The effects of Chinese Herbal Medicine on Blood-Brain Barrier

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ABSTRACT

The blood-brain barrier (BBB), which can open under both physiology and pathophysiology, is an important diffusion barrier to brain. It can block many compounds from blood and protect the brain. BBB is mainly built by cerebral endothelium, tight junctions, adherens junctions, astrocytes, and pericytes and extracellular matrix. Each element plays specific roles to protect the brain. Currently, one of the limitations to treat CNS diseases is that most drugs can not pass through the BBB and can not directly affect the focus of infection. So drugs which could help BBB open would help us to treat CNS diseases. Chinese herbal medicine has been widely used in China to treat all kinds of diseases, and some of them, like Borneol, Acorus tatarinowii Schott, Moschus, Storax and Benzoin, has notably dual effects on the permeability of the BBB. They can both reduce and increase the permeability of the BBB. More studies on the effects on Chinese herbal medicine’s effects on BBB may help us out of the limitation that brain drugs can not pass through the BBB.

Keywords:
blood-brain barrier, Chinese herbal medicine, Borneol, Acorus tatarinowii Schott, Moschus, Storax, Benzoin

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How to cite this article:

Accepted 19 June 2016; published 20 June 2016.

Figure 1 Borneol, Acorus tatarinowii Schott, Moschus, Storax and Benzoin have notably dual effects on the permeability of the blood-brain barrier. They can reduce and increase the permeability of the blood-brain barrier.
INTRODUCTION

The blood-brain barrier (BBB) is an important diffusion barrier to brain\(^1\). It can block many compounds from blood and protect the brain. BBB is mainly built by cerebral endothelium, tight junctions, adherens junctions, astrocytes, and pericytes and extracellular matrix\(^2\). Each element plays specific roles to protect the brain. BBB can open under both physiology and pathophysiology. Currently, one of the limitations to treat CNS diseases is that most drugs cannot pass through the BBB and cannot directly affect the focus of infection\(^3\). So drugs which could help BBB open would help us to treat CNS diseases.

Chinese herbal medicine has been widely used in China to treat all kinds of diseases, and some of them, like Borneol, Acorus tatarinowii Schott, Moschus, Storax and Benzoin, could easily go through the BBB and adjust the function of brain under both physiology and pathophysiology\(^4\). This review will majorly focus on reporting the current progress of the effects of Chinese herbal medicine including Acorus tatarinowii Schott, Storax, benzoin, Borneol and Moschus on BBB.

Borneol

Borneol can regulate the permeability of the BBB. One study found Borneol helped the active ingredients of astragalus pass through the BBB, down-regulated oxygen free radicals and brain cell death and promoted brain angiogenesis\(^5\). Other studies also confirmed that administration of Borneol can significantly increase the levels of Valproate sodium, Nimustine and Cisplatin in cerebrospinal Fluid by up-regulating the permeability of the BBB. To reduce the permeability of the BBB, the possible mechanism is that Borneol could inhibit the expression of ICAM-1mRNA, LFA-1mRNA, MMP-9mRNA, and AQP-4mRNA\(^6\). Furthermore, Borneol could reduce the iNOS, which then reduce the permeability of the BBB\(^7\). On the other hand, to increase the permeability of the BBB, the mechanism may be due to two factors. One is that Borneol may adjust the expression of serotonin and Catecholamines, then regulate the permeability of the BBB\(^8\). Another possible reason is that Borneol can down-regulate the tight brain Tight connection of BBB\(^9\). Like Borneol, Moschus could also increase the permeability of the BBB. Under physiology, mice treated with Moschus showed higher Evans Blue in the brain, which implies that Moschus could open the BBB and let the Evans Blue go through the BBB\(^10\). Recent study also showed Moschus significantly influenced excitatory and inhibitory neurotransmitter expression in the brain\(^11\).

Acorus tatarinowii Schott

Many studies showed that Acorus tatarinowii Schott adjusted the permeability of the BBB and helped the Hydroxysafflor yellow A, Puerarin and Ligustrazine go through the BBB\(^12\). Beta-asarone is the major component of Acorus tatarinowii Schott and has a molecular weight of 208, which could easily pass the BBB. Recent experiments found that beta-asarone could be wildly distributed in rat hippocampus, brainstem, cortex and cerebellum, without target regions in the brain\(^13\-17\).

Storax and Benzoin

Storax can notably increase the level of sulpiride in rat brain, indicating that it can increase the permeation of sulpiride through BBB\(^18\). Furthermore, Storax can increase the opening of BBB in hippocampus, cortex and hypothalamus. Benzoin may stimulate the opening in the cortex, hypothalamus and striatum. The mechanism may involve in inhibition of p-glycoprotein function\(^19\).

CONCLUSION

Chinese herbal medicine, like Borneol, Acorus tatarinowii Schott, Moschus, Storax and Benzoin, has notably dual effects on the permeability of the BBB (Figure 1). They can both reduce and increase the permeability of the BBB. More studies on the effects on Chinese herbal medicine’s effects on BBB may help us out of the limitation that brain drugs can not pass through the BBB.

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