

The Enhancement of Blood Circulation in Uterine Adenomyosis and the Underlying Mechanism of Acupuncture Therapy

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ABSTRACT

The present study centers on the impact of Acupuncture on enhancing blood circulation in adenomyosis and its underlying mechanisms. The progression of adenomyosis is intricately linked to factors such as vascular tone, blood flow rate, and platelet aggregation. The paper delves into the mechanisms through which Acupuncture facilitates the improvement of blood circulation. A thorough review of pertinent literature reveals that Acupuncture can effectively enhance blood circulation via diverse mechanisms, thereby exerting a beneficial influence on adenomyosis.

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Received: September 29, 2024; **Accepted:** October 03, 2024; **Published:** October 10, 2024

Keywords: Acupuncture, Adenomyosis, Blood Circulation

Introduction

After a thorough review of pertinent literature, scholars have pinpointed several probable factors that may contribute to the onset of adenomyosis [1]. These factors encompass hormonal imbalance, endometriosis (where endometrial tissue is located outside the uterus), genetic predispositions, and inflammation [2-4]. Furthermore, recent investigations have emphasized the significance of uterine blood circulation abnormalities in the pathogenesis of adenomyosis. Such abnormalities encompass decreased blood flow, microcirculatory disturbances, and uterine inflammatory responses [5]. By enhancing local blood circulation in the uterus, one can improve blood supply to the endometrial layer, thus mitigating inflammation within the uterine cavity. Additionally, this may bolster the immune function of the uterus, potentially minimizing the development of intrauterine adenomyosis lesions and ameliorating related symptoms, as indicated by studies [6,7].

The menstrual cycle involves bleeding and repair processes in the endometrial area, leading to hypoxia in local tissues and metabolites accumulation in ectopic regions. This initiates inflammatory responses and promotes fibrous tissue growth. Adequate blood circulation plays a pivotal role in maintaining bodily functions. By enhancing blood flow, oxygen and nutrients are delivered to facilitate the repair of ectopic endometrial regions and sustain the normal functioning of the myometrium [8].

Simultaneously, accelerated blood flow assists in reducing the inflammatory response by eliminating metabolites and waste products, thereby maintaining metabolic homeostasis within the tissues [9]. Furthermore, hormonal imbalances, particularly in estrogen and progesterone, can cause abnormal proliferation of the myometrium. Promoting blood circulation can regulate estrogen and progesterone, thereby maintaining the normal function of uterine smooth muscle cells [10].

The impact of Acupuncture on blood circulation is exerted through regulating cardiac pumping and vascular activity, optimizing the parameters of the circulatory system, and enhancing both microcirculatory blood flow rate and hemodynamics [11]. Additionally, it improves capillary permeability and blood supply, modulates cardiac contractility and frequency, and regulates erythrocyte and platelet counts. By managing blood viscosity, mitigating platelet aggregation and thrombus formation, and enhancing blood fluidity, acupuncture harmonizes the body's blood coagulation and anticoagulant mechanisms. Furthermore, studies have indicated that acupuncture stimulates the release of various bioactive substances from surrounding acupoint tissues and nerve endings. This stimulates lymphatic system movement, nitric oxide (NO) release, bradykinin release, and slow-release interleukin-1 β (IL-1 β). These actions promote lymphatic fluid circulation, vasodilation, enhanced blood flow, anti-inflammatory effects, and efficient waste and metabolite drainage between tissues. Ultimately, acupuncture improves tissue nutrient supply and metabolic status [12-15].

The Impact of Adenomyosis on Blood Circulation

Blood circulation is a crucial factor in the development of adenomyosis. When blood circulation becomes abnormal, it can result in insufficient blood supply or stasis within the uterus, leading to hypoxia in adenomyotic tissues. This hypoxic microenvironment initiates inflammatory responses and fibroplasia. Furthermore, compromised blood circulation contributes to the accumulation of toxic metabolites in the uterine environment, affecting the normal function of uterine smooth muscle cells and promoting the progression of endometriosis and aberrant myometrial hyperplasia. These conditions ultimately manifest as symptoms such as pain, irregular menstruation, and infertility. Additionally, this study demonstrates that patients with adenomyosis exhibit coagulation abnormalities and impaired vascular function, which may be associated with disease progression and symptom expression [16].

This study employs three-dimensional computed tomography angiography to demonstrate that ovarian arteries are the primary source of uterine blood supply in individuals with adenomyosis. This underscores the potential association between aberrant blood circulation and the progression of adenomyosis [17]. Additionally, this study observes elevated expression levels of vascular endothelial growth factor (VEGF) and epidermal growth factor (EGF) in patients with adenomyosis. These findings indicate that abnormal blood circulation is involved in the pathogenesis and progression of adenomyosis. The abnormalities in blood circulation are intricately linked with the pathophysiology of adenomyosis and may arise from dysregulation of coagulation function, abnormal vascular supply, and abnormal angiogenin expression.

Reduction in Blood Flow

As a result of the contraction of the myometrium and the elevated pressure within the uterine cavity, blood induces internal strain within adenomyosis lesions, thereby eliciting pain and inflammatory responses [18]. Blood accumulation within the lesions can further contribute to enlargement, fibrosis, and localized adhesions [19]. These alterations may subsequently impact the blood supply to the tissues neighboring the lesions, resulting in reduced blood perfusion. Ectopic lesions primarily affect the uterus, ovaries, and peripelvic structures [20]. Research has found that patients with adenomyosis have significantly reduced blood flow to the uterine and ovarian arteries, leading to decreased perfusion of the uterus and ovaries [21].

Pain and Inflammation Arising from Circulatory Disturbances

This review discusses the pathophysiologic mechanisms of adenomyosis, noting the effect of blood circulatory disturbances on pain and inflammation [22]. Vallvé et al. measured the oxygen levels in the pelvis of patients with endometriosis by post-hysteroscopy and found that the patients had significantly lower oxygen levels than healthy controls, indicating a potential role of blood circulatory disturbances in the manifestation of pain and inflammation in adenomyosis [23]. Bozdogan et al. investigated how blood circulatory disturbances contribute to the recurrence of adenomyosis. It found that the risk of recurrence in patients with adenomyosis was associated with abnormal blood flow in the pelvic arteries [24]. These studies prove that the symptoms of pain and inflammation in adenomyosis are related to blood circulatory disturbances.

The Influence of Blood Circulation Defects on Adenomyosis

Nasu K et al. conducted a study on the expression of vascular endothelial growth factor (VEGF) and its receptor in intrauterine

ectopic foci among patients with adenomyosis [25]. Their findings indicated that aberrant VEGF expression might be associated with blood circulation deficiency [26]. Additionally, Mowers EL conducted a study on the prevalence of adenomyosis among individuals experiencing chronic pelvic pain and observed a strong link between blood circulation defects and the development of adenomyosis in these patients [27].

Tissue Hypoxia and Nutritional Deficiencies

A recent study conducted by RN has delved into the consequences of aberrant angiogenic factor expression among patients diagnosed with adenomyosis. This study underscores the significance of impaired circulation in hindering the adequate supply of oxygen and nutrients to the endometrial lesion site, as reported in reference [28]. Furthermore, the study delves into the mechanisms that promote angiogenesis and cell survival within hypoxic uterine fibroid environments. The findings revealed that the vascular endothelial growth factor/hypoxia-inducible factor pathway plays a crucial role in initiating angiogenesis in uterine leiomyomas [29]. Additionally, Sharpe Timms and his colleagues have offered a comprehensive overview highlighting the intricate links between adenomyosis and infertility. They emphasized that defective blood circulation leads to hypoxia and nutritional deficiencies at the endometrial lesion site, thereby negatively impacting the fertility of affected individuals. These studies collectively contribute to the understanding of the association between defective blood circulation, hypoxia, and nutritional deficiencies within the uterine cavity [26].

The Accumulation of Toxins and the Compromised Ability to Eliminate Waste are Critical Issues

In patients with endometriosis, defective circulation may lead to abnormal expression of angiogenic factors, resulting in inadequate blood supply [30]. This study proposed a hypothetical mechanism for developing endometriosis, whereby ectopic endometrial cells could receive sufficient oxygen and nutrients through vascularization [31]. When blood circulation is poor, toxins and waste cannot be fully cleared, leading to accumulation at the site of endometriosis. The accumulation of these toxins can affect the cellular metabolic capacity of endometriosis sites, impairing their ability to process metabolic waste, chemicals, and hormones. As a result, these toxins may lead to inflammatory reactions, cellular damage, and tissue damage, further exacerbating the pathological process of endometriosis. Abramiuk M. et al. synthesized studies on the role of growth factors in endometriosis. The results showed that defective blood circulation may lead to abnormal expression of growth factors, thereby interfering with waste removal and toxin metabolism at the site of endometriosis [32].

Acupuncture for Enhancing Blood Circulation in Adenomyosis The Impact of Acupuncture on Vasodilation Acupuncture Effectively Induces Vasodilation and Enhances Blood Circulation.

The mechanism of Acupuncture in improving uterine blood circulation is not fully understood. Still, some studies have shown that the uterus's vascular tone and blood flow can be regulated through neural pathways after acupuncture stimulation [33]. Acupuncture has several effects on the nervous system, including activation of sympathetic and parasympathetic nerves and modulation of neurotransmitter release, which influences uterine blood circulation [34]. Acupuncture stimulation can increase uterine blood flow and improve uterine blood circulation by relaxing the vascular muscles, dilating the vascular lumen, and improving microvascular permeability. Studies show

that Acupuncture can regulate endocrine systems such as the hypothalamic-pituitary-ovarian axis and the hypothalamic-pituitary-adrenal axis, thereby affecting uterine blood circulation [35]. Acupuncture stimulation can increase uterine blood flow and improve uterine blood circulation by relaxing the vascular muscles, dilating the vascular lumen, and improving microvascular permeability. Studies show that Acupuncture can regulate endocrine systems such as the hypothalamic-pituitary-ovarian axis and the hypothalamic-pituitary-adrenal axis, thereby affecting uterine blood circulation [35]. A study found that Acupuncture can promote vasodilation through endogenous pain analgesic mechanisms, neuroendocrine regulation of central or peripheral nerve mechanisms, stimulation of nerve fibers, and improvement of local hemodynamic [36]. Acupuncture leads to the activation of pain receptors, which stimulates the body's endogenous pain analgesic mechanism, participates in central and peripheral vascular regulation, and promotes vasodilation through the release of endorphins and other substances.

Acupuncture possesses the ability to modulate both central and peripheral nerves, mediated by neuroendocrine mechanisms. This modulation impacts the autonomous nervous system's functions, specifically regulating cardiovascular activity and influencing vessel diastolic states. Furthermore, acupuncture facilitates the equilibrium between sympathetic and parasympathetic nervous systems, inducing vasodilation. By stimulating nerve fibers, acupuncture influences the release of neuromodulatory agents such as nitric oxide (NO) and norepinephrine (NE), promoting vascular smooth muscle relaxation and vasodilation. Additionally, acupuncture enhances local hemodynamics, optimizing oxygen and nutrient supply, and improving tissue metabolism and function. These hemodynamic improvements alleviate vasoconstrictive pressure, further contributing to vasodilation.

Acupuncture is Effective in Alleviating Spasms and Inflammatory Responses

Acupuncture Exhibits Efficacy in Alleviating Spasms and Inflammatory Responses

A study found that Acupuncture can relieve the spasm of adenomyosis of the uterus by adjusting the neuroendocrine system and improving local circulation [37-39]. Acupuncture promotes blood circulation, increases the supply of oxygen and nutrients, and reduces the accumulation of metabolites in the body, thus reducing the spasmodic pain caused by adenomyosis. Acupuncture stimulates nerve endings, alters nerve conduction, and regulates the neuroendocrine system to reduce spasms through a nerve reflex mechanism, resulting in a more coordinated contraction of uterine smooth muscle. Dou found that Acupuncture modulates the immune system and inhibits the inflammatory response to relieve the inflammatory reaction in adenomyosis [40]. By regulating the immune system's function, improving the immune system's balance, and promoting the body to produce an appropriate immune response, it reduces the dysregulation of the immune system caused by uterine adenomyosis and decreases the degree of inflammatory response. Acupuncture influences the body's secretion and release of inflammatory factors, such as tumor necrosis factor (TNF- α), interleukin 1 (IL-1), interleukin 6 (IL-6), among others. In adenomyosis, the inflammatory response can be reduced by inhibiting the release of inflammatory factors [41]. Acupuncture can promote blood circulation, increase local blood supply, help remove inflammatory mediators and metabolites, and provide nutrients and oxygen to the inflammation site, reducing the inflammatory response caused by adenomyosis [42]. Good blood circulation plays an essential role in adenomyosis. Acupuncture, as a regulatory mechanism, can improve adenomyosis's symptoms

and functional abnormalities by promoting blood circulation, relieving spasms, inhibiting inflammatory reactions, and regulating the nervous system.

Acupuncture Regulates Blood Viscosity and Circulatory Resistance

Acupuncture Reduces Blood Viscosity and Reduces the Risk of Thrombosis

Acupuncture can reduce blood viscosity and thrombosis risk by improving blood circulation and regulating blood components. Studies have shown that Acupuncture can reduce blood viscosity by improving blood mobility, increasing blood flow rate and flow volume, promoting unobstructed blood flow, and reducing red blood cell aggregation and adhesion [43]. It regulates platelet aggregation and fibrinogen content in plasma, which promotes the balance of coagulation and anticoagulation mechanisms, reduces blood viscosity, and decreases thrombus formation [44,45].

Acupuncture Improves Circulatory Resistance and Oxygen Supply

Acupuncture can improve circulatory resistance by regulating the nervous system, vasodilatation, improving blood flow, and other mechanisms. Acupuncture stimulation of acupoints can increase local blood flow and microcirculation, improve blood supply and circulation, reduce circulatory resistance, and increase oxygen and nutrient supply to tissues [46,47]. Acupuncture regulates the balance between sympathetic and parasympathetic nerves, thereby reducing sympathetic excitation and inhibiting parasympathetic influence, lowering blood pressure and heart rate, and reducing vasoconstriction [48]. Acupuncture prompts the body to release various biologically active substances, such as endorphins and vasoactive substances, which exert vasodilatory, anti-inflammatory, and anti-platelet aggregation effects, thereby improving hemodynamics and blood rheology [49]. Acupuncture regulates the neuroendocrine systems, such as the pituitary-adrenal axis, renin-angiotensin-aldosterone, and so on, thus regulating blood pressure homeostasis and fluid metabolism [50].

Acupuncture can improve oxygen supply through various mechanisms, including hemodynamic improvement, neuromodulatory adjustments, and metabolic and oxygen supply facilitation. Acupuncture can stimulate specific acupoints, such as the Zusanli (ST 36) and Hegu (LI 4), to regulate and enhance the circulation of qi and blood in the body, promote blood circulation and microcirculation, and increase the speed and kinetics of blood flow, thus increasing the transportation and supply of oxygen in the body [51,52]. Acupuncture regulates the nervous system, reduces pain or tension, promotes vasodilatation, stimulates the body's metabolic function, increases the cellular demand for oxygen, increases blood supply, and improves the efficiency of oxygen supply and utilization [53-55].

Regulation of Hormone Levels in the Blood by Acupuncture

Acupuncture Regulates Estrogen and Progesterone Levels

Acupuncture can regulate hormone levels in the blood through neuroendocrine, hemodynamic, and biological response regulation mechanisms. J. H. Ko found that Acupuncture can regulate hormone levels in the blood through the release of neurotransmitters and the synthesis and secretion of neuroregulatory hormones [56]. Some studies have shown that acupuncture stimulation of nerve endings can affect the secretion of related hormones by influencing the signaling of the hypothalamic-pituitary-adrenal (HPA) axis, the hypothalamic-pituitary-gonadal (HPG) axis, and regulating the function of the thyroid gland, among other pathways [57]. Acupuncture regulates a variety of neurotransmitters, endorphins,

norepinephrine, and 5-hydroxy tryptamine, which affect the synthesis, secretion, and metabolism of estrogen and progesterone [58]. Acupuncture improves blood circulation, promotes blood supply and excretion, and regulates hormone synthesis and metabolism [59]. Studies have shown that improving blood perfusion to the liver may help regulate hormone metabolism and clearance in the liver [60]. Acupuncture may activate the body's self-regulatory response, anti-inflammatory response, and immune regulation, affecting hormone synthesis and secretion.

Acupuncture Reduces the Release of Inflammatory Mediators

Inflammatory mediators are a class of biologically active substances the body produces during inflammation, including cytokines, chemical mediators, and inflammatory mediators. Jiang found that Acupuncture can have a specific regulatory effect on releasing inflammatory mediators. Acupuncture regulates and influences the function of the nervous system through the stimulation of nerve endings, thereby modulating the inflammatory response [61]. Yao found that Acupuncture can stimulate the sympathetic nerves, causing them to release norepinephrine, which inhibits the release of inflammatory mediators [62]. A study found that Acupuncture can regulate and balance the secretion of cytokines, decrease the level of inflammatory cytokines (tumor necrosis factor- α , interleukin-1 β , etc.), increase the level of anti-inflammatory cytokines (interleukin-10), and promote the clearance and metabolism of inflammatory mediators [63]. Acupuncture affects the function of the HPA axis and HPG axis, regulating hormone secretion in the body, which affects the release of inflammatory mediators [64].

The Physiological Mechanism and Effects of Acupuncture

Acupuncture's physiological mechanisms and effects involve studying many aspects, including nerve conduction, neuroendocrine regulation, inflammation and immune regulation, blood circulation improvement, and activation of substance production. Acupuncture can regulate the functions of various organs and systems, such as cardiovascular, digestive, respiratory, and urinary systems. Specific effects include analgesic effect, anti-inflammatory effect, regulation of nervous system function, improvement of blood circulation, regulation of the endocrine system, enhancement of immune function, regulation of internal organ function, and improvement of the psychological state, etc [65].

Acupuncture can stimulate nerve endings, causing nerve reactions and regulation. Through the relaxation response of the central nervous system, modulation of the autonomic nervous system, and activation of endogenous pain modulation systems (e.g., endorphin system) [66]. Acupuncture regulates inflammatory and immune responses, inhibits the release of inflammatory mediators, improves local blood circulation, and enhances the activity of immune cells while increasing capillary permeability and promoting the excretion of metabolites. Acupuncture can stimulate the production and release of various bioactive substances, such as endorphins, vasoactive substances, neurotransmitters, and growth factors. Acupuncture affects brain function and neurotransmitter activity, causing central responses, including regulating pain sensation, mood, and cognitive changes [67]. Acupuncture can regulate the endocrine function of the body, pituitary, and hypothalamus functions, improve endocrine disorders, and promote hormone balance through the neuroendocrine system [68].

Conclusion

Improved blood circulation relieves adenomyosis symptoms, controls pain and prevents complications. Improved circulation increases the blood supply to the endometrium, provides nutrients

and oxygen to support its growth and metabolism, reduces its ischemic state, increases the supply of nutrients to the endometrial lesions, can carry away metabolites and toxins produced by the ectopic tissues, and helps to reduce the inflammatory response and pain. Enhanced blood circulation through the body also helps to maintain the proper muscle temperature, which can reduce painful symptoms, promote healing and repair, increase immune system activity, and strengthen the body's resistance.

Acupuncture has been shown to enhance local microcirculation, increase blood supply, regulate neural and hematological mediators, dilate blood vessels, reduce blood pressure, and improve blood viscosity and flow. It also can modulate autonomic nervous system function, promote cardiac contraction and relaxation, and enhance myocardial perfusion and cardiac output [69]. In adenomyosis of the uterus, Acupuncture improves blood supply to the uterus and pelvic area by regulating visceral organ function and promoting the circulation of Qi and blood in the meridians, alleviates local congestion and inflammatory response, and facilitates the absorption and repair of ectopic lesions.

Acupuncture has some potential clinical applications in the treatment of adenomyosis, but more scientific studies are needed to confirm its efficacy. Adenomyosis is a common gynecological disorder characterized by the growth of ectopic tissue in the endometrium, leading to problems such as pain, irregular menstruation, and infertility. Acupuncture can regulate physiological functions and promote self-healing through stimulation at specific acupuncture points. Current research shows that Acupuncture can be used to treat adenomyosis through various mechanisms. Some studies have shown that Acupuncture can improve blood circulation, reduce inflammatory responses, and promote contraction and relaxation of the uterine muscle layer, thereby relieving painful symptoms. In addition, Acupuncture can regulate hormone levels, enhance immune function, and have a moderating effect on irregular menstruation and infertility problems. However, existing studies have shown that Acupuncture, as a non-drug and nonsurgical treatment, has some efficacy in relieving pain and improving symptoms. Research on the mechanism of Acupuncture in the treatment of adenomyosis is still in the exploratory stage, and further clinical experiments and basic research are needed to clarify its mechanism further and provide more substantial evidence for its clinical application.

Supported by: National Natural Science Foundation of China: Mechanism of Chong Meridian is the sea of Blood Acupuncture in the improvement of Endometrial Angiogenesis in pcos via HIF-1 α Regulating Crosstalk between Mitochondria and Endoplasmic Reticulum to Mediate Mitochondrial Fission-Glycolysis (No.82460974)

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