Asia Pacific Science Press

Asia Pacific Journal of Clinical Medical Research
ISSN(O):3079-8345
ISSN(P):3079-8337
Vol. 1 No.5 (2025)

Research Status of the Mechanism of Action of Danshen Dropping Pills on Diabetic Retinopathy

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Abstract: Diabetic retinopathy (DR) is one of the common complications in patients with diabetes, which seriously affects the patient's vision and quality of life. With the increase in the number of patients with diabetes, the prevention and treatment of DR has become an urgent clinical problem to be solved. In recent years, Danshen dripping pills, as a traditional Chinese medicine preparation, have received widespread attention for its unique pharmacological effects. Studies have shown that Danshen Dropping Pills has a significant regulatory effect on retinal vascular damage, oxidative stress, inflammatory response and cell apoptosis. Current research results show that Danshen Dropping Pills can reduce retinal damage and improve the vision of diabetic patients through multiple mechanisms. However, in-depth research on its specific mechanism of action is still needed to better understand its potential application in the prevention and treatment of DR. This article aims to explore the mechanism of action of Danshen Dropping Pills in diabetic retinopathy by reviewing relevant literature and provide a theoretical basis for clinical application.

Keywords: Danshen Dropping Pills; Diabetic Retinopathy; Mechanism of Action; Oxidative Stress; Inflammatory Response

Published: Dec 2, 2025

DOI: https://doi.org/10.62177/apjcmr.v1i5.897

1.Introduction

Diabetic retinopathy (DR) is the most common eye complication of diabetes. As the incidence of diabetes increases globally, the incidence of DR is also increasing year by year. The main pathological characteristics of DR include retinal microvascular damage and neovascularization, which may eventually lead to severe visual impairment or even blindness [1]. In recent years, Salvia miltiorrhiza dropping pills, a traditional Chinese medicine preparation made from Salvia miltiorrhiza extract, have attracted attention for its microcirculation improvement, antioxidant and anti-inflammatory effects. Studies have shown that Danshen Dropping Pills show significant efficacy in the treatment of DR, especially in reducing retinal damage and improving vision [2]. This article will focus on exploring the mechanism of action of Danshen Dropping Pills in diabetic retinopathy, with a view to providing new ideas for clinical treatment.

The occurrence of diabetic retinopathy is closely related to multiple factors, including oxidative stress caused by hyperglycemia, chronic inflammatory response, and microvascular dysfunction [3]. These factors work together to cause damage to retinal endothelial cells and neurons, thereby affecting vision [4]. In this context, Danshen Dropping Pills may play an important role in the treatment of DR by resisting oxidative stress and inflammatory responses through its active ingredients. Studies have shown that the main active ingredients in Salvia miltiorrhiza, such as tanshinone and

salvianolic acid, have significant antioxidant and anti-inflammatory effects and can effectively reduce oxidative damage and inflammatory response in the retina, thereby improving the pathological changes of DR [5].

In recent years, more and more studies have focused on the mechanism of action of Danshen Dropping Pills on DR. Studies have found that Danshen Dropping Pills may exert its therapeutic effect by regulating multiple signaling pathways in the retina, especially pathways related to oxidative stress and inflammation [4, 6]. In addition, Danshen Dropping Pills may also reduce the pathological damage of DR by improving microcirculation and promoting the regeneration of retinal blood vessels [7]. In summary, in-depth study of the mechanism of action of Danshen Dropping Pills in diabetic retinopathy will provide important basis for its clinical application and point the way for future research directions.

2.Main body

2.1 The main components and pharmacological effects of Danshen dripping pills

2.1.1 Effect of tanshinone

Tanshinone is one of the main active ingredients in Danshen dripping pills and has significant pharmacological effects. Studies have shown that tanshinone can exert its biological activity through multiple mechanisms, including antioxidant, anti-inflammatory and anti-fibrotic effects. Specifically, tanshinone can inhibit oxidative stress and reduce intracellular reactive oxygen species (ROS) levels, thereby protecting cells from damage [8]. In addition, tanshinone has also been found to regulate multiple signaling pathways, such as the PI3K/Akt and MAPK pathways, which play an important role in cell proliferation and survival [9]. In the study of diabetic retinopathy, tanshinone is believed to improve retinal microcirculation and reduce retinal damage, thus having potential theutic effects on diabetic retinopathy [10].

2.1.2 Role of flavonoids

Flavonoids are another important component in Danshen dripping pills and have a wide range of biological activities. Studies have shown that flavonoids can exert their protective effects through mechanisms such as anti-oxidation, anti-inflammation and improving blood circulation. For example, flavonoids can significantly reduce the level of inflammatory factors and inhibit the release of cytokines such as TNF-α and IL-6, thereby reducing the inflammatory response [11]. In addition, flavonoids have also been shown to promote the function of vascular endothelial cells and improve blood vessel relaxation, which is particularly important for the treatment of diabetic retinopathy [12]. By regulating endothelial function and inhibiting platelet aggregation, flavonoids help improve microcirculation, thereby protecting retinal nerve cells [13].

2.1.3 Contribution of other active ingredients

In addition to tanshinone and flavonoids, Danshen dripping pills also contain a variety of other active ingredients, such as water-soluble phenolic acid compounds (such as danshenic acid) and polysaccharides. These ingredients work together to enhance the overall efficacy of Danshen dripping pills. Studies have shown that water-soluble phenolic acid compounds have good antioxidant and anti-inflammatory effects, and can improve the pathological state of diabetes-related complications by inhibiting oxidative stress and inflammatory reactions [14]. In addition, the polysaccharide components in Danshen dripping pills are also believed to enhance the body's immune function and promote cell repair, which in turn plays an auxiliary role in the prevention and treatment of diabetic retinopathy [15]. The synergistic effect of these ingredients makes Danshen dripping pills show good prospects in the treatment of diabetic retinopathy.

2.2 Effect of Danshen Pills on retinal vascular injury

2.2.1 Improving microcirculation

As a traditional Chinese medicine preparation, Danshen dripping pills have significant effects on improving microcirculation. The occurrence of diabetic retinopathy is closely related to microcirculation disorders. Improvement of microcirculation can effectively reduce the occurrence of retinal ischemia and hypoxia, thereby reducing retinal damage. Studies have shown that Danshen dripping pills can promote blood flow and improve microcirculation by dilating blood vessels and reducing blood viscosity. This improvement not only helps increase the oxygen supply to the retina, but also promotes the clearance of metabolic products, thereby reducing retinal damage and pathological processes. In addition, Danshen dripping pills may further improve microcirculation and enhance the stability and function of retinal blood vessels by regulating the function of endothelial cells [16].

2.2.2 Promote the recovery of endothelial cell function

Endothelial cells play a vital role in maintaining blood vessel integrity and function, and hyperglycemia caused by diabetes can lead to impairment of endothelial cell function. The application of Danshen dripping pills can promote the functional recovery of endothelial cells and improve their living environment. Studies have found that Danshen dripping pills can reduce endothelial cell damage caused by diabetes through antioxidant and anti-inflammatory mechanisms, promote cell proliferation and migration, thereby enhancing blood vessel repair capabilities. In addition, Danshen dripping pills may also regulate relevant signal pathways, promote the functional recovery of endothelial cells, improve blood vessel permeability and reactivity, and further reduce the occurrence and development of retinopathy [17]. The study of these mechanisms provides important theoretical basis and clinical guidance for the treatment of diabetic retinopathy with Danshen dripping pills.

2.3 Effect of Danshen Dripping Pills on Oxidative Stress

2.3.1 Antioxidant mechanism

As a traditional Chinese medicine preparation, Danshen dripping pills are mainly composed of tanshinone and Danshen polysaccharide, which has significant antioxidant effects. Studies have shown that Danshen dripping pills can enhance the expression of intracellular antioxidant enzymes by activating the Nrf2/ARE signaling pathway, thereby improving the antioxidant capacity of cells. This mechanism reduces the production of nitric oxide (NO) by inhibiting the expression of inducible nitric oxide synthase (iNOS), thereby reducing the level of oxidative stress and reducing cell damage. In addition, Danshen dripping pills can also directly scavenge free radicals, block free radical chain reactions, and reduce the incidence of oxidative damage [18]. This multi-target antioxidant mechanism makes Danshen dripping pills show good prospects in the treatment of diseases related to oxidative stress.

2.3.2 Protection against oxidative damage

In multiple studies, Danshen dripping pills have been shown to effectively protect cells from oxidative damage. For example, Danshen dripping pills can significantly improve the survival rate of HepG2 cells in a hydrogen peroxide (H2O2)-induced oxidative damage model and reduce intracellular reactive oxygen species (ROS) levels. This protective effect is closely related to its promotion of the activity of antioxidant enzymes such as the superoxide di*ase SOD and glutathione peroxidase GPx [19]. In addition, Danshen dripping pills also improve mitochondrial function and reduce intracellular lipid peroxidation, further reducing oxidative damage. These research results show that Danshen dripping pills have important clinical application value in the prevention and treatment of diseases related to oxidative stress such as diabetic retinopathy [20].

2.4 Regulation of Danshen Dripping Pills on Inflammatory Response

2.4.1 Inhibition of inflammatory factors

The role of Danshen dripping pills in regulating inflammatory reactions is mainly reflected in the inhibition of multiple inflammatory factors. Studies have shown that Danshen dripping pills can significantly reduce the levels of multiple pro-inflammatory cytokines, such as tumor necrosis factor alpha (TNF-α), interleukin-1 β (IL-1β) and interleukin-6 (IL-6). These factors play a key role in the pathogenesis of diabetic retinopathy, and their over-expression can lead to inflammation and damage to the retina [21]. By inhibiting the expression of these inflammatory factors, Danshen dripping pills can reduce the inflammatory response of the retina, thereby protecting the function and structure of retinal cells. In addition, Danshen dripping pills have also been found to further reduce the production of inflammatory factors by inhibiting the activation of the nuclear factor κB (NF-κB) signaling pathway [22]. The study of this mechanism provides a theoretical basis for the application of Danshen dripping pills in diabetic retinopathy.

2.4.2 Regulation of immune cells

The regulatory effect of Danshen dripping pills on immune cells is also an important part of its anti-inflammatory effect. Studies have found that Danshen dripping pills can regulate the functions of macrophages and lymphocytes and promote their transformation into an anti-inflammatory phenotype. For example, Danshen dripping pills can promote the polarization of M2-type macrophages, which are known for their anti-inflammatory and tissue repair properties [23]. In addition, Danshen dripping pills can also inhibit the activation of M1 type macrophages and reduce the pro-inflammatory factors they secrete, thereby reducing the level of systemic inflammation. This regulation of immune cells not only helps reduce the

inflammatory response in diabetic retinopathy, but may also promote retinal repair and regeneration by improving the local microenvironment [21]. Therefore, the role of Danshen dripping pills in regulating the function of immune cells provides a new perspective and possible treatment strategies for their treatment of diabetic retinopathy.

2.5 Effect of Danshen dripping pills on apoptosis

2.5.1 Regulation of apoptosis signaling pathways

Danshen dripping pills have shown a significant regulatory effect on apoptosis signaling pathways in the treatment of diabetic retinopathy. Studies have shown that Danshen dripping pills can exert their anti-apoptosis effect by regulating multiple signaling pathways such as PI3K/Akt, STAT, TGF-β and Fas. Specifically, the PI3K/Akt signaling pathway plays a key role in cell survival and apoptosis. Danshen dripping pills activate this pathway to promote cell survival and inhibit apoptosis [24]. In addition, Danshen dripping pills also inhibit the expression of apoptosis related proteins such as Bax and Caspase-3 and enhance the expression of Bcl-2, thereby reducing the degree of apoptosis [25]. This regulatory mechanism is not only obvious in retinal cells, but has also been verified in many other cell types, indicating that Danshen dripping pills have extensive cytoprotective effects.

2.5.2 Improvement in cell survival rate

The use of Danshen dripping pills significantly improved cell survival, especially in diabetic retinopathy models. Studies have shown that Danshen dripping pills can effectively reduce the apoptosis rate and promote cell proliferation and survival. This phenomenon is closely related to its regulation of apoptosis signaling pathways. Danshen dripping pills inhibit the expression of apoptosis related factors and enhance the activity of intracellular anti-apoptosis factors, thereby improving cell survival [26]. In the experiment, the survival rate of cells treated with Danshen dripping pills was significantly higher than that of the control group. This result provided theoretical support for its clinical application in diabetic retinopathy. In addition, Danshen dripping pills may further promote cell survival and reduce pathological damage by improving the metabolic status of cells and enhancing antioxidant capacity [25]. These research results provide important experimental basis for the treatment of diabetic retinopathy with Danshen dripping pills.

3.Discussion

The application of Danshen dripping pills in the treatment of diabetic retinopathy (DR) is gradually becoming a research hotspot. This article reviews how Danshen dripping pills can effectively slow down the progression of DR by improving retinal microcirculation, anti-oxidation, anti-inflammation and regulating apoptosis. The interaction of these mechanisms provides an important basis for our understanding of the theutic potential of Danshen Pills.

However, although the current research results show that Danshen dripping pills have good prospects in the treatment of DR, the safety and effectiveness of clinical applications still need further in-depth discussions. There may be certain differences in results between different studies, which reflects the influence of factors such as study design, sample selection and evaluation criteria. Therefore, future research should focus more on standardized clinical trial design to better compare the results of different studies and ensure that the most effective treatment options are provided for diabetic patients.

At the same time, researchers should also pay attention to the combined application of Danshen dripping pills with other anti-diabetic drugs to explore their synergistic effects. Comprehensively considering the views and findings of various studies and reasonably balancing different treatment strategies will help improve the management level of DR. In addition, long-term follow-up studies are also extremely important to evaluate the long-term effects and safety of Danshen Pills in different patient groups.

4.Conclusion

Danshen dripping pills have shown good application potential in the treatment of diabetic retinopathy, but more reliable data support is needed to fully understand its clinical role. Future research should not only focus on the mechanism of the drug itself, but should also be closely integrated with clinical practice to bring more scientific and effective treatment options to diabetic patients.

Funding

No

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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