

Transcutaneous Auricular Vagus Nerve Stimulation on Neurological and Mental Disorders: From Germination to Future

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Received date: Jul 19, 2016; Accepted date: Aug 20, 2016; Published date: Aug 29, 2016

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Abstract

Auricular therapies have been applied to diseases since ancient times. Inspired by auricular acupuncture of TCM, and to overcome the disadvantages classic vagus nerve stimulation (VNS), we developed transcutaneous auricular vagus nerve stimulation (taVNS). It was applied to neurological and mental disorders, and also shows a bright prospect to these diseases.

Key words:

Transcutaneous auricular vagus nerve stimulation; taVNS; Pain; Epilepsy; Major depressive disorder; MDD; Disorder of consciousness; DOC

Ancient Applications of Auricular Treatments

Earrings have been favored by the ladies since ancient times (Figure 1). Meanwhile, ears have been used to treat diseases from time immemorial (Figure 2A). The Egyptologist Alexandre Varille (1909-1951) has demonstrated that women in ancient Egypt, who did not want any more children, had their external ear pricked with a needle or cauterized with heat [1]. Mediterranean sailors' wearing gold earrings were not just used as decorations, but were said to improve vision [2]. Hippocrates, who was the father of Greek medicine, reported doctors made small openings in the veins situated behind the ear to facilitate ejaculation and reduce impotency problems [3]. Cutting of veins situated behind the ear was used to treat leg pain as well [4]. The Greek physician Galen introduced Hippocratic medicine to the Roman Empire in the second century CE, commenting on the healing value of scarification at the outer ear [2].



Figure 1: Dancing lady with charming earrings on a remnant of ceramics date to 3200 years ago, which is the Nineteenth Dynasty in the ancient Egypt.



Figure 2A: Brick of Chinese Han dynasty which engraved ancient miracle-working doctor Bian Que using auricular acupuncture for diseases.

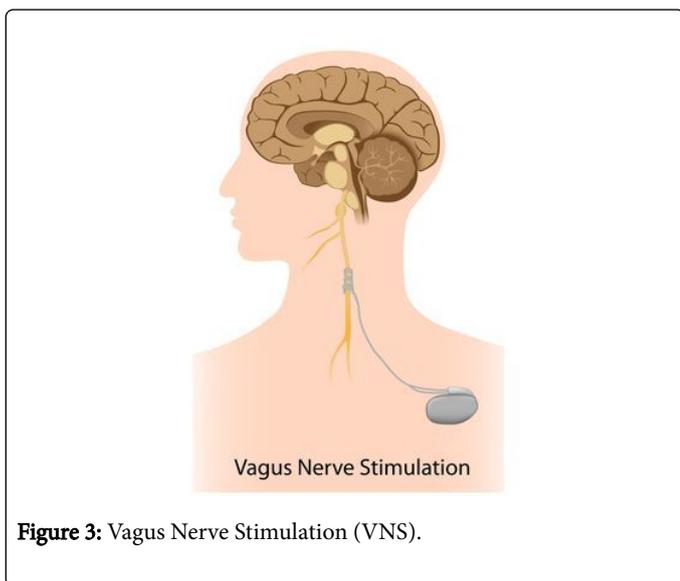


Figure 2B: Persian Surgery Textbook (Imperial Surgery) in the 12th century illustrated that the doctor cauterizing the external ear for patient's migraine.

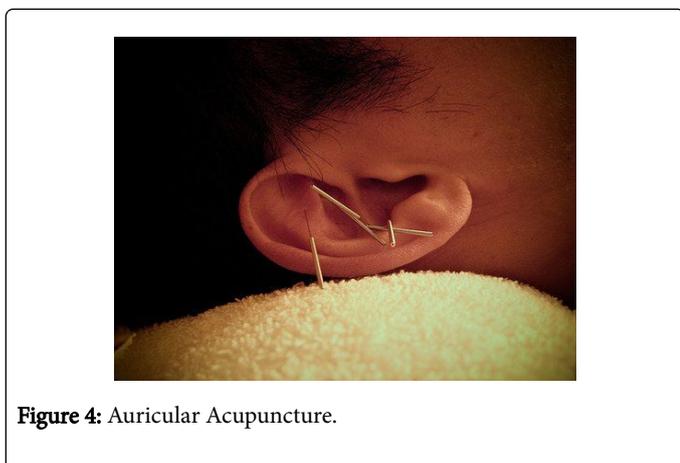
After the fall of Roman Empire, the medical records of Egyptian, Greek and Roman medicine were best preserved in ancient Persia and Arabian world. Persian records were specific references to medical treatments for sciatic pains and sexual related disease produced by cauterization of the external ear (Figure 2B) [2].

From Auricular Acupuncture to Transcutaneous Auricular Vagus Nerve Stimulation (taVNS)

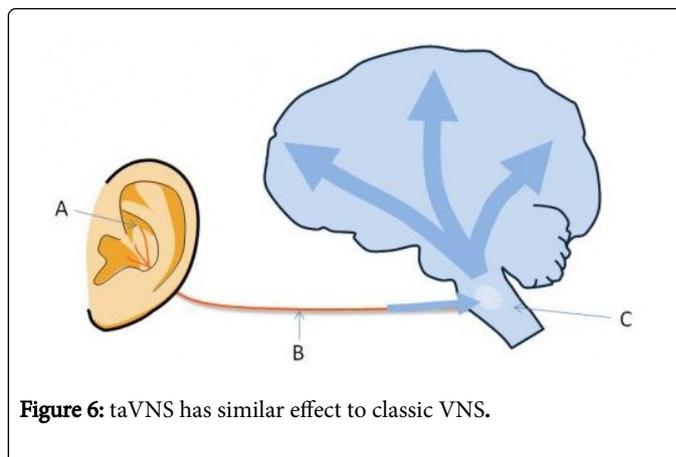
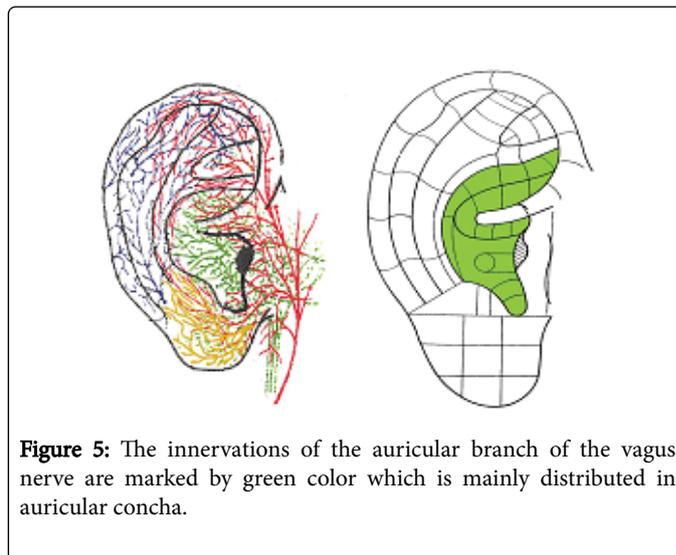
Vagus nerve stimulation (VNS) has been approved by FDA (Figure 3) for epilepsy in 1997 [5] and treatment-resistant depression in 2005 [6,7]. However, they have their limitations as well, including high cost, the involvement of surgery, perioperative risks, and potentially significant side effects [8].



Transcutaneous auricular vagus nerve stimulation (taVNS) is developed from auricular acupuncture several years ago by our team. Auricular acupuncture (Figure 4) is a very important part of Traditional Chinese Medicine (TCM) [9]. In the classic TCM text of Huang Di Nei Jing was compiled in around 500 B.C whose correlation between the auricle and the body had been described that all six Yang meridians were directly connected to the auricle, whereas the six Yin meridians were indirectly connected to the ear by their corresponding yang meridian, respectively [4,10]. Since the ancient time, Chinese doctors have been using auricular acupuncture to treat a wide range of diseases, including insomnia, depression and anxiety etc [11]. Nogier presented his discovery in several congresses and published it in an international circulation journal which eventually led to the widespread acceptance of his approach. With some exceptions, the Chinese charts were very similar to Nogier's originals [12].



Also, according to anatomical studies which suggest that the ear is the only place on the surface of human bodies where there is afferent vagus nerve distribution [13,14], especially in the auricular concha (Figure 5) [15], a direct stimulation of these afferent nerve fibres on ear supposes to have similar effect to classic VNS without surgical intervention, which is fertile for more disorders (Figure 6) [16].



Transcutaneous Auricular Vagus Nerve Stimulation (taVNS) on Neurological and Mental Disorders

At the very beginning, transcutaneous auricular vagus nerve stimulation (taVNS) was for pain relief [1,17,18]. As the classic VNS was approved by US FDA for both epilepsy and treatment-resistant depression, clinical trials of taVNS for these two diseases were increased gradually [16,19-22]. And then, because auricular acupuncture was very effective for insomnia disorder (ID), taVNS was therefore applied to these patients [23]. In addition to the above mentioned, more and more results of taVNS on neurological and mental disorders were achieved including tinnitus [24,25], chronic migraine [26], schizophrenia [27,28], postoperative cognitive dysfunction [29].

In 2013, Compelling evidence exists to suggest that vagus nerve stimulation (VNS) may improve outcomes after severe brain injury. The clinical trial for which researchers have obtained FDA IDE

clearance will be the first step in determining the efficacy of VNS for improvement of consciousness after severe brain injury [30]. Inspired by this, our team is focusing on transcutaneous auricular vagus nerve stimulation (taVNS) on patients with disorder of consciousness (DOC). Stirring results are coming out.

Conclusion

Auricular treatments to diseases can be traced back to ancient Egyptian and Chinese times. Inspired by auricular acupuncture of TCM, and to overcome the disadvantages classic vagus nerve stimulation (VNS), we developed transcutaneous auricular vagus nerve stimulation (taVNS). It was applied to neurological and mental disorders, including pain, epilepsy, depression, insomnia, tinnitus, chronic migraine, schizophrenia, postoperative cognitive dysfunction etc. It also shows a bright prospect in other neurological and mental disorders. Further studies should be carried out.

Grants

1. Natural Science Foundation of China (No. 30973798, 81473780); 2. The Fundamental Research Funds for the Central Public Welfare Research Institutes (ZZ16012); 3. Chinese Postdoctoral Science Foundation (2016M590185).

References

- Horriagan BJ (2008) New auricular therapy providing pain relief to some patients. *Explore: J Sci Heal* 4: 228-231.
- Gori L, Firenzuoili F (2007) Ear acupuncture in European traditional medicine. *Evidence-Based Complementary and Alternative Medicine* 4: 13-16.
- Nogier P (1981) From acuriculotherapy to auriculomedicine. *Maisonneuve*. France, Sainte-Ruffine
- He W, Xiaoyu Wang, Hong Shi, Hongyan Shang, Liang Li, et al. (2012) Auricular acupuncture and vagal regulation. *Evidence-Based Complementary and Alternative Medicine*.
- Ben-Menachem E (2002) Vagus-nerve stimulation for the treatment of epilepsy. *The Lancet Neurology* 1: 477-482.
- Nemeroff CB, Mayberg HS, Krahl SE, McNamara J, Frazer A, et al. (2006) VNS therapy in treatment-resistant depression: clinical evidence and putative neurobiological mechanisms. *Neuropsychopharmacology* 31: 1345-1355.
- Daban C, Martinez-Aran A, Cruz N, Vieta E (2008) Safety and efficacy of Vagus Nerve Stimulation in treatment-resistant depression: A systematic review. *J Affect Disord* 110: 1-15.
- Ventureyra EC (2000) Transcutaneous vagus nerve stimulation for partial onset seizure therapy. *Child's Nerv Syst* 16: 101-102.
- Oleson T (2013) Auriculotherapy manual: Chinese and Western systems of ear acupuncture. Elsevier Health Sciences.
- Yang H (2009) A brief analysis on the treatise of ears in Huangdi Neijing. *Zhejiang Journal of Traditional Chinese Medicine* 44: 14-15.
- Chen HY, Shi Y, Ng CS, Chan SM, Yung KK, et al (2007) Auricular acupuncture treatment for insomnia: a systematic review. *J Altern Complement Med* 13: 669-676.
- Chalmers J (2007) Modern auricular therapy: a brief history and the discovery of the vascular autonomic signal. *Journal of Chinese Medicine* 84: 5.
- Henry TR (2002) Therapeutic mechanisms of vagus nerve stimulation. *Neurology* 59: S3-14.
- Peuker ET, Filler TJ (2002) The nerve supply of the human auricle. *Clin Anat*, 15: 35-37.
- He W, Wang X, Shi H, Shang H, Li L, et al. (2012) Auricular acupuncture and vagal regulation. *Evid Based Complement Alternat Med* 2012: 786839.
- Rong PJ, Ji-Liang Fang, Li-Ping Wang, Hong Meng, Jun Liu, et al. (2012) Transcutaneous vagus nerve stimulation for the treatment of depression: a study protocol for a double blinded randomized clinical trial. *BMC Complement Altern Med* 12: 255.
- Johnson M, Hajela VK, Ashton CH, Thompson JW (1991) The effects of auricular transcutaneous electrical nerve stimulation (TENS) on experimental pain threshold and autonomic function in healthy subjects. *Pain* 46: 337-342.
- Noling LB, Clelland JA, Jackson JR, Knowles CJ (1988) Effect of transcutaneous electrical nerve stimulation at auricular points on experimental cutaneous pain threshold. *Physical Therapy* 68: 328-332.
- He W, Jing X, Wang X, Rong P, Li L, et al. (2013) Transcutaneous auricular vagus nerve stimulation as a complementary therapy for pediatric epilepsy: a pilot trial. *Epilepsy & Behavior* 28: 343-346.
- Rong P, Liu A, Zhang J, Wang Y, Yang A, et al. (2013) An alternative therapy for drug-resistant epilepsy: transcutaneous auricular vagus nerve stimulation. *Chin Med J* 127: 300-304.
- Rong P, Liu A, Zhang J, Wang Y, He W, et al. (2014) Transcutaneous vagus nerve stimulation for refractory epilepsy: a randomized controlled trial. *Clin Sci* : CS20130518.
- Fang J, Rong P, Hong Y, Fan Y, Liu J, et al. (2016) Transcutaneous vagus nerve stimulation modulates default mode network in major depressive disorder. *Biological psychiatry* 79: 266-273.
- Shao-Yuan L, Jiao Yue, Rong Pei-Jing, Li Su-Xia, Yu Yu-Tian, et al. (2016) Transcutaneous Vagus Nerve Stimulation for the Treatment of Insomnia Disorder: A Study Protocol for a Double Blinded Randomized Clinical Trial. *J Clin Trials* 6: 2167-0870.
- Lehtimäki J, Hyvärinen P, Ylikoski M, Bergholm M, Mäkelä JP, et al. (2013) Transcutaneous vagus nerve stimulation in tinnitus: a pilot study. *Acta oto-laryngologica* 133: 378-382.
- Kreuzer PM, Landgrebe M, Resch M, Husser O, Schecklmann M, et al. (2014) Feasibility, safety and efficacy of transcutaneous vagus nerve stimulation in chronic tinnitus: an open pilot study. *Brain stimulation* 7: 740-747.
- Straube A, Ellrich J, Eren O, Blum B, Ruscheweyh R, et al. (2015) Treatment of chronic migraine with transcutaneous stimulation of the auricular branch of the vagal nerve (auricular t-VNS): a randomized, monocentric clinical trial. *J Headache Pain* 16: 543.
- Schmitt A, Falkai P (2015) Negative symptoms and therapy strategies in schizophrenia. *Eur Arch psychiatry Clin Neurosci* 265: 541-542.
- Hasan A, Wolff-Menzler C, Pfeiffer S, Falkai P, Weidinger E, et al. (2015) Transcutaneous noninvasive vagus nerve stimulation (tVNS) in the treatment of schizophrenia: a bicentric randomized controlled pilot study. *European archives of psychiatry and clinical neuroscience* 265: 589-600.
- Xiong J, Xue FS, Liu JH, Xu YC, Liao X, et al. (2009) Transcutaneous vagus nerve stimulation may attenuate postoperative cognitive dysfunction in elderly patients. *Medical hypotheses* 73: 938-941.
- Shi C, Flanagan SR, Samadani U (2013) Vagus nerve stimulation to augment recovery from severe traumatic brain injury impeding consciousness: a prospective pilot clinical trial. *Neurol Res* 35: 263-276.