

# *Exploration of the Mechanism of Zhongzhu Acupoint for the Treatment of Tinnitus Syndrome*

Zi Meng<sup>1,a</sup>, Lifen Wang<sup>2,b,\*</sup>

<sup>1</sup>*Shaanxi University of Chinese Medicine, Xi'an, Shaanxi, 712046, China*

<sup>2</sup>*The Fourth Department of Acupuncture and Moxibustion, Shaanxi Provincial Hospital of Traditional Chinese Medicine, Xi'an, Shaanxi, 710000, China*

*<sup>a</sup>mz13484618429@163.com, <sup>b</sup>wang-lifen@126.com*

*\*Corresponding author*

**Keywords:** Tinnitus; Zhongzhu Points; Mechanism; Root cause and anifestation; Bone empty; Imageological examination

**Abstract:** Zhongzhu Point is often used in clinical treatment of tinnitus. However, at present, the mechanism of Zhongzhu acupoint in the treatment of tinnitus is not fully and clearly understood. This article expounds the effective mechanism of Zhongzhu point for tinnitus treatment from ancient medical books, traditional Chinese medicine meridian and five elements theory of Zangfu organs, modern disarticulation, different treatment methods, including acupuncture, electroacupuncture, moxibustion, modern imaging, etc. It fully shows that Zhongzhu point has clinical rationality and modern science and technology research support for the treatment of tinnitus, and puts forward a new research idea for the treatment of tinnitus.

## 1. Introduction

Tinnitus refers to the patient does not come from the external sound source stimulation as the premise, the formation of intracranial or ear "buzzing" "hissing" and other irregular hallucinatory sound, this sound can be a type of auditory hallucination noise, can also be a variety of types of auditory hallucination noise together, tinnitus affects about 5% of the population. 20% of tinnitus patients experience severe pain due to auditory hallucinations. The negative emotions caused by tinnitus, such as difficulty in concentrating attention, depression and anxiety, are the main factors troubling patients[1]. Current studies have found that there is a positive functional connection between tinnitus patients and orbitofrontal cortex, which is responsible for human emotions[2]. Volume 23 of "The Source of Miscellaneous Diseases" records: "Cicadas singing in the ear, gradually leading to deafness." The first Zhongzhu point is listed in "Lingshu · Benshou". "In Zhongzhu, Zhongzhu, after this section, it is also lost." It is the infusion point of Shaoyang Sanjiao Meridian of the hand, "Acupuncture Dacheng · Kaozheng Point Method" recorded: "Zhongzhu, the little finger of the hand is stuck after this section, one inch under the liquid gate, the Shaoyang Sanjiao pulse of the hand is noted as Yu Mu, Sanjiao empty fill", "middle" and "outside" relative, "middle" refers to the inside; A small mound or river in the "Nagisa" pool. The name of the point means that the scattered part of the vein Qi and blood of the Shaoyang pulse of the sanjiao hand

gathers here. Zhongzhu is the hand Shaoyang Sanjiao meridian of the transfusion point, "Ling Shu nine needles twelve original": "the note is lost." It means that the qi of the meridians becomes stronger here, just like when the water is injected deeper." A and B Classics of Acupuncture and Moxibustion" recorded: "madness, mutual headache, eye pain, tinnitus, Zhongzhu main," Professor Chen Yiguo [3] Clinical Zhongzhu main point combined with other points, the effect of tinnitus treatment is quite significant, so the mechanism of Zhongzhu point treatment tinnitus was discussed, and new ideas were put forward to verify the mechanism. The details are set out below for your information

## 2. TCM theory support of Zhongzhu's treatment of tinnitus

### 2.1. Channel to reach disease, safe inside and outside

The "Yin and Yang Eleven pulse Moxibustion Classic" describes that the Sanjiao hand Shaoyang pulse is also called "ear pulse", pointing out that the Sanjiao channel plays an important role in the treatment of diseases related to the ear, which is closely related to the circulation of the meridians. The gallbladder channel is in a branch of the ear: from behind the ear into the ear, out in front of the ear, to the sharp canthus behind the eye. Zhongzhu point as the sanjiao hand Shaoyang channel injection point, is the most powerful point of its meridian qi, according to the sanjiao route should be a very important point to treat tinnitus. According to the contents of eight trigrams and Yin and Yang of the meridians, and the balance between the Sanjiao channel and the gallbladder channel, this balance can be considered as a small cycle[4]. When there are lesions on this cycle, appropriate stimulus amount will be used to restore the cycle to a stable state.

### 2.2. Tune up to guide down, enlightening clear

"Jingyue Complete Book of Ear Syndrome" said: "Deafness syndrome, always because of qi blocked ear", and also mentioned: "Qi blocked, mostly because of the liver and gallbladder qi opposition, the syndrome is not empty or fire, or anger, or depression, qi has ended." The liver and gallbladder qi machinery is disarranged, does not follow the normal path, and the ear orifice is disturbed, so the qi blockage can cause deafness[5]. Shaoyang Sanjiao and foot Shaoyang gallbladder are different, Zhongzhu point is wood, for the mother of Shaoyang Sanjiao, foot Shaoyang gallbladder five elements are Yin wood, in clinical practice occasionally this meridian is not good effect, can take the same name of the meridian Zi mother supplement drainage, suitable for liver and gallbladder fire syndrome type tinnitus, puncture Zhongzhu point with drainage method. "Ling Shu · Evil Qi Zangfu disease form Article No. 4" said: "Twelve meridians 365 collaterals, its blood and gas are on the surface and go empty orifice. Its qi on the eye and for the eye, its other gas walk in the ear and listen to ", the ear as clear, it is smooth, like clear evil turbid. The Sanjiao channel is a network of pipes inside and outside the whole body. Zhongzhu point as the hand Shaoyang Sanjiao channel of the injection point, can Tongli Sanjiao, opening and closing, is the experience of the treatment of tinnitus to the point [6] Foot Shaoyang Sanjiao channel is not only the pipeline of gas, but also the pipeline of water, "Su ask Linglan secret book" narrated: "Sanjiao, the officer of desecration, the waterway out of". If the three jiao impassability is bound to affect water metabolism, resulting in edema abdominal distention and other diseases, kidney Yang warming the human body, not to the body too much water storage, but the disease of the three jiao meridian for a long time to pass to the foot Shaoyin kidney meridian, wasting kidney Yang." Ling Shu · Pulse Degree" said: "kidney qi through the ear, kidney and ear can hear the five tones." Kidney is the origin of birth, and the opening is in the ear. Modern studies have also confirmed that chronic kidney disease is related to hearing damage [7]. Plain Question · Comment

on deficiency and reality" records: "Headache tinnitus, nine orifice adverse, stomach and intestines", spleen and stomach adverse phlegm dampness, wet heavy viscous blind Qingqi easy to cause tinnitus, according to the meridian: Foot Taiyin spleen meridian - Foot Yangming stomach meridian - Hand Shaoyang Sanjiao Meridian, Zhongzhu point as a Sanjiao hand Shaoyang pulse delivery point, bearing on the spleen and stomach can resolve the phlegm from the meridian, regulate the whole meridian Qi, guide can reduce the pressure of water dampness phlegm drink on the kidney meridian." Preventing disease" is an important aspect of medical diagnosis and treatment, which requires to predict the development of disease. Therefore, it is essential to choose Zhongzhu point to treat tinnitus.

### 2.3. Branch end cure root, bone empty retreat

"Biao You Fu" recorded: "Even poorer four roots and three knots, according to the specimen and all thorns are healed."The root knot theory of traditional Chinese medicine is to connect the meridians at the far end of the limbs with the five senses to clear the Qiaoqiao[8], and the ear is the gathering of the zong pulse, so acupuncture at the far point can dredge the meridians Qi and blood, and promote the smooth flow of the ear pulse qi. There are many nerve trunks, spinal cords, and blood vessels in the "bone void"[9]. "Bone void" was first mentioned in "Suwen - Theory of Bone Void". After later generations of doctors continued to supplement and revise the specific definition of bone void, it is now referred to as: (1) the pores connecting the brain, spinal cord; (2) facial bone pores; (3) interosseous joint pores; (4) acupoints between the two bones; (5) Pores that nourish long bones; The acupoints of the hands and feet can generally relieve the diseases of the head, face and facial features, and the majority of them are clearing the orifice and opening the orifice. The Zhongzhu point is located in the back of the 4th metacarpophalangeal joint and the depression of the 4th and 5th metacarpal joint joints. Zhongzhu Point is a typical distal point and a bone hole that exists "between two bones". Zou Mingzhu [10] performed acupuncture at Zhongzhu point under the observation of modern imaging techniques, and clearly observed that auditory regions in the cerebral cortex became excited.

### 3. Anatomy of Zhongzhu Point

The plane anatomical structure of Zhongzhu Point [11] mainly consists of the following parts: 1. Subcutaneous tissue: the ulnar part containing the dorsal digital nerve and the dorsal vein network of the hand (extending upward as the main vein). 2. Deep fascia of back of hand: divided into shallow layer and deep layer. The superficial and deep fascia join each other at the web of the fingers and are connected by a fibrous diaphragm at the base of the metacarpal bone. The tip of the needle finally reaches the fourth interosseous dorsal muscle, which is innervated by the deep branch of the ulnar nerve, and its nerve fibers are composed of the C8 cervical nerve and the first thoracic nerve. The posterior branch of C3-8 cervical nerve divides from the spinal nerve and runs backward and inward through the bone fiber pore and canal of the posterior branch of cervical nerve respectively, and then passes through the tendinous cross fibers between the semi-spinous muscle of the neck and the rotator muscle, distributing in the nymphal muscle [12]. When the nymphal muscle is relieved, it can reduce the degree of cervical vascular compression and restore the blood supply to the brain, providing anatomical theoretical support for alleviating tinnitus. Relevant studies can be further improved in subsequent clinical trials.

## 4. Stimulate the clinical method of Zhongzhu Point and support the theory of Chinese and Western medicine

### 4.1. Tingling

Tinnitus is divided into two kinds of tinnitus, the sharp and high tone is mostly deficiency syndrome, and the low tone is mostly evil abundance. The treatment of tinnitus must be taken into account with specimens, and the clinical effect can be significant. "Burning mountain fire" and "clear day cool" have a good effect on the application of respiration, lifting and inserting, twisting, opening and closing, 96 and other single-type supplementing and draining techniques [13]. The heat syndrome recorded in acupuncture and moxibustion is treated with clear day cool three times, and the fever is eliminated by itself. Burning mountain fire as the most representative of the hot acupuncture method, after the appearance of heat, with the hand to keep qi to achieve "qi to the disease", when the needle is not obvious, you can use the "scraping method" to shock the qi. The mechanism of cooling through the sky is summarized as "inducing Yang (Yang evil) out of Yin"; The mechanism of burning mountain fire can be summarized as "inducing Yang into Yin". It has been confirmed by modern imaging that the drainage method can reduce the blood vessel volume, the replenishment method can increase the blood vessel volume, and the two methods can regulate the microcirculation, improve the brain circulation, and promote the recovery of brain cells[14].

### 4.2. Electroacupuncture

Electroacupuncture instrument, as the product of acupuncture theory combined with modern technology, is a micro current wave in line with human bioelectricity passed on the needle after acupuncture is inserted into the acupoint to obtain gas. The pulse current stimulation of the electric needle strengthens the needle sensation effect of acupuncture, stimulates the cerebral cortex and promotes the blood circulation in the brain. Compared with ordinary acupuncture, acupuncture can enhance the regulatory function of neuro-endocrine-immune network[15]. And instead of the traditional needle, it effectively reduces the workload of the doctor. Jing et al.[16] used electroacupuncture in the acupuncture treatment of rabbits, and found that electroacupuncture could enhance the synaptic efficacy of OBC brainstem neurons and peripheral auditory pathway transmission, restore the high and low frequency hearing level of cochlea, and improve hearing ability.

### 4.3. Moxibustion

"God Moxibustion Jinglun" says: "Moxibustion, warm meridians, promote qi and blood, so that the reverse of the conformity, the stagnation of the line." The light radiation, the photothermal action and the chemicals contained in moxibustion during combustion are the three main reasons for its effect[17]. The light radiation generated in the process of moxibustion tends to be consistent with the absorbable spectrum of the body [18]. In the meridian energy system, acupuncture points are points composed of cells with more triphosphorus in the mitochondrial gland [19]. When the body receives this radiation energy, ATP is driven to resonate and produce energy, which makes the low-energy state of local cells transmitted to distant places. The radiation from moxibustion can promote the normal and pathological cells at the acupoints to regulate the immune, endocrine and nervous systems. "Ling Shu · Thorn Section true evil" says that "fire and qi have been passed, blood is in line", and the heat action of moxibustion is subdivided into three stages: local initiation, local effect induction, and subsequent effect conduction. Local initiation stage refers to activating heat sensitive acupoints, expanding local blood flow and improving local circulation; At the stage of

local effect induction, a variety of cytokines are released locally, such as epoxide Eicosatrienoic acid (EET), hydrogen sulfide (H<sub>2</sub>S), vasoactive intestinal peptide (VIP), etc. After these factors combine with vasomotor nerves and vasoconstrictor nerves, the subsequent conduction stage begins immediately. In this stage, the stimulation of moxibustion heat action passes through the spinal brain region and endogenous regulatory system. Treatment of abnormal brain function [20]. The light, heat and medicinal effects produced by moxibustion can be transmitted to the distal end along the meridians after being received by the receptors [21]. When the transient receptor potential family (TRP) on skin cells is stimulated by moxibustion heat, sensory nerves are excited, mast cells are activated and degranulated, neurotransmitters are released, electrical signals are transmitted to the center through nerve fibers, and brain functions are improved [22]. In the book of 100 Kinds of Herbal Classics of Shennong, it is said that "those who are fragrant should have the right qi, and those who are full of the right qi will eliminate the evil and eliminate the dirty also." Muggrass is a representative recipe of aromatic herbs, in which volatile oils and polyphenols have significant antioxidant and oxygen free radical scavenging functions to protect neurons [23]. Modern research shows that neuro-endocrino-immune network is an important way for TCM therapy to work. The nervous system plays a leading role. In turn, the nervous system is also regulated by the endocrine and immune systems to reshape the central nervous system and reduce the expression of Caspase-3 protein [24].

## 5. Brain imaging of acupuncture at Zhongzhu point for tinnitus treatment

Acupuncture and moxibustion, as a kind of therapy inherited for thousands of years, has been widely used and has remarkable curative effect. In recent years, our understanding of brain function has become deeper and more accurate with the development of imaging. Nicole M [25] found that the nerve activity of the middle temporal gyrus in tinnitus patients was significantly increased, and there were many abnormal functional connections with the middle frontal gyrus, interlobaric posterior cerebellum, and lingual gyrus. Panwei [26] conducted research on acupuncture points through imaging to make it clear that acupuncture points can strengthen the connection of various functional areas in the brain, and exert its influence on the whole body and various viscera. Based on the meridian-brain correlation theory, studies have shown that acupuncture points and qi generation effect after acupuncture can be specifically activated in the brain region [27]. This was also confirmed by acupuncture at Zhongzhu point under the observation of modern magnetic resonance imaging technology, which clearly observed the excitation of auditory related regions in the cerebral cortex [41]. Currently, imaging techniques that have been applied in the clinic include: Transcranial Doppler ultrasound (TCD) [28] positron emission computed tomography (PET) [29], single photon emission computed tomography (SPECT) [30], Functional magnetic resonance imaging (fMRI) [31], etc. Song Quanmei [32] integrated the existing symptoms of Zhongzhu point. The results show that tinnitus is the core advantageous disease of Zhongzhu point, and the application of modern imaging technology can provide a reference mechanism for the neurobiological basis of Zhongzhu point treatment of tinnitus.

### 5.1. Transcranial Doppler Ultrasound (TCD)

TCD can dynamically monitor the blood flow physiological parameters, dynamics, spectral waves and audio signals of intracranial arteries to evaluate cerebral blood flow [33]. Therefore, TCD can sensitively perceive blood flow velocity and direction, and play a role in reflecting brain parenchymal changes. Li Shiliang et al. [34] found that among 51 patients with improved tinnitus symptoms after electroacupuncture treatment, 31 patients showed significant improvement in the peak blood flow velocity of vertebasilar artery during systolic and diastolic periods, which proved

that insufficient blood supply in the ear was a factor leading to tinnitus. Wang Hongbo et al. [35] treated 60 tinnitus patients with Zhongzhu as the main point combined with electroacupuncture. After TCD comparison before and after treatment, the blood flow velocity of pushing basilar artery of patients was significantly improved after electroacupuncture stimulation of Zhongzhu and other points, and the tinnitus caused by ear ischemia was reversed.

## 5.2. Functional magnetic resonance imaging (fMRI)

fMRI [31] determines the distribution of water molecules in the body and analyzes the internal structure of the human body, thereby indirectly reflecting the strong and weak activity and function of neurons in the brain tissue, or activated and inactive magnetic resonance imaging methods [36]. Yarui Wei et al. [37] included 17 patients with chronic tinnitus and 22 normal patients, and performed acupuncture at Zhongzhu and other points for 12 times. The results showed that acupuncture at Zhongzhu and other points may improve tinnitus by reducing the time variability of dynamic functional connection (DFC) in patients with chronic tinnitus. Based on the rs-fMRI study, CAI Weiwei et al. [38] found that the ReHo value of the auditory cortex and the lingual gyrus of the visual network in tinnitus patients was enhanced simultaneously, and the functional connection between the auditory cortex and the lingual gyrus was enhanced. Chi Xu [39] acupuncture at the left Zhongzhu point could activate the cingulate gyrus and bilateral temporal lobe of the brain, among which the longitudinal neurodegeneration of the temporal lobe structure was closely related to hearing. Heschl's gyrus (Heschl's gyrus) in the temporal lobe is the main auditory center of the cerebral cortex, also known as the "primary auditory cortex", this area receives neural information from the ear, the initial analysis and processing of sound signals, changes in the cingulate gyrus are closely related to the bad mood of patients with tinnitus, changes in both areas will lead to tinnitus.

## 6. Discussion and expectation

Brain-derived nerve growth factor (BDNF) changes the plasticity of auditory central neurons through the "activity dependent" principle, and is affected by the neuronal activity of the central auditory system [40]. Acupuncture can stimulate the high excitability and sensitivity of neurons. Effectively promoting the release and expression of BDNF and its related receptors can restore the plastic changes that occur in multiple nervous systems of tinnitus patients. At present, the number and methods of research on the mechanism of Zhongzhu point treatment of tinnitus are still relatively small. In the future, the following technologies can be utilized: PET [41][42] technology can be used to capture the dynamic changes of cerebral blood flow, glucose metabolism and neurotransmitter activity when Zhongzhu point treatment of tinnitus; Based on CTA [43]'s sensitive changes in circulatory indicators, or the photoacoustic signals generated by PACT's laser pulse irradiating acupoints to integrate the position and structure of optical absorber to explore the mechanism of Zhongzhu point's treatment of tinnitus; SPECT [30][44] was used to visualize the cerebral perfusion, metabolism and neurotransmitter activity during acupuncture treatment of tinnitus at Zhongzhu point. In recent years, these advanced brain imaging technologies can also be combined with different stimulation means and stimulus amounts applied in the experimental study of "exploring the mechanism of Zhongzhu Point treatment of tinnitus", which is expected to more directly observe the integration information process in the brain. In the future, the research sample size should be expanded, and different methods should be applied to conduct multi-directional experimental comparison. Integrating the cellular, molecular and gene level technology of modern medicine with the overall concept of traditional Chinese medicine and the advantages of syndrome differentiation for the treatment of tinnitus in the future to provide more optimized and accurate therapy.

## References

- [1] Chen Xiulan, Song Fan, Qin Zhaobing et al. Relationship between tinnitus severity and anxiety, depression and personality characteristics [J]. *Journal of Audiology and Speech Disorders*, 2019, 29(04):444-446.
- [2] Yuchen C, Shenghua L, Han L, et al Abnormal Resting-State Functional Connectivity of the Anterior Cingulate Cortex in Unilateral Chronic Tinnitus Patients. [J]. *Frontiers in neuroscience*, 2018, 12.
- [3] Ke Aijun, Chen Yiguo. Chen Yiguo acupuncture Zhongzhu treatment of miscellaneous diseases [J]. *Journal of Practical Chinese Medicine Internal Medicine*, 2013(8):9-9.
- [4] Gao Yicheng, Wang Jihong, Yang Ling. *Chinese Journal of Traditional Chinese Medicine*, 2021, 36(04):2369-2371.
- [5] Zhou Yating, He Yangzi. Preliminary study on the treatment of tinnitus and deafness from Trijiao Meridian [J]. *Chinese Journal of Clinical Acupuncture and Moxibustion*, 2013, 29(08):68-70.
- [6] Li Dongmei. Treatment of tinnitus with acupuncture and moxibustion [J]. *Shandong Journal of Traditional Chinese Medicine*, 2010, 29(08):570-571.
- [7] Dong Yang, Shi Jianrong. Research progress and ideas of modern biology on the theory of kidney governing ear in Traditional Chinese medicine [J]. *Journal of Integrative Chinese and Western Medicine*, 2012, 10(02):128-134.
- [8] Fu Qixi, Tian Shanshan, Liu Dai et al. Study on the tenderness response and tenderness threshold in patients with tinnitus based on "specimen" theory [J]. *Journal of Acupuncture and Moxibustion*, 2018, 34(02):39-42.
- [9] Zhao Wenlin, Ji Zhi, Xie Xiaojia et al. On "bone cavity" [J]. *Chin J Traditional Chinese Medicine*, 2016, 31(04):1157-1160.
- [10] Zou Mingzhu, Zhou Cheng, Chen Min et al. Functional magnetic resonance imaging of brain on acupuncture points: The relationship between acupuncture at Zhongzhu and Yanglingquan Points and excitability of cerebral cortex [J]. *Chinese Journal of Neuroimmunology and Neurology*, 2009, 16(04):266-270.
- [11] Yan Zhenguo, Zhang Zhaofeng. Applied anatomy of the cross section of Lao Gong, toothache, Shaofu, Sanjian, neck neck, Zhongzhu and Houxi Points [J]. *Liaoning Journal of Traditional Chinese Medicine*, 1980, (08):34-36.
- [12] Liu Zongliang, Huang Suqun, Liu Shuang, Li Xingguo. Applied anatomical study of posterior branch of Cervical nerve [J]. *Chinese Journal of Rehabilitation Medicine*, 2007, (02):112-114+95.
- [13] Wang Binwen, Qin Xiaoguang. Discussion on the Manipulation of "burning mountain fire" acupuncture [J]. *Asia-pacific Traditional Medicine*, 2017, 13(08):76-77.
- [14] Ma Yongqiang, Xu Yanlong. Study on the mechanism of mountain fire cooling the sky [J]. *Journal of Liaoning University of Traditional Chinese Medicine*, 2010, 12(07):62-63.
- [15] Chen Yong, Chen Zelin, Chen Bo et al. Prediction of potential therapeutic diseases by electroacupuncture based on complex network analysis of serum exosomal proteome [J]. *Chinese Journal of Traditional Chinese Medicine*, 2022, 37(07):4125-4129.
- [16] Zheng Zheng, Deng Xiaozhu, Zhang Quan, Tian Li, Wang Yi, Wei Xuemei, Li Guochen, Li Li, Ma Lu, Song Kaiyuan. Electrophysiological study of electroacupuncture on cervical sensorineural hearing loss [J]. *Chinese Journal of Acupuncture and Moxibustion*, 2004, (02):47-51.
- [17] Liu Yun, Chu Haoran, Hu Jin. Study on the mechanism of moxibustion therapy [J]. *Chinese Journal of Clinical Acupuncture and Moxibustion*, 2012, 38(12):10-14.
- [18] Hu Jing, Yang Huayuan. The transmission pathway of moxibustion Stimulation Physical Signal and its Effect [J]. *Chinese Acupuncture and Moxibustion*, 2021, 41(05):577-581.
- [19] Gao Zhen. On the essence of energy system and stimulation conduction mechanism of meridian points [J]. *Chinese Journal of Acupuncture and Moxibustion*, 2001(03):33-35.
- [20] Chen Limei, Wang Hui, Zeng Xin, He Qirui, Liu Hongning. Research progress of moxibustion on energy-related diseases [J]. *Chinese Journal of Traditional Chinese Medicine*, 2022, 37(02):919-923.
- [21] Tang Yani, Cui Yimin, He Yifan, Zhang Ning, Lv Peiran, Xing Wenwen, Liu Qi. Research progress on mechanism of moxibustion heat, light and smoke [J]. *Chinese Information Journal of Traditional Chinese Medicine*, 2022, 29(11):148-151.
- [22] Xu Senlei, Zhang Hongru, Gu Yihuang. Effect of moxibustion warm heat stimulation on blood flow and its related mechanism [J]. *Acupuncture Research*, 2018, 43(11):738-743. (in Chinese)
- [23] Chen Juan, Xu Xingyan, Lin Lin, Guo Dongxiao, Cui Weiliang, Lin Yongqiang, Zhang Huijie, Tan Huijie. Research progress on pharmacological effects of wormwood [J]. *Journal of Pharmaceutical Research*, 2019, 40(12):807-811.
- [24] Zhang Hao, Xiong Haozhong, Gong Lili et al. Effect of heat-sensitive moxibustion on apoptosis of cerebral cortical cells in rats with cerebral ischemia-reperfusion injury [J]. *Shi Zhen Chinese Medicine*, 2015, 26(09):2279-2282.
- [25] Nicole M. Armstrong, Yang An, Jimit Doshi, Guray Erus, Luigi Ferrucci, Christos Davatzikos, Jennifer A. Deal, Frank R. Lin, Susan M. Resnick. Association of Midlife Hearing Impairment with Late-Life Temporal Lobe Volume Loss [J]. *JAMA Otolaryngology– Head & Neck Surgery*, 2019, 145(9).

- [26] Pan Weixing. Neurobiological mechanism of acupuncture and moxibustion [J]. *Chinese Journal of Traditional Chinese Medicine*, 2018, 33(10):4281-4297.
- [27] Lai Xinsheng, Huang Yong. Brain function definition of meridian point specificity, acupuncture qi and compatibility rule under the guidance of meridian-brain correlation hypothesis [J]. *Chinese Acupuncture and Moxibustion*, 2007(10):777-780.
- [28] Yue Yukun. Review on "Brief Transcranial Doppler Ultrasound Diagnosis" and its application status [J]. *Clinical Misdiagnosis and mistreatment*, 2019, 36(02):153.
- [29] Guo Qiulei, Liu Qingguo, Yang Fangyuan, Wang He, Zhan He, Ji Zhi, Yuan Jingyun, Wang Zijuan, Liang Jingrong, Sun Jiao. Application of PET technology in acupuncture research [J]. *Chinese Journal of Acupuncture and Moxibustion*, 2019, 39(03):337-341.
- [30] Dong Haoli. Study on functional imaging and acupuncture of brain [J]. *Journal of Integrative Chinese and Western Medicine*, 2009, 18(10):1188-1191.
- [31] Zhong Chengshuang. Research on the principle of nuclear magnetic resonance and Key techniques for fault handling [J]. *China Medical Device Information*, 2019, 25(06):188-189.
- [32] Song Quanmei, Zhang Xuecheng, Jia Yangli, Jia Hongling, Zhang Yongchen. Analysis of modern dominant symptoms and compatibility rules of Zhongzhu Point based on data mining [J]. *China Journal of Basic Medicine of Traditional Chinese Medicine*, 2022, 28(04):602-607.
- [33] Yue Yukun. Review on "Brief Transcranial Doppler Ultrasound Diagnosis" and its application status [J]. *Clinical Misdiagnosis and mistreatment*, 2019, 36(02):153.
- [34] Li Shiliang, Li Hui, Shi Rongxing et al. A preliminary study on the changes of self-conscious symptoms and vertebrobasilar artery flow velocity in patients with tinnitus before and after electroacupuncture treatment [J]. *Clinical Research of Chinese Medicine*, 2013, 5(11):6-9.
- [35] Wang Hongbo, Liu Yong. Immediate effect of TCD on vertebrobasilar artery blood flow in tinnitus patients [J]. *Journal of Traditional Chinese Medicine*, 2015, 43(03):104-105.
- [36] Guan Ying, Zhu Luwen, Wang Feng et al. Application of different rs-fMRI data processing methods in vascular cognitive impairment [J]. *Journal of Rehabilitation*, 2019, 29(01):70-74.
- [37] Wei Y, Zhang W, Li Y, et al. Acupuncture treatment decreased temporal variability of dynamic functional connectivity in chronic tinnitus[J]. *Frontiers in Neuroscience*, 2022, 15:737993.
- [38] Cai Weiwei, Gu Jieying, Liang Jiangang, Zhang Tao. Study on local consistency of resting magnetic resonance of tinnitus [J]. *Journal of Practical Medicine*, 2017, 33(14):2329-2332. (in Chinese)
- [39] Chi Xu, Ju Yanli, Sun Shentian. Functional magnetic resonance imaging of brain after acupuncture at Houxi Point in Zhongzhu [J]. *Chinese Journal of Traditional Chinese Medicine*, 2007, (04):843-844.
- [40] Zhang Rongchao, Guo Kuikui, Guo Xinrong, Du Xu. Study on the possible mechanism of acupuncture in treating craniocerebral injury based on brain-derived neurotrophic factor [J]. *Clinical Journal of Acupuncture and Moxibustion*, 2019, 39(02):102-105.
- [41] Zhang Guifeng, Huang Yong, Song Yuanbin, Zeng Tongjun. Application of PET functional brain imaging in acupuncture research [J]. *Jiangsu Chinese Medicine*, 2008, (08):87-90.
- [42] X. L. Dea ´n-Ben, a S. Gottschalk, a B. Advanced optoacoustic methods for multiscale imaging of in vivo dynamics [J]. *Chem Soc Rev*. 2017, 46(8):2158-2198
- [43] Sun Qing, Li Yaofeng, Yang Weibing et al. The value of arterial CT angiography in the diagnosis of head and neck vascular diseases [J]. *Laboratory Medicine and Clinical Medicine*, 2022, 19(13):1795-1798. (in Chinese)
- [44] Laureano M R, Onishi E T, Bressan R A, et al. The effectiveness of acupuncture as a treatment for tinnitus: a randomized controlled trial using 99m Tc-ECD SPECT [J]. *European radiology*, 2016, 26: 3234-3242