MedCrave
Step into the World of Research
Journal of Anesthesia and Critical Care: Open access

Review Article

Open Access
CrossMark

Physiological effects of acupuncture in the anaesthetic time

Abstract

Introduction: Traditional chinese (Chinese) medicine (TCM) is one of the oldest medical systems in the world. It hypothesizes the existence of many points in the way of channels, where the vital energy (Qi) flows. These points have therapeutic actions and many of them can be used in the anaesthetic time to improve the perioperative patient management.

Materials and methods: A bibliographic research was conducted to identify the evidence based of acupuncture benefits during the anaesthetic time and the physiological mechanisms implicated in these actions.

Results and discussion: The main areas where acupuncture showed evidence based benefits during the anaesthetic time were anxiety, sedation, hypnosis, analgesic requirements and nausea and vomiting. Almost all these actions are mediated by the nervous system and chemical substances such as endogenous opioids and some neurotransmitters.

Despite the great knowledge it has been reached in this review on the basic mechanisms that explain actions of acupuncture during anaesthesia, more studies are needed to allow us to know in detail and precision the physiological mechanisms and the structures involved.

Conclusion: The understanding of the mechanisms underlying the actions of acupuncture during anaesthesia has advanced greatly in recent years, however more studies are needed to identify them more precisely.

Keywords: acupuncture; anaesthesia; perioperative; pain; nausea

Volume 12 Issue 5 - 2020

Diego Díaz Rodríguez,[1] Carmen Sánchez Blanco,[2] Bartolome Fernández Torres[3]

[1]Anaesthesiology, Reanimation and Pain Management Department, Complexo Hospitalario Universitario de A Coruña, Spain

[2]Anaesthesiology, Reanimation and Pain Management Department, Hospital Universitario Virgen Macarena de Sevilla, Spain

[3]Anaesthesiology, Reanimation and Pain Unit" Hospital Universitario Virgen Macarena de Sevilla, Spain

Correspondence: Bartolomé Fernández Torres, Anaesthesiology, Reanimation and Pain Management Department, Hospital Universitario Virgen Macarena de Sevilla. Associated Professor, Medicine Faculty. University of Seville. Spain. Tel (+34) 981 178 152, Email diegodiazrodriguez@gmail.com

Received: December 05, 2020 | **Published:** December 14, 2020

Introduction

Traditional Chinese medicine (TCM) is one of the oldest medical systems in the world.[1] It's considered a complementary and alternative medicine whose coherent system of thought and practice began over 4000 years ago.[2] Human being is considered an integrated oneness in Nature and TCM studies the interaction between the different parts of the human body by synthesis and analysis and its relationship to the surrounding environment.[3]

TCM hypothesizes the existence of a Vital Energy (Qi) that travels through the body via channels or meridians, alone or with other basic substances like Xue (blood), Jing (essence) and Jin Ye (organic liquids). These channels promote the relationship between the different organs and parts of the body (Zangfu theory). Qi regulates spiritual, emotional, mental and physical balance, and it is affected by the opposing forces of yin and yang. According to traditional Chinese medicine, the disease occurs when the flow of Qi changes, producing an imbalance.[4]

The 5 basic elements of nature (wood, fire, earth, metal and water) have a number of features, relations and pathophysiological mechanisms (wuxing theory), that may explain the changes in the flow of Qi, causing some different diseases.[5] Each organ has its own functions; the presence of some internal, external or constitutional agents and the way of life may promote the onset of diseases.[6]

Symptoms and signs presented by patients are organized into Syndromes which are classically treated by acupuncture, moxibustion and herbal therapy. Acupuncture involves the introduction of a needle at points located in the path of the meridians (acupoints), to reach the sensation called "De Qi" and achieve therapeutic actions whose ultimate goal is to cure the disease syndrome of the patient.[7] When an electric current is applied to the handle of the needle, the accomplished therapeutic action may be greater; this therapy is known by the name of electroacupuncture.[8] Another variants of classical acupuncture may be: homeosiniatry, injection of homeopathic substances in the acupoints; and laser stimulation, application of a laser light on these points.

In addition to the points in channels, we have another extra acupoints with specific localizations. All acupoints, besides its therapeutic actions in restoring the internal balance of the basic substances, may also have specific clinical applications once stimulated; for example, the yin tang point stimulation produces hypnosis.[9]

Anaesthesiology is defined as the medical specialty concerned with the attention and care of patients during surgery and other processes that may be uncomfortable or painful. For this, the anaesthesiologist must developed several medical procedures intended to achieve the following objectives:

1. Analgesia or pain abolition.
2. Protection of the body homeostasis against adverse reactions caused by surgical invasion, maintaining vital functions of the patient in a physiological range.
3. Hypnosis, in general anaesthesia or sedation, in loco-regional anaesthesia.
4. Neuromuscular blockade to get immobility and minimized resistance to cavities opening.

In order to carry out these objectives, the anaesthetic act takes place in three well distinguished phases:

- Preoperative time, when the assess to patient's clinical status prior to the anesthetic-surgical procedure takes placed.

- Intraoperative time when all the medicals procedures are applied to allow the develop of surgery. It is divided into: induction, maintenance and eduction, with different clinical times depending on type of surgery, anaesthesia technique and individual patient characteristics.
- Postoperative time, when standard cares or critical cares are carried out after surgery (depending on the type of surgery or the situation of patients).[10]

These procedures are performed by a variety of medical actions in conventional medicine. In the middle of the last century, in China, they started to do some surgeries under acupuncture anaesthesia exclusively. The first surgeries performed by this method were tonsillectomy, pneumonectomy and cholecystectomy. They wore on without incidents but were technically complex, because of the large number of needles needed.[11] The combination of acupuncture techniques with the commonly used in conventional anaesthesiology may offer us another weapon to improve outcomes and minimize complications during the anaesthetic acts.[12-14]

These acupuncture actions have a physiologic substrate which explains these clinical phenomena.[15] In this review we try to explain the scientific evidence that can explain these actions, since a clinical point of view to a physiological one.

Material and methods

To conduct this review a literature research was conducted in the electronic database Medline through PubMed search interface with the key terms "anaesthesia" "acupuncture" and "perioperative", getting 3751 articles. When the search is restricted to reviews and clinical trials in humans, published in English, Spanish or German, the total findings are reduced to a total of 617 items. Once reviewed and limited to those published in the past 10 years and excluded those who were not focused on the anaesthesiologist act, we obtained a total of 39 items, which we used to introduce in the clinical benefits of acupuncture in the anaesthesiology (Figure 1).

Once having identified the contribution of acupuncture to conventional anaesthesiology, an individualized search was performed using all means at our disposal, trying to demonstrate the pathophysiological mechanism that may justify it, using all the bibliographic resources available. We have also used other materials whose relevance has seemed of special interest, such as traditional books, abstracts of articles in different languages than those mentioned and systematic reviews like the Cochrane Database of Systematic Reviews.

Results and discussion

Once revised selected articles we could identify those areas where there is scientific evidence on acupuncture action during anaesthesia. These areas were: hypnosis, intraoperative opioid needed, postoperative pain, postoperative nausea and vomiting, hypothermia/shivering, perioperative anxiety, postoperative ileo and perioperative autonomic disfunction.[12-14]

Hypnosis and perioperative anxiety

Two of the main goals of preoperative acupuncture application are to achieve a reduction of the anxiety and to get hypnosis or sedation in patients who undergo an anaesthesia procedure. The reviewed studies suggest a positive effect of acupuncture to achieve these "objetives" (Table 1). This action has been demonstrated in studies with healthy volunteers; they were measured parameters as hypnotic depth entropy or bispectral index (BIS), observing an absolute decrease since the first minute[18]. A reduced in anaesthetic requirements to get an enough level of hypnosis to prevent movement to painful stimulus was not observed.[22] But studies with patients (non healthy people) could show these phenomena,[21] as well as lower scores on anxiety scales after the application of acupuncture.[20] The most commonly accupoints used in these trials were: Shenting (GV 24), Yintang (Ex.1), Sedative Point 1 (Ex. 8), Sedative Point 2 (Ex. 9), Shenmen (HE 7), Hegu (LB 4) and Zusanli (ST 36).

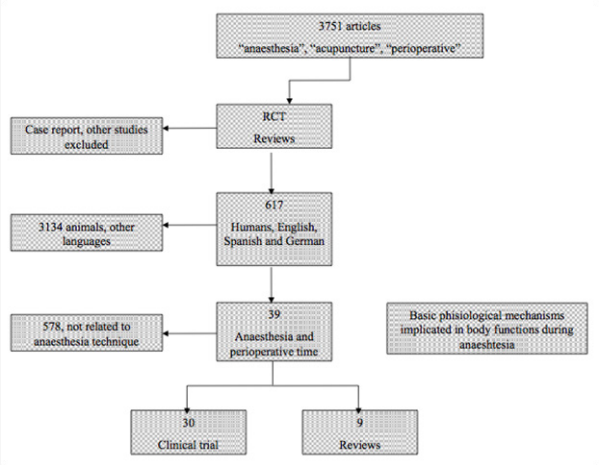

Figure 1

Table 1 Acupuncture and hypnosis

Trial	N	Effect	SS
El-Rakshy[16]	107	No differences with control	-
		Anxiety reduction	+
Wang[17]	52		
		No impact BIS values	-
Fassoulaki[18]	12	BIS reduction values	+
Litscher [19]	9	Entropy values	+
Gioia[20]	75	Anxiety reduction	+
Dong[21]	60	Lower anesthetic requeriments	+
Chernyak[22]	13	No lower anesthetic requeriments	-
Resim[23]	35	Sedation	-

SS +: Statistical significance; SS - : No statistical significance

It is necessary to understand the effects happened in central nervous system after the stimulation of these points, to comprehend the physiological mechanisms of preoperative acupuncture. In TCM Zangfu theory suggests that sleep is a function of the "Shen", which is controlled by the heart. Acupuncture tries to regulate heart function, and so, to normalize the "Shen" and to induce sleep in a physiologically way.[24]

Experimental studies have demonstrated that the stimulation of these accupoints modify brain contents of norepinephrine, dopamine, serotonin, gamma amino butiric acid (GABA) and melatonin:

- Hypothalamic-pituitary-adrenal axis is an important neuroendocrine system involved in the regulation of sleep. The balance of this neurotransmitters caused by acupuncture participates in the hypnosis during anaesthetic acupuncture inductions.

Citation: Díaz Rodríguez D, Sánchez Blanco C, Fernández Torres B. Physiological effects of acupuncture in the anaesthetic time. *J Anesth Crit Care Open Access.* 2020;12(5):185–191. DOI: 10.15406/jaccoa.2020.12.00458

- GABA is an important neuro-mediator in sleep regulation. There are studies which have shown that acupuncture increases significantly levels of GABA and up-regulates the expression of GABA (A) receptors in hypothalamic neurons in rats.
- Melatonin is a hormone with an important paper in circadian rhythm of sleep-wake cycle regulation. In a clinical trial, anxious patients underwent an increased in nocturnal melatonin secretion during 5 weeks after acupuncture treatment.[25]

Other experimental studies using imaging techniques such as magnetic resonance image (MRI), have demonstrated certain brain areas activation during the stimulation of these points, which must be involved in hypnosis process and anxiolysis.[26] These areas are mainly frontal lobe, cingulate gyrus and cerebellum.[27] Although the reduction of anaesthetic requirements for hypnosis was not clinically relevant,[12] a new interesting path is opened to minimize doses, reducing the possibility of adverse effects and the duration of drugs action.[13]

Reduction in analgesic requirements

The analgesic effects of acupuncture will be manifested in a reduction in perioperative pain and opioids or other analgesic requirements during anaesthesia.[12,13] There are multiple studies and reviews in which a favourable analgesic effect of acupuncture is collected. Although these papers cannot conclude to have statistical significance, the clinical relevance must be highlighted (Table 2). The most common accupoints used in these trials were Hegu (LI 4), Jiache (ST 6), Xiaguan (ST 7), Hanyan (GV 4), Zusanli (ST 36) and ashi points. The TCM explains that after a surgical aggression, the balance of human body is altered, causing a disruption in the flow of Qi, Xue and other basic substances. This disruption causes pain itself, and the organic dysfunction generated in the zangfu[38,39] (Figure 2).

Table 2 Acupuncture and analgesia

Trial	N	Effect	SS
Sahmeddini[28]	90	No differences with control	-
Wu[29]	60	Reduction postoperative analgesia	+
El-Rakshy[16]	107	No differences with control	-
Tavares[30]	24	Lower postoperative pain and analgesia requirements	+
Sauberer[31]	113	No reduction pain intensity and analgesic consumption	-
Usichenko[32]	120	Reduction analgesic requeriment	+
Likar[33]	113	Reduction postoperative pain and analgesic consumption	+
Usichenko[34]	60	Less intraoperative opioid requirements	
Wong[35]	27	Lower postoperative opioid requeriments	+
Pohodenko[36]	120	Postoperative pain reduction	
Katzenschlager[37]	94	Lower intraoperative opioid requeriment	+
Resim[23]	35	Lower postoperative pain intensity	-

SS +: Statistical significance; SS - : No statistical significance

The physiological mechanisms involved in the analgesic role of acupuncture have been studied for several decades. Initially, researchers began to consider the possibility that acupuncture analgesia was related to the endogenous opioid system (EOS), and they conducted interesting experiments trying to show the chemical substances which produced analgesia. They supposed that it could be a neurotransmitter or an opioid agent as they realized that some of this analgesia components were inhibited by naloxone but not others. Then, several groups started studying the physiological mechanisms of acupuncture analgesia, in parallel to the study of the pathways implicated in painful experience production.[40,41] Nowadays, we already know that endogenous opioids (enkephalins, endorphins and dynorphins) and monoamines (serotonin, dopamine and norepinephrine) are involved, and how they organize to provide analgesia.[18,40,42]

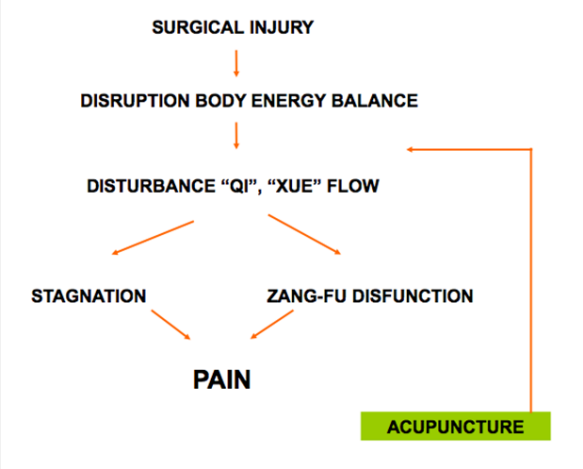

Figure 2 Pain pathophysiology in TCM.

The insertion of an acupuncture needle at skin will lead to a variety of phenomena in several parts of the body: near to the needle (peripheral phenomena), in spinal cord structures and in supraspinal centres in the central nervous system (CNS).[43]

- Peripheral phenomena; needle introduction causes changes in nearby structures with redness and vasodilation due to axonal reflexes. The needle stimulates Aδ and/or C fibres and causes the release of vasoactive neuropeptides with pro-inflammatory/anti-inflammatory properties: calcitonine gene-related peptide (CGRP), substance P (PS), neurokinin A (NKA), opioids, galanin, somatostatin and vasoactive intestinal peptide (VIP). These peptides usually maintain the balance between pro-inflammatory/anti-inflammatory events, leading to an increase blood flow that allows the arrival of new antinociceptive substances (AS) and some others that can motivate the release of more AS through new inflammatory phenomena, which will have analgesic actions by themselves (PS, opioids, neurokinin A, etc). Many of these AS can remain several days and generate an increase in the synthesis of receptors in some other structures involved in nociceptive conduction, and in their own area of dichotomous innervation.[44]
- Spinal cord antinociceptive events; can be explained by the gate control theory, the propriospinal inhibition and the long-term hyperpolarization phenomena in the wide range dynamic neurons located in the dorsal horn of spinal cord.

The acupuncture needle stimulates Aβ, Aδ and C fibres. The nociceptive fibres are Aδ and C, which are slower than Aβ. The Aβ information arrives before to the dorsal horn and stimulates inhibitory interneurons in lamina V, leading to a hyperpolarizing effect on the projective neuron to supraspinal centres. So, when nociceptive information reaches this neuron, which is hyperpolarized, its ability to

convey this information is impaired, getting the antinociceptive effect (Figure 3). These inhibitory interneurons are not only activated by peripheral fibres to a noxious stimulus; they receive influence of other neural structures from spinal and supraspinal level. The balance of these afferents can determine their state, tending to hyperpolarization what difficult the transmission of nociceptive information, or to despolarization what facilitates it. These neuronal plasticity phenomena seem to have a great role to understand the analgesic mechanisms of acupuncture and its permanence in time beyond the period of stimulation. And they can also occur at supraspinal level.

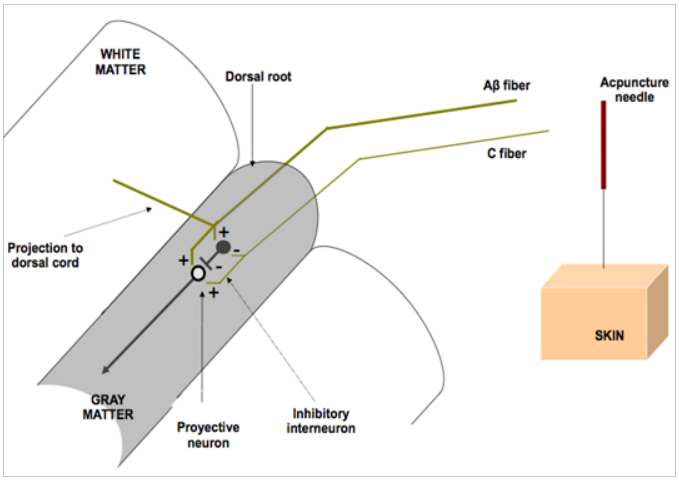

Figure 3 Spinal action after acupuncture.

There are propriospinals intersegmental connections on these neural networks too, whose activation can justify analgesic actions secondary to other spinal level stimulation.[44,45]

- Supraspinal centres. There are several supraspinal structures (greater raphe nucleus, periaqueductal gray area, nucleus reticularis paragiganto-celullaris and locus ceruleus) that send connections across rafespinal paths to the interneurons in the dorsal horn that can modify the nociceptive information input. This system is known as the descending inhibitory system, and has a great importance in the genesis of acupuncture analgesia. Other systems that play an important role in the analgesic action of acupuncture have been identified: the diffuse nociceptive system, the autonomous system, the neuroendocrine nervous system and other cortical complex mechanisms such as the placebo effect or other psychological phenomena (its believed they may be GABA and NMDA receptors related).[40,44,46]

Experimental studies with laboratory animals have revealed that acupuncture application can inhibit the production of superoxide anions, which act as modulators for the activation of microglial cells in CNS. In this way, one of the main mechanisms that promotes the development of chronic postoperative pain (CPP) is blocked. This subject is very important, because the incidence of CPP is increasing nowadays, mainly in patients with high levels of acute postoperative pain, due to central sensitization phenomena.[43,47,48]

The implication of these structures has been demonstrated at the biochemical level and by imaging studies of MRI. This is one of the most promising techniques in the understanding of the biological basis of acupuncture. But the wide variability of factors that can affect the interpretation of the results, makes necessary a consensus to further develop studies to enrich our knowledge.[49,50]

Reduction de postoperative nausea and vomiting incidence

Most published studies endorse a preventive effect of acupuncture in the development of postoperative nausea and vomiting (PONV), as well as a beneficial effect in their treatment (Table 3). This coupled with the fact that the treatments are safe, efficient, non-invasive and without adverse effects, and can be taught easily for the patient or the family members, makes it a good treatment option. The TCM explains the PONV like a disruption in normal Qi and Xue flow, as a consequence of the surgical act (Figure 4). Acupuncture restores the normal stomach Qi flow preventing and treating PONV. More than 30 classic meridian points have been identified to reduce PONV; the most used in these studies were Zusanli (ST 36) and Neiguan (PC 6).

Table 3 Acupuncture and postoperative nausea and vomiting (PONV)

Trial	N	Effect	SS
Sahmeddini[28]	90	Lower PONV incidence	+
El-Rakshy[16]	107	No differences with control	-
Sahmeddini[51]	100	Lower PONV incidence	+
Zheng[52]	60	Lower PONV incidence	
Arnberger[53]	220	Lower PONV incidence	+
Ho[54]	110	Lower PONV incidence	-
Butkovic[55]	120	Lower PONV incidence	+
White[56]	105	Lower PONV incidence	+

SS +: Statistical significance; SS - : No statistical significance

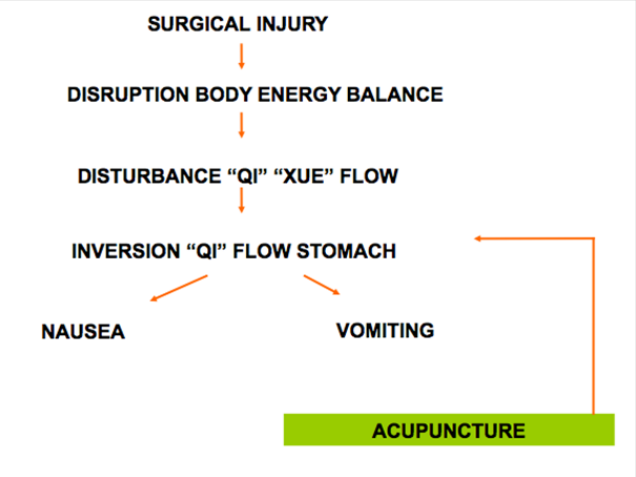

Figure 4 Nausea and vomiting pathophysiology in TCM.

To understand how acupuncture can prevent and treat PONV, we must know the pathophysiological mechanism of its development. CNS and gastrointestinal tract are both involved in the control of PONV. CNS receives inputs from the peripheral sensors and cerebral cortex, then integrates these information and activates the autonomic nervous system and motor fibres of the gastrointestinal tract to produce nausea and vomiting (NV). There are two areas implicated in the development of NV in the CNS: the chemoreceptor trigger zone (CTZ), and the vomiting centre (VC):

- CTZ is located in the postrema area in the floor of the fourth cerebral ventricle. As it is not protected by the blood-brain barrier, chemical substances and neurotransmitters from blood

and cerebrospinal fluid can stimulate it (dopamine, serotonin, opioids and some anaesthetic agents). It is connected with VC by the fasciculus solitarius.

- VC is comprised by three nuclei: tractus solitarius nucleus, the dorsal motor nucleus of the vagus and the ambiguous nucleus. It is located within the dorsal lateral reticular formation of the medulla oblongata. This centre can be activated by smell and physiological stresses such: pain, anxiety and sensorial overloads. It receives the afferent inputs from CTZ, cerebral cortex, labyrintho-vestibular centre and autonomic nervous system from the medulla. When the vomiting centre is triggered, motor impulses are transmitted through several cranial nerves (trigeminal, facial, glossopharyngeal, vagus and hypoglossal nerves) to spinal nerves, which activate the diaphragm and abdominal muscles producing vomiting.[57]

When acupuncture is applied, two mainly phenomena occur:

- Afferent type I and II nerve fibbers are stimulated and inputs are send to spinal cord, releasing endorphin at this level.
- These inputs are conducted to the periaqueductal gray area in the midbrain and encephalin is released. The encephalin cause the liberation of monoamine neurotransmitters, serotonin and norepinephrine, changing their transmission. This stimulation can release B-endorphins and adrenocorticotropic hormone into the bloodstream and CSF, from the pituitary gland.[57]

Opioids have a dual action: an emetic effect when they act in the CTZ area, and an antiemetic effect when they act in VC.[58] Acupuncture gets a balance between these two actions to avoid PONV; this antiemetic effect of acupuncture can be suppressed after naloxone hydrochloride administration. Furthermore, acupuncture can reduce the frequency of retrograde propulsive vasopressin induced by movements, that also may cause NV.[58]

Decreasing the hypothermia and shivering

We have located only one paper that included 80 patients with postoperative shivering (PS) treated with acupuncture. The points used in this trial were Zusanli (ST 36) and Shangjuxu (ST 37). They observed a smaller decrease in perioperative tympanic temperature, a lower incidence of postoperative tremors and less severity of them compared to control. The main cause of postoperative shivering is hypothermia and the attempt of human body to recalibrate the temperature to a higher level than real. The authors explain that stimulation of ST 36 point can facilitate the preservation of internal body heat because it can cause peripheral vasoconstriction, mediated by autonomic nervous system. This vasoconstriction can prevent the heat loss and avoid shivering.[59]

Descreasing the postoperative ileo

Although the study founded did not show a beneficial effect of acupuncture on postoperative peristalsis recovery [60], it had been found another previous trial in which stimulation of ST 36 was associated with an earlier recovery of peristalsis.[61] The acupuncture at ST-36 point can stimulate the parasympathetic activity and inhibits sympathetic activity under stressful conditions, resulting in the restoration of impaired digestive motility.[58,62] There are experimental studies that have shown a decrease of inflammatory cholinergic pathway mediators after peritoneal aggression in rats treated with acupuncture techniques. It is believed that it could have an important role in preventing adhesion formation[63] and perhaps, in restoration of postoperative ileo.

Compensation of the perioperative autonomic disfunction

There is a work that highlights the role of electrical stimulation to certain frequencies at acupuncture points Jianshi (5PC) and Neiguan (6PC) to attenuate the hypotensive response associated with sympathetic blockade coupled with neuroaxial anaesthesia.[64] These actions can be explain studying the action of acupuncture in CNS. There are several regions in CNS that receive somatic inputs during acupuncture (arcuate nucleus, paraventricular nucleus, ventrolateral periaqueductal gray, tractus solitari nucleus, rostral ventrolateral medulla, medullary raphe and ambiguous nucleus in the medulla as well as the dorsal horn and intermediolateral columns of spinal cord). When the acupuncture is developed, neurons in these regions are activated through a network of projections that use inhibitory neurotransmitter mechanisms, including opioids, GABA, nociceptin or serotonin. These neurotransmitters act postsynaptically, either directly or indirectly, to modulate autonomic outflow. So, using acupuncture basal autonomic tone can be modify and hence, arterial blood pressure, heart rate and other autonomic functions with interest during the anaesthetic time.[65] It is important to note that despite having identified the clinical advantages of acupuncture during anaesthesia, and having identified the underlying neurobiological mechanisms of these actions, there are approximately a 30% of patients who do not respond to therapy although the technique is correctly developed. The hypo or non-responsiveness to acupuncture could be related to unsatisfactory actions of several of the modulatory neurotransmitter systems, opioids, GABA and others, each of which contributes to prolonged actions of this stimulus. Sometimes these unsatisfying actions occur because of the presence of other substances, which antagonize the opioids actions like cholecystokinin.[65]

Conclusion

In conclusion, it is remarkable that the understanding of basic physiological mechanisms that may explain the beneficial effects of acupuncture is very important to advance the knowledge of acupuncture mechanisms. This information will allow to continue expanding the clinical applications of acupuncture, not only in anaesthesiology field, but in many other medical and surgical disciplines that can benefit with them. Despite the low evidenced because of the lack of randomized controlled trials, the positive effects of acupuncture during the perioperative period have been enough found in different studies. The understanding of the mechanisms underlying these actions has advanced greatly in recent years, however more studies are needed to identify them more precisely.

Disclosure policy

The autors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Discourse of Dra Margaret Chan, Director-General of the World Health Organization (WHO), Address at the WHO Congress on Traditional Medicine, in Beijing (People's Republic of China) in 2008.
2. Cobos R, Bases teóricas. In Cobos R. and Vas J. Manual de Acupuntura y Moxibustion (libro de texto). 1º Ed. Beijing: Morning Glory, 2000;23–25.
3. Cobos R. Otra forma de ver las cosas. In Cobos R. and Vas J. Manual de Acupuntura y Moxibustion (libro de texto). 1º Ed. Beijing: Morning Glory, 2000;27–34.

4. Cobos R. Teoría de los Zangfu. In Cobos R. and Vas J. Manual de Acupuntura y Moxibustion (libro de texto). 1º Ed. Beijing: Morning Glory, 2000;723–771.
5. Maciocia G. Los cinco elementos. In Maciocia G. Los fundamentos de la medicina china. Un texto de consulta para acupuntores y fitoterapeutas. 2º Ed. Portugal: Aneid Press, 2007;15–35.
6. Maciocia G. Las causas de enfermedad. In Maciocia G. Los fundamentos de la medicina china. Un texto de consulta para acupuntores y fitoterapeutas. 2º Ed. Portugal: Aneid Press, 2007;129–144.
7. Zhang S. Is Deqi an indicator of clinical efficacy of acupuncture? A systematic review. Evidence-Based Complementary and Alternative Medicine. 2013:15.
8. Zhang R. Mechanisms of Acupuncture-Electroacupuncture on persistent pain. *Anesthesiology.* 2014;120(2): 482–503.
9. Hecker HU. Puntos de acupuntura. In Hecker HU, Steveling A, Peuker ET, Kastner J. Acupuntura. 1º Ed. Mexico: El Manual Moderno, 2007;25–38.
10. Orkin FK. Ámbito de la práctica anestésica moderna. In Miller RD. Miller Anestesia. 6º Ed. Madrid: Elsevier, 2005;55–66.
11. Chai-Hsi. Descubrimiento y desarrollo de la acupuntura anestésica. In Chai-Hsi EL. Acupuntura anestésica. 1º Ed. Barcelona: Bellaterra, 2006;17–27.
12. Lee A. Acupuncture and anaesthesia. *Best Practice & Research Clinical Anaesthesiology.* 2006;20(2):303–314.
13. Chernyak G. Perioperative acupuncture and related techniques. Anesthesiology. 2005;102:1031–1049.
14. Liodden I. Acupuncture and related techniques in ambulatory anesthesia. *Curr Opin Anesthesiol.* 2013;26:661–668.
15. Yang ES. Ancient Chinese medicine and mechanistic evidence of acupuncture physiology. *Eur J Physiol.* 2011;462:645–653.
16. El-Rakshy M. Effect of intraoperative electroacupuncture on postoperative pain, analgesic requirements, nausea and sedation: a randomised controlled trial. *Acupunct Med.* 2009;27 (1):9–12.
17. Wang SM. Extra-1 acupressure for children undergoing anesthesia. *Anesth Analg*. 2008;107:811–816.
18. Fassoulaki A. Acupressure on the Extra 1 acupoint: the effecto on Bispectral Index, Serum Melaonin, Plasma β-Endorphin, and Stress. *Anesth Analg.* 2007;104:312–317.
19. Litscher G. Electroencephalogram-Entropy and Acupuncture. *Anesth Analg.* 2006; 102:2745–2751.
20. Gioia L. Sedative effect of acupuncture during cataract surgery. *J Cataract Refract Surg.* 2006;32:1951–1954.
21. Dong QL. Effect of general anaesthesia with combination of acupuncture and enflurane applied in radical operation of laryngocarcinoma. *Chin J Integr Med.* 2006;12(4):306–309.
22. Chernyak G. The timing of acupuncture stimulation does not influence anesthetic requirement. *Anesth Analg.* 2005;100(2):387–392.
23. Resim S. Effectiveness of electro-acupuncture compared to sedo-analgesics in relieving pain during shockwave lithotripsy. *Urol Res.* 2005;33(4):285–290.
24. Maciocia G. Las funciones del corazón. In Maciocia G. Los fundamentos de la medicina china. Un texto de consulta para acupuntores y fitoterapeutas. 2º Ed. Portugal: Aneid Press, 2007;67–69.
25. Zhao K. Acupuncture for the treatment of Insomnia. *International Review of Neurobiology.* 2013;111:217–234.
26. Zhang WT. Evidence from brain imaging with fMRI supporting functional specifity of acupoints in humans. *Neuroscience Letters.* 2004;354(1):50–53.
27. Zheng Y. Post-stimulation effect of electroacupuncture at Yintang (Ex-HN3) and GV20 on cerebral functional regions in healthy volunteers: a resting functional MRI study. *Acupunct Med.* 2012;30(4):307–315.
28. Sahmeddini MA. Electroacupuncture for pain relief after nasal septoplasty: a randomized controlled study. *J Altern Complement Med.* 2010;16(1):53–57.
29. Wu HC. Effects of acupuncture on post-cesarean section pain. *Chin Med J.* 2009;122(15):1743–1748.
30. Tavares MG. Electo-acupuncture efficacy on pain control after mandibular third molar surgery. *Braz Dent J.* 2007;18(2):158–162.
31. Michalek-Sauberer A. Perioperative auricular electroacupuncture has no effect on pain and analgesic consumption after third molar tooth extraction. *Anesth Analg.* 2007;104:542–547.
32. Usichenko TI. Auricular acupunture for pain relif after ambulatory knee surgery: a randomized trial. CMAJ 2007;176(2):79–83.
33. Likar. Electrical point stimualtioin (P-STIM) via ear acupuncture: a randomized, double-blind, controlled pilot study in patients undergoing laparoscopic nephrectomy. Schmerz. 2007;21(2):154–159.
34. Usichenko TI. Auricular acupuncture reduces intraoperative fentanyl requirement during hip arthroplasty- a randomized double-blinded stydy. *Aucupunct Electrother Res.* 2006;31(3-4):213–221.
35. Wong RHL. Analgesic effect of electroacupuncture in postthoracotomy pain: a prospective randomized trial. *Ann Thorac Surg.* 2006;81(6):2031–2036.
36. Pohodenko-Chudakova I. Acupuncture analgesia and its application in cranio-maxilofacial surgical procedures. *Journal of Cranio-Maxiollofacial Surgery.* 2005;33(2):118–122.
37. Sator-Katzenschlager SM et al. Auricula electro-acupuncture as an additional perioperative analgesic method during oocyte aspiration in IVF treatment. *Hum Reprod.* 2006;21(8):2114–2120.
38. Kelly RB. Acupuncture for pain. *Am Fam Physician.* 2009;80(5):481–484.
39. Pelin S. Etiología y patología del dolor. In Peilin S. Tratamiento del dolor con fitoterapia china y acupuntura. 2º Ed. Barcelona: Masson, 2012;10–20.
40. Han JS. Acupuncture and endorphins. *Neuroscience letters.* 2004;361(1-3):258–261.
41. How does acupuncture work?. Brithish Medical Journal. 1981;283:746–748.
42. Chang SL. Involvement of serotonin in the hypoglycemic response to 2 Hz electroacupuncture at zusanli acupoint (ST36) in rats. *Neurosci Lett.* 2005;379(1):69–73.
43. Díaz D. Neuropathic pain and acupuncture. Scientific evidence of its effectiveness. Rev Int Acupuntura. 2013;7(4):109–118.
44. Carlsson C. Acupuncture mechanisms for clinically relevant long-term effects–reconsideration and a hypothesis. *Acupuncture in Medicine.* 2002;20(2–3):82–99.
45. Wang SM. Acupuncture Analgesia: II. Clinical considerations. *Anesth Analg.* 2008;106(2):611–621.
46. Cobos R. Acupuntura, electroacupuntura, moxibustión y técnicas relacionadas en el tratamiento del dolor. *Rev Soc Esp Dolor.* 2013;20(5):263–277.
47. Choi DC. Inhibition of ROS-induced p38 MAPK and ERK activation in microglia by acupuncture relieves neurophatic pain after spinal cord injury in rats. *Exp Neurol.* 2012;236(2):268–282.

48. Blichfeldt-Eckhardt MR. Early visceral pain predicts chronic pain after laparoescopic cholecystectomy. *Pain.* 2014.

49. Takamoto K. Effects of acupuncture needling with specific sensation on cerebral hemodynamics and autonomic nervous activity in humans. *International Review of Neurobiology.* 2013;111:25–48.

50. Pérez A. Functional magnetic resonance imaging and acupuncture. *Rev Int Acupuntura.* 2013;7(4):119–123.

51. Sahmeddini MA. Does auricular acupuncture reduce postoperative vomiting after cholecystectomy? J *Altern Complement Med.* 2008;14(10):1275–1279.

52. Zheng LH. Effect of transcutaneuous electrical acupoint stimulation on nausea and vomiting induced by patient controlled intravenous analgesia with tramadol. *Chin J Integr Med.* 2008;14(1):61–64.

53. Arnberger M. Monitoring of neuromuscular blockade at the P6 acupuncture point reduces the incidence of postoperative nausea and vomiting. *Anesthesiology.* 2007;107(6):903–908.

54. Ho CM. P6 acupressure does not prevent emesis during spinal anesthesia for cesarian delivery. Anesth Analg. 2006;102(3):900–903.

55. Butkovic. Comparison of laser acupuncture and metoclopramide in PONV prevention in children. *Paediatr Anaesth.* 2005,15(1):37–40.

56. White PF. Optimal timing of acustimulation for antiemetic prophylaxis as an adjunct to ondansetron in patients undergoing plastic surgery. *Anesth Analg.* 2005;100(2):367–372.

57. Nunley C. The effects of stimulation of acupresure point P6 on postoperative nausea and vomiting: a review of literature. *Journal of perianesthesia nursing.* 2008;23(4):247–261.

58. Takahashi T. Effect and mechanisms of acupuncture on gastrointestinal diseases. *International review of neurobiology.* 2013;111:273–294.

59. Yeh BY. Effect of electroacupuncture in postanesthetic shivering during regional anesthesia: a randomized controlled trial. *BMC Complementary and Alterantive Medicine.* 2012;12:233.

60. Meng ZQ. Electro-acupuncture to prevent prolonged postoperative ileus: a randomized clinical trial. *World J Gastroenterol*. 2010;16(1):104–111.

61. Wan Q. Auricular plaster therapy plus acupuncture at zusanli for postoperative recovery of intestinal function. *J Tradit Chin Med.* 2000;20(2):134–135.

62. Takahashi T. Mechanism of acupuncture on neuromodulation in the gut–a review. *Neuromodulation.* 2011;14(1): 8–12.

63. Zhang L. Inhibiting effect of electroacupuncture at zusanli on early inflammatory factor levels formed by postoperative abdominal adhesions. Evidence based complementary and alternative medicine. 2014.

64. Young-Chang PA. TENS on the PC-5 and PC-6 points alleviated hypotension after epidural anesthesia, depending on the stimulus frequency. Evidence based CAM. 2012;727121.

65. Longhurst JC. Acupuncture regulation of blood pressure: two decades of research. International review of neurobiology. 2013;111:257–271.

Citation: Díaz Rodríguez D, Sánchez Blanco C, Fernández Torres B. Physiological effects of acupuncture in the anaesthetic time. *J Anesth Crit Care Open Access.* 2020;12(5):185–191. DOI: 10.15406/jaccoa.2020.12.00458