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# Research Progress on the Mechanisms of Acupoint Catgut Embedding and Related Materials

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**Abstract:** ***By searching in China Knowledge Network, PubMed, with the search time from September 2014 to September 202, and by using "acuoint catgut embedding" as the key words in English, a of more than 3000 documents were retrieved in the past 10 years. By summarizing and analyzing, it was found that among the many methods acupuncture, acuoint catgut embedding therapy has the advantages of long stimulation time, less treatment times and wide clinical application. In recent years, the and innovation of embedded materials have been continuing, and it is expected to play a similar role as the previous sheep intestinal thread in the treatment of diseases, which can the treatment of part of the patients who are allergic to sheep intestinal thread. The mechanism of the material of acuoint catgut embedding is also very important the development of new high molecular acuoint catgut embedding materials. This article will discuss the introduction of high molecular acuoint catgut embedding materials, research, and the application of new embedding materials, etc., so as to provide ideas for the development and selection of new acuoint catgut embedding materials mechanism research in the future.***

**Keywords:** Acupoint embedding, Mechanism research, New materials, Hydrogel**.**

## 1. Introduction

Among various acupuncture techniques, acupoint catgut embedding therapy offers advantages such as prolonged stimulation, reduced treatment frequency, and broad clinical applicability. In recent years, the exploration and innovation of embedding materials have advanced significantly, aiming to develop alternatives to traditional catgut sutures for patients with allergies while maintaining therapeutic efficacy. Therefore, investigating the mechanisms of acupoint embedding materials is critical for advancing novel polymer-based materials. In this paper, we will discuss the mechanism research, and application of new types acuoint catgut embedding, providing insights for the development and selection of new types of acupoint embedding materials and mechanism research in the future.

Acupuncture point embedding theory provides guidance for the formation of Acupoint Stimulation Therapy. The therapy is based on the theory of acupuncture and moxibustion, through the stimulation of meridians and collaterals, harmonization of qi and blood, balancing yin and yang, regulating internal organs, so as to achieve the purpose of treating acute, chronic and intractable diseases. Sheep intestinal thread is one of the most widely used acupoint embedding materials in clinical practice, however, its lack of functional characteristics such as drug-carrying properties and magnetic responsiveness leads to limited utilization of the material and possible allergic reactions in some patients. Therefore, the development and application of other polymer materials as embedded wire materials has a broad application prospect. At the same time, the mechanism research and material development of acupoint buried wire should complement each other, and the mechanism research provides the theoretical basis for material development and promotes the mutual promotion of the two.

## 2. Acupoint Buried Line Material Requirements

Acupuncture point buried wire materials usually use biodegradable materials, these materials through a variety of physical and chemical factors, can continue to stimulate the acupoints, so as to regulate the meridian qi and blood, to achieve the purpose of relieving diseases [1]. According to the source of the material, buried wire materials can be categorized into natural and synthetic materials. Natural materials should have physical properties and chemical structures similar to the tissue to be buried to ensure their adaptability and biocompatibility in the body [2]. In contrast, synthetic materials are cost-effective and their physical properties can be adjusted to meet the various requirements of acupoint embedding. However, most synthetic materials lack certain functional characteristics, such as self-expansion, antimicrobial activity, and growth-promoting effects [3]. In addition, many embedded wire materials are usually hydrophobic, limiting the ability of cell adhesion and spreading, so when selecting appropriate embedded wire materials, it is important to consider whether the material properties need to be modified to enhance their functionality and biological effects.

## 3. Common Types of Acupuncture Point Embedding Materials

Currently, commonly used acupoint buried wire materials include polylactic acid (PLLA), polycaprolactone (PCL), polyglycolic acid (PGA), and polylactic acid-hydroxyacetic acid copolymer (PLGA), which have attracted extensive academic attention since their introduction to acupoint buried wire application. Among them, PLGA is a biodegradable material approved by the U.S. Food and Drug Administration (FDA), which possesses ideal biocompatibility, good biodegradability and excellent mechanical properties. PLGA is synthesized by propylene glycol ester (LA) and glycolic acid (GA) in a certain ratio, which endows it with a

controllable molecular structure and properties, and thus is widely used in surgical suturing, acupoint suturing and drug release devices and other fields [4-6]. Compared with PLGA, PCL has lower hydrophilicity and biocompatibility, so PLGA is often preferred as a buried wire material in some cases. However, PLGA performs relatively weakly in promoting cell adhesion, proliferation and mineralization due to the lack of specific cell-molecule interaction sites on its surface. For this reason, researchers have introduced hydrophilic and cellular interaction groups, such as hydrophilic chitosan molecules, to the surface of PLGA threads to improve its performance in cell adhesion and proliferation, thus enhancing its potential for application as a buried thread material.

## 4. Mechanism of Acupoint Thread Embedding Therapy

### 4.1 Analgesic Effect of Acupoint Acupuncture Thread Embedding

Compared with traditional acupuncture, acupoint acupuncture not only reduces the frequency of treatment and improves patient compliance, but also shows certain therapeutic effects in anti-inflammation and analgesia. Animal experiments showed that in the model of inflammatory pain caused by complete Freund's adjuvant (CFA), the use of sheep's intestinal thread buried in the bilateral Kunlun (BL60), Shusanli (ST36) and Sanyinjiao (SP6) points of SD rats for treatment could significantly exert specific analgesic effects after 5 days of intervention. Specifically, on days 1, 3 and 5 after treatment, the buried thread therapy was able to significantly increase the foot-contraction reflex threshold, reduce CFA-induced plantar edema and decrease the expression of Sig-1R protein in rats. On days 1 and 3, the buried wire therapy effectively inhibited the expression of p38 MAPK and ERK in the spinal cord, while no further reduction in the expression of these two proteins was observed on day 5. The results of this study suggest that the effective action period of buried thread therapy is at least 5 days, and its therapeutic effect is more durable and convenient compared with the daily intervention of needling, so it can be used as a more effective therapeutic means, especially in the CFA-induced inflammatory pain model, which showed better antinociceptive allergic effects [7].

In addition, clinical studies have also shown that acupuncture combined with acupoint buried thread has significant advantages in the treatment of sciatica. Embedded thread can not only rapidly relieve the pain symptoms of patients, but also consolidate and improve the long-term therapeutic effect, improve the quality of life of patients, optimize the course of treatment, and its effect is significantly better than that of simple acupuncture treatment.

### 4.2 Immunoinflammatory Response of Acupoint Embedded Wire

The study of Chen Lichuan et al found that the application of buried threads at the Foot Sanli and Ren Yu points in SD rats not only significantly reduced the levels of the inflammatory factors IL-6 and IL-8 in the peripheral blood of rats with rheumatoid arthritis, but also attenuated the deposition of immunoglobulin-immunocomplexes in the joint tissues, which in turn acted on the neural - endocrine - immunoregulatory network through immunotransmitters. The results of the study suggest that buried thread therapy is able to exert its role in cytokine immunomodulation by reducing inflammatory substances in the dorsal horn of the spinal cord and in the peripheral blood. In addition to regulating cytokine expression, acupoint thread burial can also regulate the expression of immune-positive cells CD4+, CD8+ T cells and their receptors, thus enhancing immune response.

The thread materials used in acupoint thread embedding, such as sheep's intestine thread or medicinal thread, act as exogenous antigens and can activate lymphocyte sensitization. The combination of antigen and antibody can produce a series of biochemical stimuli to the acupoints, and these stimuli include the promotion of the degradation of goat gut threads as well as the activation of the immune system response, which can regulate the balance of yin and yang in the body's internal organs. Zheng Fengming et al showed that acupuncture point buried thread can effectively reduce the inflammatory symptoms of experimental autoimmune uveitis rats, slow down the pathological changes in the anterior eye area, reduce the ratio of CD4+ T lymphocytes and CD4+/CD8+ T lymphocytes, and promote the activation of CD8+ T lymphocytes. In addition, acupoint burrowing has also played a significant role in the immunotherapy of rhinitis and nephrotic dysfunction. Studies have shown that the proportion of CD4+ T cells and CD4+/CD8+ T cells in the serum of patients treated with acupoint burrowing is significantly higher than that of the control group, while the expression of inflammatory factors is significantly lower than that of the control group, suggesting that acupoint burrowing is able to improve the cellular immune function of the body, and thus enhance the therapeutic effect.

### 4.3 Neuromodulation Mechanism of Acupuncture Point Thread Embedding

In the study of acupoint buried line treatment of obese rats, high-fat feed feeding method is often used to establish animal models, this method is equivalent to clinical simple obesity. Studies have shown that acupoint burrowing at Yinlingquan and Fenglong points can significantly reduce the body weight of obese rats, lower the Lee index, and reduce the content of serum lipocalin and its receptors, a process that is one of the mechanisms of weight loss in acupoint burrowing therapy .

The efficacy of acupuncture point wire burial is closely related to the implantation level of the buried material in the local area. Clinical studies have shown that the efficacy of fat layer buried wire is more significant. After the intervention of different layers such as fat layer, muscle layer and mixed layer, the effect of acupuncture point wire burial on the body weight of obese rats was observed, and the changes of serum lipids, glucose, leptin and adipocyte morphology were analyzed, and the results showed that the fat layer wire burial significantly reduced the body weight of the rats compared with the muscle layer, and increased the expression of leptin. This effect may be related to the fact that the implantation of sheep's intestinal wires in the adipose layer directly stimulated the adipocytes, which prompted the adipocytes to synthesize and secrete leptin. In addition, acupuncture point embedding activated the regulation of leptin by the hypothalamic-pituitary-gonadal

axis, promoted the binding of leptin to its receptor, and improved leptin resistance in rats, inhibited the synthesis and secretion of neuropeptide Y in the hypothalamus, which led to a reduction of energy intake and an increase in the heat production and energy expenditure of the central nervous system, and ultimately realized the effect of weight loss. These findings suggest that the selection of the fat layer as the implementation level of acupoint burrowing may help to enhance the efficacy of the treatment of simple obesity, thus providing an experimental basis for the clinical selection of the appropriate level of burrowing. In addition, it was also found that the central influence mechanism of acupoint buried wire on obese rats was mainly concentrated in the hypothalamus and spinal cord, and exploring this central mechanism is of great significance for understanding the role of acupoint buried wire in the treatment of simple obesity.

In the treatment of gastrointestinal diseases, the mechanism of action of acupuncture point buried wire mainly involves the regulation of gastrointestinal function, gastrointestinal metabolism and the secretion of corresponding hormones. When gastrointestinal function is hyper- or insufficient, acupoint acupuncture regulates the secretion of angiotensin I and angiotensin II through the hypothalamic - pituitary - adrenocortical axis, which in turn causes vasodilatation and contraction, regulates the constriction and dilatation of gastrointestinal arteries, and promotes the secretion of gastrin and the expression of gastric mucosal proteins. Future studies are needed to further explore the specific mechanism of acupoint burrowing in the treatment of gastrointestinal diseases.

In the treatment of gynecological diseases, acupoint buried wire is mainly used for the treatment of endometriosis, primary dysmenorrhea and perimenopausal syndrome. Modern medical research has concluded that acupoint acupuncture can regulate the function of the hypothalamic - pituitary - ovarian axis (HOP axis), regulate the reproductive endocrine disorders in rats by decreasing the secretion of luteinizing hormone (LH) and androgen, promote the normal development of the follicle and ovulation, and improve the physiological functions such as insulin resistance. This mechanism of action provides a new theoretical basis for the application of acupuncture point buried line in gynecological diseases.

## 5. Hydrogel Could be Used as a New Type of Acupoint Buried Line Material

According to the previous research on the therapeutic mechanism of sheep's intestines at acupuncture points, the development of new acupoint burrowing materials, the choice should be based on its effect in the treatment of diseases and the corresponding mechanism research. In recent years, with the in-depth research on acupoint embedding materials, new polymer hydrogel has gradually become one of the potential materials, among which chitosan is considered to be the first choice. Chitosan not only has good hydrophilicity and biocompatibility, but also possesses degradability, and its degradation products can be ultimately metabolized to glycoproteins and carbon dioxide in the human body. In addition, chitosan is capable of activating macrophages by inducing immune responses, interfering with bacterial protein synthesis and destroying bacterial cell walls to exert antimicrobial effects, which are properties that make it one of the ideal materials for acupoint acupuncture thread embedding.

The excellent antibacterial properties of chitosan are particularly suitable for the treatment of various inflammatory diseases [8]. In order to further enhance its performance, the buried thread material can be effectively introduced functional groups into the fiber surface by techniques such as coating method, surface graft polymerization method and wet chemical method [9], which can improve the immobilization of biomolecules and thus enhance the hydrophilicity of the material. For example, researchers [10] successfully produced products with the ability to inhibit Gram-positive or Gram-negative bacteria by binding chitosan to polyamide sutures via a coating method. In addition, the introduction of chitosan-gelatin coating to the surface of PLGA embedded thread material not only improved its surface hydrophilicity, but also significantly enhanced the mechanical properties of the samples, such as tensile properties and bending stiffness, as well as the antimicrobial properties. This improvement effectively breaks the single function of the traditional buried wire material and promotes the diversification of the biological function of the material, which is the key technology that needs to be broken through for the future development of new acupoint buried wire materials.

Based on the wide range of applications and numerous advantages of chitosan in the field of tissue engineering, the development and innovation of injectable chitosan-based embedded wire materials can not only optimize the operation technique of embedded wire and reduce the operation cost, but also effectively prolong the treatment time of embedded wires, thus enhancing the clinical therapeutic effect.

## 6. New Ideas

The research of acupoint injection hydrogel has experienced the process from simple mixing to the continuous expansion of function and application. Early studies, such as Kong Lihong et al, prepared a temperature-sensitive Chuanxiongzine injection gel by mixing polymeric materials such as chitosan with Chuanxiongzine to form a hydrogel, which was able to form a semi-solid drug release system in vivo. After the gel was injected into bilateral Neiguan and Daxi points, it was shown that it could significantly reduce the expression of matrix metalloproteinase-9 and matrix metalloproteinase tissue inhibitor-1 in the cerebral cortex of cerebral ischemia/reperfusion rats, which played a positive cerebrovascular protective effect.

The degradation rate and volume of the gel can be adjusted by selecting different injectable material types, concentrations, and injection volumes, so the duration and intensity of acupoint burrowing can be precisely controlled according to clinical needs. Another important advantage of acupoint injection gels is their ability to encapsulate other bioactive ingredients in the gel for multi-level and multi-modal stimulation. For example, heat-producing nanoparticles can generate heat at localized acupoints, thus realizing thermal stimulation, while magnetic nanoparticles are able to provide mechanical stimulation through the force generated in a

non-uniform state. At the same time, the drug-carrying capacity of the gel allows for precise control of drug delivery and slow release.

In recent years, researchers have observed the protective effect of PLGA (poly (lactic acid)-hydroxyacetic acid copolymer) gel on myocardial ischemia/reperfusion injury by using acupoints embedded in PLGA. The degradation and absorption of this gel not only stimulates the relevant acupoints and reduces the area of myocardial infarction, but also effectively alleviates oxidative stress injury and inflammatory response [11]. In addition, peptide supramolecular gels or drug-assisted integrated Chinese medicine components with gel-forming ability have realized the advantages of needle-medicine combination in acupoint therapy, showing better clinical prospects.

In addition to direct acupoint injection, the combination of gel material and acupuncture treatment can also be used as an innovative acupoint patch therapy. The research team successfully applied the PNIPAM novel acupoint dressing dosage form in an asthma model, which provided the basis for the clinical promotion of the novel acupoint dressing formulation. In addition, researchers have explored the option of combining biomaterials, stem cells and acupuncture as a new strategy to accelerate tissue regeneration. For example, the prepared hydrogel material combined with acupuncture peripuncture was applied to the treatment of skin ulcers in diabetic wounds, further providing a theoretical basis for the development of novel acupoint dressing materials and their clinical application in combination with acupuncture therapy [12].

## 7. Summary

According to the theory of acupuncture and moxibustion, acupoint placement, as a minimally invasive therapeutic method, has been widely used in clinical practice by applying nonspecific stimulation to localized areas, especially in the treatment of a wide range of chronic diseases with significant effects. These diseases include, but are not limited to, inflammatory pain, simple obesity, immune-responsive diseases, gastrointestinal diseases, and gynecological diseases. Current research focuses on the role of acupoint acupuncture in the regulation of immune-inflammatory response, endocrine and metabolic regulation, neuromodulation, and analgesic mechanism. Based on the in-depth exploration of these mechanisms, the future development of acupoint acupuncture materials will gain important theoretical support. In this process, the selection of materials for acupoint thread embedding, the improvement of thread embedding technology and the revelation of the mechanism of thread embedding are the focus of future research. Among a variety of embedded wire materials, gel has gradually become one of the preferred materials for acupoint embedding due to its excellent biocompatibility, intelligent response properties and biodegradability, which greatly enriches the research content in this field. In addition, the combination of acupuncture therapy and polymer materials has gradually become one of the emerging research directions. This interdisciplinary combination not only broadens the scope of application of acupuncture therapy, but also promotes the application of new polymer materials in acupoint thread embedding and acupoint patch therapy. Through this approach, the clinical therapeutic effect can be further improved, and the underlying mechanism also provides new topics for future research.

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