal wall hernia repair. For patients, the choice of method depends on factors such as the size and location of the hernia, age, and overall condition. In the early 19th century, the development of surgery made people aware that trauma caused to tissues during the surgical process could affect wound healing. Therefore, the “tension-free method” became the focus of surgeons. However, due to anatomical structure and material limitations, this method can only be used to repair smaller abdominal wall defects, so it is mainly used for clinically simple abdominal wall hernia treatment. However, there are some issues when performing mesh fixation: Firstly, some patients may experience complications such as free inguinal canal stenosis; secondly, it is important to select an appropriately sized mesh based on the patient’s specific conditions to ensure that the mesh fits perfectly with the patient’s abdominal wall and reduce

the probability of complications; finally, maintaining good surgical habits is key to preventing postoperative complications. For example, strictly following tension-free suturing techniques, correctly selecting the surgical field size and approach, and maintaining appropriate tension. After fully understanding the patient's physical condition and disease characteristics, comprehensive consideration of the above factors and the formulation of individualized treatment plans can bring greater benefits to patients. At the same time, further research on mesh types, elastic gradients, and suturing methods is needed to lay the foundation for precision medicine in the future.

Disclosure statement

The authors declare no conflict of interest.

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Study on the Effect of Sini Powder and Huatan Xiaoyu Decoction Combined in the Treatment of Whole Stomach Gastritis with Precancerous Lesions

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Abstract: *Objective:* To analyze the combined effect of Sini Powder and Huatan Xiaoyu Decoction in treating whole stomach gastritis with precancerous stomach lesions. *Methods:* 138 patients with whole stomach gastritis with precancerous lesions of the stomach admitted to the hospital from January 2021 to June 2024 were selected. According to the difference in treatment methods, they were divided into the study group (Sini Powder, Huatan Xiaoyu Decoction combined treatment) and the control group (Huatan Xiaoyu Decoction treatment), with 69 cases in each. *Results:* The curative effect and negative rate of *Helicobacter pylori* in the study group were significantly higher than those in the control group ($P < 0.05$); the TCM syndrome score and carcinoembryonic antigen and carbohydrate antigen 125 in the study group were lower ($P < 0.05$). *Conclusion:* The treatment of patients with whole stomach gastritis with precancerous gastric lesions can be improved by using Sini Powder combined with Huatan and Xiaoyu Decoction.

Keywords: Sini Powder; Huatan and Xiaoyu Decoction; Chronic atrophic gastritis; Precancerous gastric lesions

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1. Introduction

Chronic gastritis, especially chronic atrophic gastritis, is one of the common diseases of the digestive system. It is clinically characterized by the inflammatory response of the gastric mucosa and has a risk of progression^[1]. At present, it is believed that the continuous development of chronic atrophic gastritis can lead to gastric mucosal atrophy, resulting in pathological states such as intestinal metaplasia, which not only indicates the malignant progression of the disease but also can be regarded as the manifestation of precancerous gastric lesions. The occurrence of gastric cancer is closely related to mechanisms such as chronic inflammation, atrophy, and intestinal metaplasia. In order to reduce the risk of gastric cancer, for patients with chronic atrophic gastritis and

precancerous gastric lesions, it is necessary to actively block and reverse the relevant mechanisms, to prevent the occurrence of gastric cancer. Western medicine is effective in treating this disease, but there are problems of drug safety and drug resistance. Traditional Chinese medicine believes that atrophic gastritis with precancerous lesions of the stomach can be classified as “epigastric pain” and other categories. The incidence of this disease is mostly related to weakness of the spleen and stomach and stagnation of Qi and blood. The treatment of this disease should be mainly to eliminate blood stasis and strengthen the spleen and stomach [2]. Sini Powder and Huatan Xiaoyu Decoction are common traditional Chinese medicine formulas for the treatment of the digestive system at present and have the functions of strengthening the spleen and nourishing Qi. This time, 138 patients with total gastritis with precancerous lesions of the stomach admitted to the hospital from January 2021 to June 2024 were selected to explore the clinical value of the combined treatment of Sini Powder and Huatan Xiaoyu Decoction.

2. Materials and methods

2.1. General data

138 patients with total gastritis and precancerous lesions of the stomach admitted to our hospital from January 2021 to June 2024 were selected. Among them, there were 50 males and 19 females in the study group, aged 36–60 years old, with an average age of (48.00 ± 3.74) years old. In the control group, there were 42 males and 27 females, aged 35–60 years old, with an average age of (48.10 ± 3.54) years old. This study was reviewed and approved by the hospital ethics committee. The general data of the two groups of patients could be compared, $P > 0.05$.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Meet the diagnostic criteria of chronic atrophic gastritis [1]; (2) Meet the diagnostic criteria of traditional Chinese medicine gastritis [2]; (3) Clear cognition and no history of drug allergy.

Exclusion criteria: (1) Cognitive impairment; (2) Other gastrointestinal diseases; (3) Targeted severe organ damage.

2.3. Methods

Both groups were given conventional quadruple therapy, including basic treatment of anti-inflammatory, antibacterial and acid suppression. Control group increased the phlegm and blood stasis removal decoction treatment: group prescription tangerine peel, banxia, curcuma, chicken neijin and puhuang powder each 10 g, fried coix seed 30g, *Poria cocos*, half branch lotus and snake tongue grass, cranium and Zidanshen each 15 g, 1 daily dose, 2000 mL water decoction, day and night each 1 time, 300 mL/time. The study group further increased Sini powder, phlegm and blood stasis removal decoction combined treatment: group: based on phlegm and blood stasis removal decoction group, increase 5 g of Bupleurum, aurantium, white peony each 10 g, hot licorice 3 g, 1 daily dose, 2000 mL water decoction, morning and evening warm 1 time, 300 mL/time. Both groups continued treatment for 4 weeks.

2.4. Observational indicators

- (1) Efficacy: After treatment, gastroscopy, clinical symptoms disappeared completely, and *H. pylori* turned negative, which was markedly effective; gastroscopy reduced the ulcer surface by $\geq 50\%$, and the

symptoms improved, and *H. pylori* did not improve, which was effective; gastroscopy reduced the ulcer surface by < 50%, and the symptoms and *H. pylori* test results did not improve, which was ineffective. The curative effect was counted by the number of markedly effective and effective cases.

- (2) The TCM syndrome points were evaluated with reference to the “Guiding Principles for Clinical Research of New Chinese Medicine.” The lower the score, the better.
- (3) Fasting venous blood of 2nmL was collected, and carcinoembryonic antigen and carbohydrate antigen 125 were detected by enzyme-linked immunosorbent assay.
- (4) The negative rate of *H. pylori* was evaluated by a 14 C breath test.

2.5. Statistical analysis

Using SPSS 23.0 analysis, measurement data conformed to normal distribution, expressed as mean \pm standard deviation (SD), by *t* test, count data by χ^2 test, expressed as (%), the difference was statistically significant $P < 0.05$.

3. Results

3.1. Comparison of curative effect between the two groups

The curative effect of the study group was significantly higher than that of the control group ($P < 0.05$) (Table 1).

Table 1. Comparison of curative effect between the two groups [*n* (%)]

Groups (<i>n</i>)	Markedly effective	Effective	Ineffective	Total effective
Research group (<i>n</i> = 69)	39 (56.52)	27 (39.13)	3 (4.35)	66 (95.64)
Control group (<i>n</i> = 69)	27 (39.13)	31 (44.93)	11 (17.94)	58 (82.06)
χ^2				88.876
<i>P</i>				< 0.001

3.2. Comparison of TCM syndrome scores

The TCM syndrome scores of the study group were lower ($P < 0.05$) (Table 2).

Table 2. Comparison of TCM syndrome scores (mean \pm SD, scores)

Groups (<i>n</i>)	Before treatment	2 weeks of treatment	4 weeks of treatment
Research group (<i>n</i> = 69)	19.45 \pm 2.41	13.23 \pm 1.12*	10.23 \pm 1.11*
Control group (<i>n</i> = 69)	19.52 \pm 2.61	15.53 \pm 1.24*	12.31 \pm 1.05*
<i>t</i>	0.164	11.444	28.813
<i>P</i>	0.870	< 0.001	< 0.001

Note: Comparison before and after treatment within the same group in the table, * $P < 0.05$.

3.3. Comparison of laboratory indicators between the two groups

The carcinoembryonic antigen and carbohydrate antigen 125 were lower in the study group ($P < 0.05$) (Table 3).

Table 3. Comparison of laboratory indicators between the two groups (mean \pm SD)

Groups (<i>n</i>)	Carbohydrate antigen 125 (U/mL)		Carcinoembryonic antigen (ng/mL)	
	Before treatment	After treatment	Before treatment	After treatment
Research group (<i>n</i> = 69)	58.65 \pm 3.11	18.23 \pm 2.41*	40.52 \pm 3.11	10.23 \pm 1.01*
Control group (<i>n</i> = 69)	58.52 \pm 3.14	22.34 \pm 3.51*	40.51 \pm 3.15	15.23 \pm 2.11*
<i>t</i>	0.244	8.018	0.019	17.755
<i>P</i>	0.807	< 0.001	0.985	< 0.001

Note: Comparison before and after treatment within the same group in the table, * P < 0.05.

3.4. Conversion rate comparison

The *H. pylori* negative conversion rate in the study group was 56.52% (37/69), which was higher than that in the control group of 39.13% (27/69) ($\chi^2 = 4.182$, $P = 0.041$).

4. Discussion

As a malignant tumor, gastric cancer had a certain epidemic trend in our country in recent years with the change in population structure and life, dietary patterns, and the increase in the incidence of chronic gastritis. It is one of the common tumor diseases that lead to the death of residents. Gastric cancer is mostly developed from chronic gastritis. Patients do not receive timely and effective treatment in the stage of chronic inflammation. The deterioration of the disease can lead to pathological changes in gastric mucosal tissue and increase the risk of carcinogenesis. At present, in the prevention and treatment of gastric cancer, it has become a clinical consensus to actively identify and block the pathway of precancerous lesions. Traditional Chinese medicine has a long history of adjuvant treatment of chronic atrophic gastritis and gastric cancer. Traditional Chinese medicine therapy is safe and reliable, and the curative effect is accurate. It has a positive significance for controlling the progress of the disease and reducing the burden of the disease. Chronic atrophic gastritis with precancerous lesions of the stomach can be included in the category of “ruffian.” Traditional Chinese medicine scholars believe that the disease is located in the stomach and is closely related to the function of the spleen and liver. The stomach is a sea of water and valleys, and the water and valleys can be decomposed when the physiological function is normal, while the liver mainly excretes, the spleen mainly transports and transforms, and the organs work together to digest and absorb food to meet the needs of qi and blood operation.

As a short summary of the pathogenesis of chronic atrophic gastritis with gastric precancerous lesions, which is related to the following factors: weakness of the vegetarian body, deficiency of righteousness and Qi, inability to resist the invasion of external evil, and then gastric lesions; improper diet, long-term intake of cold, spicy food, or long-term overeating, resulting in damage to the spleen and stomach function and disease; emotional discomfort, depression, anxiety, or excessive mental stress, long-term liver qi stagnation offends the stomach; overwork, resulting in loss of Qi and blood, manifested as weakness of the spleen and stomach; damages on the gastric mucosa, which can also increase the risk of gastric cancer. The synergistic effect of the above factors can damage the function of lifting the spleen and stomach, causing the body to produce toxic scales due to blood stasis and phlegm turbidity. In the early stage of chronic atrophic gastritis with precancerous lesions of the stomach, a small number of patients have no specific symptoms. Most patients have digestive system diseases such as abdominal pain, vomiting, fullness, and nausea, and with the progress of the disease,

low appetite, bitter mouth, belching gas, acid reflux and other diseases. In addition, in severe cases, it can be manifested as black stools, anemia, and weight loss.

Studies have pointed out that it is a mix of cold and heat, and the syndrome of this deficiency is standard. Factors such as spleen deficiency, stomach damage, and emotional disorders can lead to damage to the spleen and stomach, gathering moisture into phlegm, stagnating Qi and blood, and phlegm and dampness trapped, which leads to epigastric pain and other diseases. Treatment ideas need to be based on reducing phlegm and dampness, strengthening the spleen and stomach, and eliminating blood stasis. *Fangzhong banxia* reduces inverse vomiting, dryness and phlegm; tangerine peel, fried coix seed, puhuang powder regulates Qi and strengthens the spleen, dryness and dampness and reduces phlegm; curcuma nourishes the spleen and nourishes Qi, dryness and dampness and water; *Poria cocos*, chicken neijin and other water infiltration strengthen the spleen and calm the nerves; cranium grass and snake tongue grass break qi and accumulate, reduce phlegm and disperse knots; Zidanshen, Banzhilian promote blood circulation and remove blood stasis [3]. Sini Powder has the functions of soothing the liver and regulating Qi and regulating the spleen and stomach. *Fangzhong bupleurum* soothes the liver and relieves depression, rises the sun and lifts depression; Baishao nourishes blood and softens the liver, relieves pain urgently [4]. The combination of the two can play the role of strengthening the spleen and nourishing the stomach, eliminating blood stasis, dispersing knots and relieving pain.

The advantages of Sini Powder and Huatan Xiaoyu Decoction in combination for the treatment of this disease includes: the multi-target drug effect, Sini Powder prescription can invigorate the spleen, soothe the liver, relieve depression, and clear pathogens, and various drugs in Huatan Xiaoyu Decoction can remove blood stasis, promote blood circulation, disperse knots, and reduce phlegm. The combination of the two can effectively relieve the symptoms of patients with gastric lesions, and can also correct the stomach microenvironment and repair damaged gastric mucosa; promote pathological changes and outcomes, the two drugs can synergistically inhibit intestinal epithelial metaplasia and hyperplasia, and can also promote the reversal of atrophic gastric mucosal glands; synergistic treatment has high safety, and both are Chinese herbal preparations. The combined use does not increase the side effects of drugs [5].

The study showed that the curative effect of the study group and the negative rate of *H. pylori* were significantly higher than those of the control group ($P < 0.05$), suggesting that the combination of the two can improve the treatment effect and protect the gastric mucosal barrier. The study group's TCM syndrome score was lower ($P < 0.05$), suggesting that the combination therapy in this study can reduce the burden of symptoms and improve the condition. The reason for the analysis is that Sini Powder has the effect of dredging the liver and regulating Qi, regulating the spleen and stomach, while the Decoction Removing Phlegm and Dampness, promoting blood circulation and removing blood stasis. The combined use of the two can effectively improve the problems of poor qi, phlegm-dampness block and blood stasis, thereby enhancing the treatment effect and reducing the burden of symptoms Huatan Xiaoyu Decoction can help improve gastric microcirculation, and Sini Powder can regulate liver and spleen functions. The combination of the two can improve the overall physiological environment in the stomach and control the progression of disease deterioration [6].

The expression levels of carcinoembryonic antigen and carbohydrate antigen 125 are closely related to tissue carcinogenesis. The study pointed out that the higher the expression levels of carcinoembryonic antigen and carbohydrate antigen 125, the higher the severity of gastric cancer disease. This study showed that the carcinoembryonic antigen and carbohydrate antigen 125 in the study group were lower ($P < 0.05$), suggesting that the combination therapy in this study could reduce the level of tumor markers and have positive

significance for the control of gastric precancerous lesions^[7]. Studies have pointed out that both Huatan Xiaoyu Decoction and Sini Powder can prevent and treat gastric precancerous lesions, which is closely related to the broad-spectrum anti-tumor components in each group of the two groups^[8]. The main active ingredients of Bupleurum in Sini Powder, paeoniflorin of Baishao and flavonoids of tangerine peel, all have certain anti-inflammatory, antioxidant, immune regulation and other biological activities. Glycyrrhizic acid has multiple effects such as anti-inflammatory and antiviral. The naringin and neohesperidin of *Fructus aurantii* can improve gastrointestinal motility. By inhibiting the nuclear factor signaling pathway, it can down-regulate the expression of pro-inflammatory factors, reduce the inflammatory response in the stomach, and also reduce the damage caused by oxidative stress to gastrointestinal tissue^[9]. Atractylodes contain a variety of amino acids and trace elements, which can enhance the function of the spleen and stomach, and the extracts of Atractylodes have the effect of inhibiting the growth of cancer cells. The combination of Huatan Xiaoyu Decoction and Sini Powder can play many roles such as sterilization and anti-inflammatory, protection of gastric mucosal barrier and promotion of local damage repair. It can actively reduce inflammatory response, reduce the disease and control the progression of the disease. It has a good effect on controlling gastric precancerous lesions^[10].

During the actual treatment of Sini Powder and Huatan Xiaoyu Decoction, in order to reduce the incidence of gastric cancer, the following matters should be paid attention to:

- (1) Dialectical regulation of medication: As the course of the disease advances, the patient's syndrome type may change, so regular follow-up visits should be made, and the medication plan should be adjusted based on the change of the syndrome type.
- (2) Reasonable control of dose and course of treatment: Traditional Chinese medicine scholars match drugs based on the patient's physique, condition and the principle of "Junchen Zuo" to synergize. If large doses of administration can increase the risk of toxic side effects, small doses of administration cannot achieve the desired effect, if short-term administration is difficult to completely cure the disease, long-term administration can increase the economic pressure of patients.
- (3) Diet adjustment: Choose fresh fruit and vegetable foods, easy-to-digest food, and eat regularly and quantitatively to avoid overeating.
- (4) Correct work and rest: Urge patients to maintain good work and rest habits, avoid overwork, stay up late, and carry out Tai Chi, race walking and other sports to enhance physical fitness.
- (5) Emotion adjustment: If long-term emotional discomfort can aggravate the disease, patients should be told to self-guide anxiety and tension, and carry out psychological counseling when necessary to solve the incentives of patients' mood swings.
- (6) Re-examination: Follow the doctor to complete the pathology, gastroscopy, evaluate the progress of the disease, and accept the follow-up of traditional Chinese medicine, dialectically adjust the treatment plan.
- (7) Reasonable medication: If the long-term intake of non-steroidal anti-inflammatory drugs can aggravate the damage of gastric mucosa, so the medicine should be taken in accordance with the doctor to avoid the adverse inducement of gastric disease.

5. Conclusion

In summary, Sini powder combined with Huatan Xiaoyu Decoction in the treatment of patients with total

gastritis and precancerous gastric lesions can improve the therapeutic effect, improve the clearance effect of *H. pylori*, and have a certain effect on controlling the progression of the disease.

Disclosure statement

The authors declare no conflict of interest.

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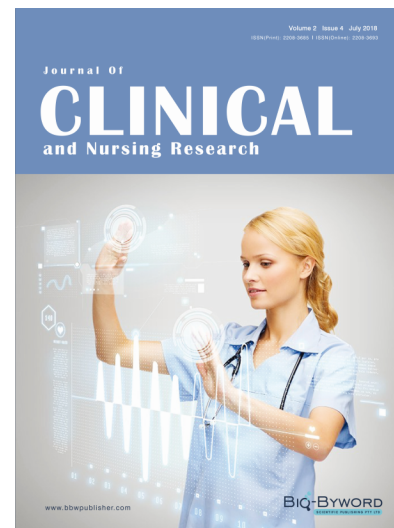
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