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The evolution of arsenic-containing traditional Chinese medicine prescriptions for treatment of toothache due to tooth decay



KEYWORDS

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Dental caries is a human common oral disease with a long history.¹ Humans have been plagued by toothache due to tooth decay since the prehistoric period. Archaeological evidence shows that the tooth decay is an ancient disease dating back to prehistoric period. The dental caries intervention on a human specimen (Villabruna, about 14,000 years ago) from Northern Italy represents the oldest known archaeological evidence of operative manual intervention on the biting surface of one rotten tooth in the jaw, suggesting an effort to remove the decayed tissue to relieve toothache. In addition, there are also few documented cases known from the Neolithic, when the adoption of early agricultural culture leads to an increase of the carious lesions.² These findings indicate that the human war against dental caries and toothache has begun as early as the prehistoric period.³ Furthermore, the records in traditional Chinese medicine (TCM) classics show that the ancient Chinese people, like prehistoric humans, were also plagued by toothache. Zhang Zhongjing (150–219 AD), a medical sage in the late Eastern Han Dynasty, also recorded the content about teeth in “Synopsis of Golden Cabinet”. His prescription was to use the realgar to treat toothache in children. The chemical component of the realgar is arsenic disulfide, which is toxic and may be used to inactivate the dental pulp tissue to relieve toothache. This is the earliest known record of using the arsenic-containing substance to

treat toothache among TCM classics. In this article, we searched and analyzed TCM prescriptions using arsenic-containing substances to treat toothache due to tooth decay or oral pain based on the Compendium of Materia Medica (CMM).

The CMM, also known as Great Pharmacopoeia, is a Chinese herbology volume written by Li Shizhen during the Ming dynasty. Its first draft was completed in 1578 and printed in Nanjing in 1596. It is a work that lists the Chinese medicine known at that time.⁴ For this reason, we used it as the research material. In this analysis, the Chinese Text Project (<https://ctext.org/zh>) was used to filter prescriptions included in CMM related to treatment of toothache by the arsenic-containing substances. Six related prescriptions were extracted. The characteristics of these prescriptions are shown in Table 1. These prescriptions come from the medical literatures of prescriptions (n = 4) and from the pediatric literatures (n = 2). The earliest one is Zhang Zhongjing’s prescription for the children’s toothache due to tooth decay about 1800 years ago. Among these prescriptions, the treatment targets include children (n = 3) and general patients (n = 3), while the main indications are toothache due to tooth decay (n = 2) or acute toothache due to tooth decay (n = 4). Some prescriptions mention gum sores, rotting and bleeding, especially those for the children. The pulp-inactivating agents in the prescriptions are the realgar (n = 4) and arsenic (n = 2). The main execution method is to mix the realgar (or arsenic) with other medicines or liquids, and then apply it on the affected area or fit it into the tooth cavity. In the case of using the arsenic to treat toothache due to tooth decay, the prescription emphasizes that the arsenic should be taken out of the tooth cavity the next day.

As early as the Eastern Han Dynasty, TCM classics mentioned prescriptions for toothache in children. It is more

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Table 1 Traditional Chinese medicine (TCM) prescriptions using the arsenic-containing substances to treat toothache due to tooth decay or oral pain based on the Compendium of Materia Medica (CMM) written by Li Shizhen during the Ming dynasty.

Title of book	Time of publication	Authors	Introduction of book	Prescription or indication	Execution method
Synopsis of Golden Cabinet	Around 205 AD	Zhang Zhongjing (150–219 AD) of the late Eastern Han Dynasty	The miscellaneous diseases section of "Treatise on Cold Damage and Miscellaneous Diseases" written by Zhang Zhongjing is the earliest existing book on the clinical treatment of miscellaneous diseases in China, which laid the foundation for clinical treatment of TCM.	Prescription for children's toothache due to tooth decay	Use realgar and pepperweed seed to make powder, and then melt it with the pig fat of the twelfth lunar month, and then wrap it by four or five pieces of cotton of locust branches. After baking, apply it on the affected area.
Wang Gun's Medical Prescriptions	1047 AD	Wang Gun of the Northern Song Dynasty	This is a medical literature of prescriptions. The original book has been lost after the Ming Dynasty, but the current version contains 350 prescriptions. Although each prescription has its clinical value, it also contains some prescriptions with superstitious content.	Acute toothache due to tooth decay	Burn a piece of fresh jujube pulp with yellow cypress to make powder, and then mix oil and apply it on the affected area. It would be better if add a little arsenic.
Prescriptions for Children's Diseases	About mid-13th century	Chen Wenzhong of the Southern Song Dynasty	This is a pediatric literature. In addition to expounding the care and development of children, the book also gives the descriptions of the syndrome and treatment of pediatric diseases, including prescriptions.	Realgar powder for toothache due to tooth decay or gum sores in children	Use one part of realgar and two parts of patina to make powder, and then measure the size of the sore to apply it on the affected area.
Prescriptions for Universal Relief	1406 AD	Zhu Ju, Teng Shuo and Liu Chun of the Ming Dynasty	This is a medical literature compiling from various prescriptions before the early Ming Dynasty.	Acute toothache with gum sores due to tooth decay	Use equal parts of arsenic and patina to make powder, and then put it on paper to apply it on the affected area. It works like a miracle. Another prescription: Mix half a liang of arsenic with vinegar into a paste, put it in a bowl, and scrape it off after it dries. Then, wrap it in cotton as big as corn to fit into the tooth cavity. It should be taken out of the tooth cavity the next day, and any worms causing the tooth decay will die. Long-term patients recover within three days.

Comprehensive Guide to the Health of Children	1468 AD	Kou Ping of the Ming dynasty	This is a pediatric literature. In addition to expounding the selected classic prescriptions, the book also gives detailed descriptions of the diagnosis and treatment of the pediatric diseases.	Acute toothache with gum rotting and bleeding due to tooth decay in children	Use seven bean-sized realgar grains. Each grain is wrapped with pitted jujube from Huai, strung with iron wire, and burnt into powder on a lamp. Then, after removing the saliva, apply a little of it on the affected area every time until it heals.
Prescriptions of Ji De Tang	Unknown	Unknown	This is a medical literature containing prescriptions.	Acute toothache due to tooth decay	Use equal parts of catechu, realgar and fritillaria to make powder, and then rinse the mouth with rice swill and apply it on the affected area.

than 1600 years earlier than Dr. John Roach Spooner of Montreal, Canada who is generally given a credit as the first to use arsenic sulfide to devitalize the dental pulp tissue in 1836.⁵ From an anthropological perspective, dental caries (including toothache caused by it) is an ancient chronic disease since the development of human civilization.³ In particular, the children in ancient times also suffered from toothache, which reflects the prescriptions for children's toothache are also recorded in TCM classics. The CMM contains 6 arsenic-containing prescriptions for treating toothache, 3 of them are pediatric prescriptions from Synopsis of Golden Cabinet and 2 pediatric literatures (Prescriptions for Children's Diseases and Comprehensive Guide to the Health of Children). This may mean that toothache is also a common disease among the children in the ancient China. Besides, there are more non-arsenic prescriptions for treating toothache which are also recorded in TCM classics. Regarding the evolution of arsenic-containing TCM prescriptions, it was discovered in the Northern Song Dynasty that using a small amount of the natural arsenic had miraculous effects on treatment of acute toothache due to tooth decay. In the Ming Dynasty, the dosage of the arsenic and the period of pulp inactivation were recorded, and the notice was also recorded that the medicine was required to be taken out of the tooth cavity the next day. These were relatively scientific discoveries. However, the arsenic is highly toxic. Once arsenic leaks into the oral cavity during the dental treatment, it may cause more serious complications such as gum necrosis and even alveolar bone necrosis. The dental school of National Taiwan University (NTU), founded in 1953, informs dental students in its educational guidelines that the use of the arsenic as a dental treatment drug should be prohibited. However, as late as 1996, our hospital (National Taiwan University Hospital, NTUH) still dealt with cases of osteonecrosis of the jawbone in children due to the incorrect use of the arsenic during dental treatment. In conclusion, the majority of the dental profession would agree that there is no longer any indication or need to use the arsenic in the dental practice today, and that the unjustified use must be condemned and should be prohibited.⁵

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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