

Ancient concept of metal pharmacology based on Ayurvedic literature

ABSTRACT

Metals have had a long history in Ayurvedic system of medicine. Mercury (*Parada*), gold (*Swarna*), silver (*Rajata*), copper (*Tamra*), iron (*Lauha*), tin (*Vanga*), lead (*Naga*), and zinc (*Yasada*) are used in therapeutics in an incinerated (*Bhasma*) form. The pharmacological actions, therapeutic indications, adverse effects and management of adverse effects of these metals are described and emphasis has been given to the proper preparation, rational dose and duration during clinical practice in the classics of Ayurveda. Most important observation is, there are no contraindications of these *Bhasmas*, indicating universal applicability to all age levels with suitable adjuvant, proper dose and duration.

Key words: Ayurveda, *Bhasma*, *Marana*, *Shodhana*, *Dosha*

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INTRODUCTION

Universal presence of metals exerting beneficial or harmful effects on living systems make the understanding of the bio-inorganic mechanisms in trace metals biology, an important area of biomedical and environmental research. Metals are omnipresent in our environment, occurring in soils, foods and water as well as in polluted air. Metals enter the systems through food, drinking water, drugs and food contaminants. Metal fumes and particles present in emanations from burning of fossil fuels and industrial processes enter through lungs or get deposited on the skin to exert toxic effects. Toxic metals are retained in the body for long periods with less chances of biological inactivation. Even though the biological effects of various metals are well known, very little is known about their biological activity in terms of elemental properties (*Misra*¹).

Historically India probably was the first to maintain records of useful drugs. Acharya Charaka, the great Ayurvedic scholar of 1500 B.C. has mentioned the types of drugs on the basis of source, various formulations and surprisingly the pharmacology of drugs with considerable precision (*Agnivesha*²). The later treatises describe the medicinal properties of various metals like mercury, gold, lead, etc. The *Bhasmas* containing heavy metal salts are currently enlightened mainly from the toxicological point of view (*Saper*³, *Saper*⁴, *Kales*⁵). The ancient Ayurvedic scholars have mentioned the ill effects of improperly prepared metallic preparations and emphasis has been given to rational preparation methods through various pharmaceutical processing like *Shodhana* (purification), *Marana* (incineration), etc.

The metals used in Ayurvedic system of medicine include mercury (*Parada*), gold (*Swarna*), silver (*Rajata*), copper (*Tamra*), iron (*Lauha*), tin (*Vanga*), lead (*Naga*), zinc (*Yasada*), etc. The metallic *Bhasmas* are the result of a range of physico-chemical processes. Various medicinal herbs are made use of in the process rendering metallic poison innocuous. These are regarded as easily absorbable in the human and produce optimum benefit in a minimum dose (*Vagbhata*⁶).

Processing of metals

The Ayurvedic system of medicine is the only one, out of all traditional medicine system of various civilizations, where importance of metals for curing ailments was probably first recognized.

Metallic preparations are mainly termed as *Bhasma* and obtained by repeated incineration of metal with herbal extract or juice. After procurement of metals, these are made into coarse powder by hammering. Then these are subjected to *Shodhana* (purification) procedure according to traditional Ayurvedic references. For this, the metals are heated to red hot or melted and quenched in particular liquid media for specified times. Then these purified materials are subjected to *Marana* (incineration). The purified materials are then mixed with specific drugs for incineration (*Maraka Dravyas*) and are levigated (*Bhavana*) by particular liquid media for specified time. *Chakrikas* (pellets) are prepared from levigated doughy mass and taken into earthen crucibles faced together, and the junction is sealed by a mud smeared cloth. This apparatus, called as *Sarava Samputam* is subjected for heating in traditional *Puti* (heating grade) or electric muffle furnace. Burning is continued for a specific time limit and when cooled down, the apparatus (*Sarava Samputa*) is taken out and opened to get the incinerated powder. These procedures are repeated for a particular time and finally the prepared *Bhasma* (incinerated metal) is collected.

Pharmacology of metals

Therapeutic effectiveness of the Ayurvedic drugs have been established and well documented by the great Acharyas in the form of classics attributed to them. However lot of changes have occurred in our living milieu since the time these classics were written and impact of these changes on the therapeutic efficacy of the preparations formulated has not been ascertained. Further, the art of preparing the *Bhasmas* requires certain amount of expertise and so much information is available about the likely impact of improper

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preparation on the expression of biological activity including possibility of production of undesirable effects (Vagbhatta⁶, Somadeva⁷, Upadhyay⁸, Sharma⁹, Chaube¹⁰).

Parada (mercury)

Pharmacological actions:

Mercury is used in therapeutics in a compound (*Murchita*) form. These mercurial compounds are called as *Murchita Parada* and possess *Vrishya* (aphrodisiac), *Vardhakya Harana* (anti-ageing), and *Rasayana* (immunomodulator) properties. These increase potentiality (*Valakara*), intellect, memory, attentiveness, complexion (*Buddhi, Smriti, Prabha, Kanti Pradam*) and tissue elements (*Dhatu*). These eradicate diseases caused by all the three vitiated *Doshas* (*humoral principles*) even restricting death (*Mrityu Nasaka*).

Therapeutic uses:

Mercurial preparations are used in *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Kamala* (jaundice), *Jwara* (fever), *Shula* (spasmodic pain), *Mutrakriccha* (nephritis), *Vamana* (vomiting), *Udara Pida* (acute abdomen), *Krimi Dosa* (worm infestation), *Atisara* (diarrhea), etc.

Adjuvant:

Mercurial preparations are given with sugar, powder of *Emblica officinalis* fruit, ginger juice, lemon juice, etc. Drugs act on specific disease can be used as adjuvant for that disease.

Dose:

1 *Ratti* (125 mg)/ day.

Wholesome diet:

Some special food stuffs should be prescribed during mercurial therapy like milk, rock salt, ghee, curd, butter, *Mudga* (*Phaseolus aureus* seeds), *Keshara* (*Crocus sativus* stigma), *Sunthi* (*Zingiber officinale* root), *Mustaka* (*Cyperus rotundus* root), etc.

Unwholesome diet:

Few fruits and vegetables, Sanskrit name starting with the alphabet 'Ka' like *Kushmanda* (*Benincasa cerifera* fruit), *Kulottha* (*Dolichos biflorus* seeds), *Korkoti* (*Cucumis utilissimus* fruit), *Kakmachi* (*Solanum nigrum* fruit), *Karbellaka* (*Momordica charantia* fruit), *Kushuma* (*Carthamus tinctorius* seeds), *Kalinga* (*Citrullus vulgaris* fruit), *Kadali* (*Musa sapientum* fruit), etc. are forbidden during mercurial therapy. These fruits or vegetables are collectively known as *Kakarashtaka* or *Kakaradi Gana*.

Adverse reactions:

The improperly prepared mercurial preparations may cause various ill effects like *Kustha* (skin disorders), *Sandhivata* (osteoarthritis), *Murcha* (fainting), *Chhardi* (vomiting),

Atisara (diarrhea), *Shwasa* (dyspnoea), etc. even death.

Management of adverse effect:

Gandhaka (Sulphur) is mentioned as a specific drug, other remedies are also described like *Dhanyaka* (*Corindrum sativum*) with sugar candy or *Marich* (*Piper nigrum*) with ghee (clarified butter) should be given repeatedly for 7 days.

Swarna (gold)

Pharmacological actions:

Swarna Bhasma (incinerated gold) acts as *Vrishya* (aphrodisiac), *Hridya* (cardiac stimulant), and *Rasayana* (immunomodulator). It increases *Valya* (potentiality), *Kantikara* (complexion), *Ayushkara* (longevity), *Medha Smriti Mati Pradam* (intellect, memory and attentiveness). It alleviates disorders caused by all the three vitiated *Doshas* and is used in the management of poisoning (*Visha Mukti*).

Therapeutic indications:

Swarna Bhasma is indicated in *Yakshma* (tuberculosis), *Unmada* (schizophrenia), *Jwara* (fever), *Shoka* (grief), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Krimi* (worm infestation), *Aruchi* (anorexia), *Chakshuroga* (ophthalmic disorders) and in *Visha* (poisoning).

Adjuvant:

Swarna Bhasma should be prescribed along with milk, ghee, honey, powder of *Emblica officinalis* fruit, powder of *Acorus calamus* root, etc. as adjuvant. It can also be prescribed with other drugs according to the diseases.

Dose:

1/8th to 1/4th *Ratti* (15 to 30 mg)/ day.

Wholesome diet:

Milk, sugar, unctuous food stuffs, etc.

Unwholesome diet:

The fruit of *Aegle marmelos* and some other fruits and vegetables which are mentioned as unwholesome diet during mercurial therapy should be avoided during gold therapy.

Adverse effects:

The raw gold or improperly prepared *Swarna Bhasma* may cause various illness (*Asaukhya*), weakness (*Valaharana*), impotency (*Viryaharana*), leads to imbalance of homeostasis (*Kayakopa*) even death.

Management of adverse effects:

Powder of *Terminalia chebula* fruit should be given repeatedly along with sugar candy (*Sita*) for 3 days.

Rajata (silver)**Pharmacological actions:**

Rajata Bhasma (incinerated silver) possesses *Vrishya* (aphrodisiac), *Vayasthapana* (anti-ageing), *Lekhana* (scraping) and *Rasayana* (immunomodulator) properties. It increases potentiality (*Valya*), and intellect (*Medhya*). It eradicates diseases caused by all the three vitiated *Doshas*.

Therapeutic uses:

Rajata Bhasma is used in *Prameha* (diabetes), *Switra* (vitiligo), *Yakshma* (tuberculosis), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Nayanaroga* (ophthalmic disorders), *Arsha* (piles), *Trishna* (thirst), *Shosha* (emaciation) and in *Visha* (poisoning).

Adjuvant:

Rajata Bhasma is given with sugar, ghee, meat juice, juice of *Adhatoda vasica* leaves, etc. It is also prescribed with other plant drugs acting on particular disease.

Dose:

1/4th to 1 *Ratti* (30 to 125 mg)/ day.

Adverse reactions:

The raw silver or improperly prepared *Rajata Bhasma* may cause various ill effects like *Pandu* (anaemia), *Kandu* (itching), *Santapa* (fever), *Vivandha* (constipation), *Galagraha* (cervical lymphadenopathy), *Sukranasa* (oligospermia), *Valahati* (weakness), *Shiroruja* (headache) and reduce potency (*Viryahanti*).

Management of adverse effect:

Sugar and honey should be given repeatedly for 3 days.

Tamra (copper)**Pharmacological actions:**

Tamra Bhasma (incinerated copper) acts as *Vrimhana* (rejuvenator), *Ropana* (wound healer), *Lekhana* (emaciator), *Saraka* (purgative), and *Rasayana* (immunomodulator). It alleviates disorders caused by *Kapha* and *Pitta*.

Therapeutic indications:

Tamra Bhasma is indicated in *Jwara* (fever), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Krimi* (worm infestation), *Kshaya* (emaciation), *Aruchi* (anorexia), *Agnimandya* (dyspepsia), *Gulma* (abdominal tumor), *Pliha Roga* (splenic disorder), *Yakrita Roga* (liver disorders), *Murcha* (fainting), *Shula* (spasmodic pain), *Parinama Shula* (peptic ulcer), *Udararoga* (ascitis), *Meha* (diabetes), *Grahani* (bowel syndrome), *Arsha* (piles), *Pinasa* (rhinorrhoea), *Amlapitta* (acidity), etc.

Adjuvant:

Tamra Bhasma should be prescribed along with milk, ghee, honey, sugar candy, powder of *Piper longum* fruit, juice of *Bombax malabaricum* root, etc. as adjuvant. It can also be prescribed with other drugs according to the diseases.

Dose:

1/8th to 1/2 *Ratti* (15 - 60 mg)/ day.

Unwholesome diet:

Sour food stuffs are contraindicated during copper therapy.

Adverse effects:

The raw copper or improperly prepared *Tamra Bhasma* may cause various illness like *Vanti* (vomiting), *Murcha* (fainting), *Bhrama* (hallucination), *Kleda* (perspiration), *Kustha* (skin disorders), *Shula* (spasmodic pain), *Medoroga* (hyperlipidimia), *Daha* (burning sensation), *Moha* (delirium), *Aruchi* (anorexia), ill health (*Asaukhya*), weakness (*Valanasha*), impotency (*Viryanaasha*), leads to lack of complexion (*Kantinasha*) and even death (*Ayunasha*).

Management of adverse effects:

Powder of *Corindrum sativum* (*Dhanyaka*) fruit or *Sesbania grandiflora* (*Munivrihi*) should be given repeatedly along with sugar candy (*Sita*).

Lauha (iron)**Pharmacological actions:**

Lauha Bhasma (incinerated iron) possesses *Vrishya* (aphrodisiac), *Vayasthapana* (anti-ageing), *Lekhana* (emaciating) and *Rasayana* (immunomodulator) properties. It increases potentiality (*Valya*), complexion (*Kantijanana*) and appetite (*Agni Vardhana*). It eradicates diseases caused by vitiated *Kapha* and *Pitta*.

Therapeutic uses:

Lauha Bhasma is used in *Pandu* (anaemia), *Prameha* (diabetes), *Yakshma* (tuberculosis), *Arsha* (piles), *Kustha* (skin disorders), *Krimi Roga* (worm infestation), *Kshinatwa* (cachexia), *Sthaulya* (obesity), *Grahani* (bowel syndrome), *Pliha Roga* (splenic disorders), *Medoroga* (hyperlipidemia), *Agnimandya* (dyspepsia), *Shula* (spasmodic pain), and in *Visha* (poisoning).

Adjuvant:

Lauha Bhasma is given with honey, ghee, powder of *Terminalia chebula*, *Terminalia bellerica* and *Emblica officinalis* fruits (*Triphala*), etc. It is also prescribed with other plant drugs acting on particular disease.

Dose:

1/4th to 2 Ratti (30 to 250 mg)/ day.

Unwholesome Diet:

Some food stuffs like *Kushmanda* (*Benincasa cerifera* fruit), sesame oil, *Masha* (*Phaseolus mungo* seeds), *Rajika* (*Brassica juncea* seeds and oil), wine, sour foods, fish, brinjal, *Karbellaka* (*Momordica charantia* fruit), etc. are forbidden during iron therapy.

Adverse reactions:

The raw iron or improperly prepared *Lauha Bhasma* may cause various ill effects like *Hritpida* (angina), *Kustha* (skin disorders), *Ashmari* (urolethiasis), *Shula* (spasmodic pain), *Daha* (burning sensation), weakness (*Vala Vinasha*), etc. even death (*Ayu Nasha*).

Management of adverse effect:

Powder of *Embelia ribes* fruit (*Vidanga*) should be given repeatedly with the Juice of *Sesbania grandiflora* leaves (*Munirasa*) and patients should be exposed to sunlight. If worm infestation occurs, then patient should be purgated by giving the fruit pulp of *Cassia fistula* (*Aragvadh Phala Majja*). If patients complain of spasmodic pain (*Shula*), then *Abhraka Bhasma* (incinerated biotite mica) and Powder of *Embelia ribes* fruit (*Vidanga*) with juice of *Embelia ribes* fruit (*Vidanga*) or Powder of *Elletoria cardamomum* seeds (*Ela Churna*) should be given repeatedly.

Naga (lead)**Pharmacological actions:**

Naga Bhasma (incinerated lead) acts as *Deepan* (appetizer), *Kamavalakara* (aphrodisiac), and *Rasayana* (immunomodulator). It alleviates urinary tract disorders (*Mutra Roga Nashaka*) and diseases caused by vitiated *Vata* and *Kapha*.

Therapeutic indications:

Naga Bhasma is indicated in *Prameha* (diabetes), *Amavata* (rheumatoid arthritis), *Dhanurvata* (tetani), *Jwara* (fever), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Kshaya* (emaciation), *Shosha* (cachexia), *Swayathu* (oedema), *Gulma* (abdominal tumor), *Grahani* (bowel syndrome), *Arsha* (piles), *Vrana* (ulcer), *Atisara* (diarrhea), etc. It is also prescribed in all water born diseases (*Sarva Udaka Dosh*).

Adjuvant:

Naga Bhasma should be prescribed along with milk, rice, wheat, sugar candy, sesame oil, etc. as adjuvant. It can also be prescribed with other drugs according to the diseases.

Dose:

1/4th to 1 Ratti (30 to 125 mg)/ day.

Adverse effects:

The raw lead or improperly prepared *Naga Bhasma* may cause various illness like *Prameha* (diabetes), *Kshaya* (emaciation), *Pandu* (anaemia), *Kamala* (jaundice), *Kustha* (skin disorders), *Gulma* (abdominal tumor), *Sotha* (oedema), *Bhagandara* (peri-anal fistula), *Agnimandya* (dyspepsia), etc.

Management of adverse effects:

Hema (gold) and Powder of *Terminalia chebula* (*Haritaki*) should be given repeatedly along with sugar candy (*Sita*) for 3 days.

Vanga (tin)**Pharmacological actions:**

Vanga Bhasma (incinerated tin) possesses *Vrishya* (aphrodisiac), *Vrimhana* (rejuvenator), *Deepana* (appetizer), *Pachana* (digestive), *Ruchikara* (appetizer) and *Rasayana* (immunomodulator) properties. It increases potentiality (*Valya*), complexion (*Prabhakrit*), and intellect (*Pragnakara*). It eradicates diseases caused by vitiated *Kapha* and *Pitta*.

Therapeutic uses:

Vanga Bhasma is used in *Prameha* (diabetes), *Medoroga* (hyperlipidemia), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Akshiroga* (ophthalmic disorders), *Krimiroga* (worm infestation), *Kshaya* (emaciation), *Adhmana* (flatulence), and in *Sukrakshaya* (oligospermia).

Adjuvant:

Vanga Bhasma is given with ghee, borax (*Tankana*), camphor, juice of *Occimum sanctum* leaves, etc. It is also prescribed with other plant drugs acting on particular disease.

Dose:

1 to 2 Ratti (125 to 250 mg)/ day.

Wholesome diet:

Rice, *Mudga* (*Phaseolus aureus* seeds), butter, butter milk, *Tila* (*Sesamum indicum* seeds), and bitter food stuffs should be prescribed during tin therapy.

Adverse reactions:

The raw tin or improperly prepared *Vanga Bhasma* may cause various ill effects like *Prameha* (diabetes), *Kustha* (skin disorders), *Gulma* (abdominal tumor), *Hridroga* (cardiac diseases), *Shula* (spasmodic pain), *Arsha* (piles), *Vatashonita* (gout), *Apachi* (goiter), *Kasa* (cough), *Shwasa* (dyspnoea), weakness (*Balapaha*) and *Vamana* (vomiting).

Management of adverse effect:

Powder of *Mesashringi* (*Gymnema sylvestre*) fruit should be given with sugar candy repeatedly for 3 days.

Yasada (zinc)

Pharmacological actions:

Yasada Bhasma (incinerated zinc) acts as *Chakshushya* (ophthalmic nourisher), *Rasayana* (immunomodulator). It increases strength, potentiality, and intellect (*Vala*, *Virya*, *Viveka Samriddhikara*) and alleviates diseases caused by vitiated *Kapha* and *Pitta*.

Therapeutic indications:

Yasada Bhasma is indicated in *Prameha* (diabetes), *Pandu* (anaemia), *Shwasa* (dyspnoea), *Kasa* (cough), *Kshaya* (emaciation), *Vrana* (ulcer), *Avasada* (depression), *Kampavata* (tremor), *Chakshuroga* (ophthalmic disorder), etc.

Adjuvant:

Yasada Bhasma should be prescribed along with ghee, betel leaf juice, rice water, sugar candy, *Kharjura* (*Phoenix sylvestris* fruit), etc. as adjuvant. It can also be prescribed with other drugs according to the diseases.

Dose:

½ to 1 *Ratti* (60 to 125 mg)/ day.

Adverse effects:

The raw zinc or improperly prepared *Yasada Bhasma* may cause various illnesses like *Prameha* (diabetes), *Ajirna* (indigestion), *Vamana* (vomiting), *Bhrama* (hallucination), etc

Management of adverse effects:

Powder of green *Terminalia chebula* (*Vala Haritaki*) should be given repeatedly along with sugar candy (*Sita*) for 3 days.

Discussion

The chemistry and the basis of biological activity of the elements can be partly understood from the periodic table. Out of 92 natural elements, about 65 are considered to be involved in the sustenance of life. The useful metals can be either essential being macro or micro nutrients, or beneficial. The rest of the metals are biologically inert or toxic (Cotton¹¹).

Metals and their cations play a critical role by acting as catalysts or structural components of large molecules with specific functions and thereby indispensable for life. Of the biological active metals, the lighter ones, such as Na, K, Mg, and Ca are present in large amounts, and they are needed individually to maintain *inter alia* the osmolarity of biological fluids, the structure and function of cell membranes, synthesis of proteins, conduction of nerve impulses and construction of muscles. Heavy transition metals like Fe, Co, Cu, Mn, and Mo are present in traces and are selected for specific tasks in biological systems. Beside these, metals are essential for the activity of several enzymes,

both as activators in enzymes metal substrate complexes. Transition metals play an important role by forming stable coordinate bonds at fixed positions of immobile protein molecules. Metals can be directly bound to proteins or many attach through an organic legend such as heme (Phipps¹²).

Life essentially is a manifestation of inorganic chemistry as stated by Degens. Metals are used by mankind for building strength materials, chemicals, catalysts, nutrients and drugs. In biological systems too, the same uses are there, with bone, muscle contraction and membrane phenomena, energy production, enzymes, tissue electrolysis and metabolic regulators having essential dependence on metals (Rollinson¹³). The absorption of a metal by an individual varies with age, mental state, the amount and the chemical form of the metal ingested, and with conditions in the gastrointestinal tract and the composition of the food entering the stomach, as for example gastric pH lower than 5, amino acids, ascorbate, succinate and iron deficiency condition help in iron absorption, where as antacids, phosphate, pancreatic secretion reduce iron absorption (Satoskar¹⁴).

The Ayurvedic system of medicine perhaps should be considered as the pioneer regarding the pharmaceutical processing and therapeutic application of the metals. Even the heavy metals (Hg, Pb) and the toxic metals (Pb, Cu) are used in the practice of Ayurveda. The so called *Ayurvedic Samaskaras* (*Shodhana*, *Marana*, etc.) are claimed to make the metallic preparations relatively non-toxic (Kanase¹⁵, Pandit¹⁶, Sarkar¹⁷). The recent studies reported that the metallic *Bhasmas* are biologically produced nanoparticles and remain as multi-elemental cocktail (Kumar¹⁸, Kumar¹⁹, Bajaj²⁰, Bhoumick²¹, Singh²²). These studies help to explain the common properties of the *Bhasmas* like *Rasayana* (immunomodulator), *Yogavahi* (targeted drug delivery), etc (Sharma²³).

The management of adverse effects produced by raw metals or improperly processed metallic *Bhasmas*, mentioned in classics may prove as boon to the various industrial hazards and poisoning of metals. One recent study based on this principle reported that myrobalan (*Haritaki*) fruit powder counteracts lead acetate induced haematological parameters, splenomegaly as well as lowers lead load through excretion in faeces (Rathore²⁴).

The pharmacology of metals described in *Ayurvedic* system of medicine is based on keen observation, theories, beliefs and experiences of the great ancient Acharyas. These may also answer the unnecessary hue and cry prevailing regarding the toxicity of the metallic *Bhasmas* that an improperly prepared *Bhasma* with greater dose and duration level may cause various adverse effects. No contraindications of these *Bhasmas* indicate universal applicability to all the age levels and also to pregnant and nourishing lady with suitable adjuvant, proper dose and duration.

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