Ayurvedic View on Heavy Metal Poisoning with Special Reference to Naga bhasma (Incinerated Lead) - A Literary Study

Dhirajsingh Rajput* and Biswajyoti Patgiri

Dept of Rasashastra, IPGT & RA, Gujarat Ayurved University, Jamnagar, Gujarat, India

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ABSTRACT
Naga bhasma (incinerated Lead) is one such preparation containing lead as a main ingredient. According to the modern science, lead and lead compounds are toxic to human health. Manifestation of some extraordinary medicinal properties in Naga bhasma indicates that, the Ayurvedic processes performed during its preparation must be bringing about some radical changes in lead, which not only destroy its toxic nature but impart some extraordinary medicinal properties ascribed to Naga bhasma. Present work centered on the fact of heavy metal poisoning and Ayurvedic point of view towards the use of such metals with special reference to current research on toxicity of Naga bhasma. This study clearly shows that Naga bhasma is not just Lead, it’s a compound form predominantly crystalline i.e. mixture of PbO PbR3R4R. XRD data revealed OH and (CO2R3R2R) group which contain some other essential elements in minute quantity and didn’t have any toxic effect at LD50 which was 160 times higher to that of Therapeutic Equivalent Dose (TED) (12.5 mg/kg) in acute toxicity study.

Key words: Ayurveda, Heavy metal poisoning, Naga bhasma.

INTRODUCTION
The pharmacological section of Ayurvedic system of medicine recognizes three major sources of medicine, those of herbal origin (e.g. herbs), mineral origin (e.g. salts, metals like gold, copper, silver), and animal origin (e.g. milk, honey etc). Although, Kashthaushadhis and Rasaushadhis are two main groups of medicines, the former is devoid of any metals and minerals and is purely herbal product and can be considered as safest of medicines, and later consists of metal and minerals in the form of Bhasma (incinerated metal, minerals etc.). These metallic preparations occupies significant seat in Ayurvedic pharmacopoeia. The well known metal mostly used in Ayurveda includes mercury, gold, silver, copper, arsenic, lead and tin. These metals have specific gravity more than five hence these are categorized in group of heavy metals. Accumulated toxicity data on the hazardous effects of heavy metals have made health scientists afraid of heavy metals. As a result, renewed interest in the beneficial effects of metals and minerals is often viewed with skepticism. Many people’s which are unaware of the pharmaceutical processing of Rasaushadhis (bhasma and other herbo-metallic preparations), are in doubt about their safety and efficacy.

Bhasmas are unique Ayurvedic metallic preparations with herbal juices/fruits widely used for treatment of a variety of chronic ailments. The bhasmas are products of classical alchemy, organo-metallic compounds of certain metals and gems in a very fine powdered form, mostly oxides, made in elaborate incineration processes perfected several centuries ago. Now a days, some people who are unaware of the pharmaceutical processing of Rasaushadhis, are in doubt about their toxicity. Recent articles pertaining the alarming level of heavy metals, especially Pb, Hg, and As in Ayurvedic formulations have created a lot of controversy regarding the safety and efficacy of Ayurvedic formulations. It same context, Lead, mercury, and arsenic have been detected in a substantial proportion of Indian-manufactured traditional Ayurvedic medicines. Whether toxic metals are present in both US – and Indian – manufactured Ayurvedic Medicines are unknown, hence an attempt was made to study the fact of heavy metal poisoning and view of Ayurveda towards using the metals with special

*Corresponding Author: Dhirajsingh Rajput, Email: dhiraj.ayu@gmail.com, Phone No: +91-8460286952
reference to current research on toxicity of Naga bhasma.

Definition of Heavy metal and Heavy metal poisoning:
Heavy metals are essentially those chemical elements that have a specific gravity which is five times that of water.[1] The heavy metals which are most often found to be responsible for harmful damage to humans in cases leading to environmental pollution from various sources are mercury, arsenic, lead, cadmium and thallium. Heavy metal toxicity refers to the excessive build-up of heavy metals in the body.[2] Since body cannot degrade them, they get accumulated in body tissue and interfere in the healthy functioning of systems and may result in diseases like Alzheimer’s, neurological degenerative processes, Parkinson’s disease, muscular dystrophy, and multiple sclerosis.[3]

Modern and ayurvedic hazards of impure lead[4]:
Lead is a metallic irritant poison. As with other metals, the soluble compounds of lead are more poisonous than lead itself, except when lead is in the volatile state. Lead may obtain access to the body by inhalation, by ingestion, or by absorption from the skin or mucous surfaces. The primary effect of lead is to cause spasm of the capillaries and arterioles. The toxic effects result from fixation of lead in certain tissues such as brain and peripheral nervous system. Acute lead toxicity is infrequent and occurs from ingestion of acid-soluble lead compounds or inhalation of lead vapors. Symptoms are similar to arsenical or mercurial poisoning except that the stool is black from lead sulphide, and there may be blackened and offensive. The principal manifestations are GIT and CNS disturbances. These are Astringency, thirst, and a metallic taste, Nausea, abdominal pain, vomiting, Stools may be black from lead sulphide, and there may be diarrhea or constipation, Shock, Paresthesias, pain, muscle weakness, Hemolytic crisis followed by severe anemia and hemoglobinuria, Kidney damage with oliguria and Death may occur in 1 or 2 days.

Lead poisoning is mostly of chronic type. The signs and symptoms of chronic lead poisoning (plumbism) can be divided into six categories: gastrointestinal, neuromuscular, CNS, hematological, renal, and other. The neuromuscular and CNS syndromes usually result from intense exposure, while the abdominal syndrome is a more common manifestation of a very slowly and insidiously developing intoxication. The former is more common in children and later is more prevalent in adults.

Toxic effect of Lead mentioned in ayurveda.
Rasashastra a branch of Ayurveda basically related with use of metals and minerals. In Rasashastra not only the toxic effect of many metal and mineral are discussed in detail but also the treatment of the poisoning is also mentioned. According to Rasashastra if Naga (Lead) used without proper purification and incineration as per advised in classics, it will cause various diseases like Kushtha (various skin diseases), Gulma (abdominal tumors), Ruja (pain), Meha (diabetes), Pandu (anemia), Jwara (fever), Tridoshaprapoka (vitiation of all three dosha) [5], Mrityu (death) [6], Udara (ascitis) [7]; Sandhishula (joint pain), Pakshavadha (hemiplegia), Anaha (flatulence), Avabahuuka (stiffness of shoulder) [8]; Kandu (itching) and Anilasada (anorexia) [9] etc. most of the symptoms mentioned in ayurveda are same as mentioned in modern science, this indicate that the Lead poisoning is nothing but the effect of impure lead or improperly proceed and administered lead without following specified ayurvedic classical guidelines.

Bhasma and heavy metals:
Trituration of curd leads to formation of ghee but it doesn’t mean that curd is ghee. Similarly bhasma are prepared from heavy metals but they are not heavy metal. Sanskara (processing) brings significant difference in the initial and final material. Before using metals for therapeutic purpose Ayurveda clearly advised to conduct some procedures which are known as shodhana (purification). After purification the metals and minerals are subjected to repeated cycle of incineration followed by triturating with some herbal juices. Thus the formed product is a herbo-metallic incinerated form (bhasma) with new physical and chemical properties. Heavy Metals as popularly explained metals with specific gravity greater than 5 gm/cm which means when they are put on to the water they will settle at the bottom. But going by the tests for bhasmas for the final approval to use on the human beings must have following three qualities Varitar (they should float on water), Unnam (they should be able to take the weight of a rice grain, more weight bearing must be a critical change for the metals) , Rekhapurna (they should have microfiness to fit into the lines of the hand and should not glitter), Niruthha (metal should not gain its crystalline form after heating with ghee, seed of Abrus precatorius, honey, borax and extract of comifora mukul). It clearly
indicate that the in the process of repeated incineration the previous metal get completely destroyed (that’s why ancient acharya named this process as marana means killing of metal) thus bhasma are not heavy metals, they are nanoparticles with a mixture of organic and inorganic compounds. E.g. lead ahs a low melting point 327.46°C but the Naga bhasma (incinerated lead) didn’t melt even at 800°C and Naga bhasma is mixture of PbO Pb3O4 and contain either OH, (CO3)2 or (SO4)2 and (AsO3)3 group. The detail chemical form of Naga bhasma prepared by five different methods is given in (Table 1 & 2).

**Current research on Lead**

Pravin tate et al.\[^{10}\] conducted a work on acute and chronic toxicity of Naga bhasma. Acute toxicity study at LD\(_{50}\) which was 160 times higher to that of Therapeutic Equivalent Dose (TED) (12.5 mg/kg). In Chronic toxicity study, at a dose level TED x 0.5, and the overall toxicity study shows that both the test drugs do not produce significant toxicity at the dose level studied. Mrudula Wadekar et al.\[^{11,12}\] conducted a comparative study of some representative samples of Naga bhasma from chemical and structural point of view by using XRD, IR and UV spectroscopy and thermogravimetry is reported here. This study showed that the bhasama samples were predominantly crystalline i.e. mixture of PbO Pb3O4. XRD data reveled OH and (CO3)2 group in all samples. According to an antidiabetic research work on Naga bhasma carried out by Anjana Choube et al.,\[^{13}\] the drug showed no untoward effect in any of the patients during and after the clinical study, ninety percent of the patients expressed sense of well-being and 70% of the patients showed improvement in the symptoms. 65% of the patients showed reduction in blood sugar and they were taking other hypoglycaemics also along with Sastiputa Naga bhasma. Fifty percent patients, those on Sastiputa Naga bhasma alone, showed reduction in blood sugar. This study revealed that Sastiputa Naga bhasma can be recommended as a medicine and also as an adjuvant along with synthetic medicines for the management of diabetes mellitus.

Sing Maksoodan et al. studies on testicular regenerative potential of Naga bhasma. In this study it was observed that the test drug when given simultaneously with Cdcl2 showed marked prevention of toxic effects of Cdcl2 and when given alone after 36 hours of Cdcl2 administration, showed a noticeable regenerative potential on partially degenerated testes. It has showed specific regenerative effect on germinal epithelium of testes. Cdcl2 is toxic to testicular germinal epithelium and its effects can be minimized by Naga bhasma. In higher doses the drug is very effective, thus these findings are well collaborated with the Ayurvedic concept of vrishya property of Naga bhasma\[^{14}\]. S.K.Sing.et al.\[^{15}\] carried out a significant work on synthesis, characterization and histopathological study of a lead-based Indian traditional drug: Naga bhasma. A higher dose (adopted in the animal experimentation) of 6 mg/100 g of body weight per day has been tried for the toxicity study. No significant changes were observed in histology as well as normal anatomy of the skin, small intestine, pancreas, testis, brain, lung, kidney and liver in bhasma-treated and untreated groups of animals, while in case of crude lead treated group of animals significant changes in certain organs were observed. Thus, histopathological studies show that Naga bhasma is non-toxic (6 mg/100 g/day), while crude lead (6 mg/100 g/day) is highly toxic. Thus it appears that in bhasmikarana

### Table 1: XRD Investigation of Naga bhasma

<table>
<thead>
<tr>
<th>S. No</th>
<th>Sample Code No.</th>
<th>Constituents Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NGA.01</td>
<td>PbO+Pb3O4+ Pb(CO3)2(OH)2</td>
</tr>
<tr>
<td>2</td>
<td>NGA.02</td>
<td>PbO+Pb3O4+Pb(CO3)2(OH)2H2O+Pb10(CO3)6(OH)6O</td>
</tr>
<tr>
<td>3</td>
<td>NGA.03</td>
<td>PbO+ Pb(CO3)2(OH)2+Pb10(CO3)6(OH)6O</td>
</tr>
<tr>
<td>4</td>
<td>NGA.04</td>
<td>PbO+Pb(CO3)2(OH)2+Pb10(CO3)6(OH)6O</td>
</tr>
<tr>
<td>5</td>
<td>NGA.05</td>
<td>KNaPb8 AsO4)6+[Pb4(SO4)(CO3)2(OH)2]+[NaPb4(AsO4)3]+[K2Pb(SO4)2]+[Pb2(SO4)O]</td>
</tr>
</tbody>
</table>

### Table 2: Infrared spectra of Naga bhasma

<table>
<thead>
<tr>
<th>S. No</th>
<th>Sample Code No.</th>
<th>Significant Absorption peaks in cm(^{-1}) and Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NGA.1</td>
<td>(OH)(^{+})+ (H2O) (OH) (CO3)(^{2-}) (CO3)(^{2-}) (SO4)(^{2-}) (AsO4)(^{3-}) (OCO)(^{2-}) (OH)(^{+})</td>
</tr>
<tr>
<td>2</td>
<td>NGA.2</td>
<td>1406 1044 - - 890 682 668</td>
</tr>
<tr>
<td>3</td>
<td>NGA.3</td>
<td>1404 1020 - - 870 682 668</td>
</tr>
<tr>
<td>4</td>
<td>NGA.4</td>
<td>1417 1020 - - 880 682 668</td>
</tr>
<tr>
<td>5</td>
<td>NGA.5</td>
<td>1400 1020 1090 841 - 681 668</td>
</tr>
</tbody>
</table>
process the crude lead is converted into Naga bhasma, which is found to be non-toxic at lower dosages.

Basic concept of ayurveda and therapeutic use of metals:
The question which should arise is that whether the herbs and Metals used according to Ayurvedic principles does any harm to the human body the answer is simple and one word - no, because Ayurveda has given supreme importance to the human body and diet. Ayurvedic doctor will prescribe different medicine to the persons suffering from the same disease based on their individual Prakruti (nature), Vikruti (Disease), Dosha - dushya sammurchana (gradation of disease process) and Sroto-dushti (tissues involved) and that to with proper Anupan (vehicle for medicine) along with Patya - Apathya (do's and don'ts for diet) details. It's mentioned if a person is taking pathya ahar and vihara then he doesn't need any medicine, on the other hand if a person is not taking pathya then any medicine can’t cure his disease completely. In ayurveda detail instruction is available about pathya and apathy. E.g. Pathya and Apathya to be followed during intake of Naga bhasma;

Pathya:
Cereals, breads, rice, eat more dark green vegetables; eat more beans, fresh fruits, cow milk, Satu, Kulitha, Godhum, Sali rice, Karvellaka, Laghu and ruksha ahara.

Apathya:
Alcohol, Meat and Sweets, Poultry and eggs, fish, Dadhi, Til tail, Kshara, oily foods, Amla Rasa, Anup Mamsa and Smoking. All metals are present in the earth’s crust and enter our bodies continuously at low levels. It is a common mistake, based on fear and misinformation, to believe that a toxin has a linear toxic effect. Down to the lowest levels, all toxins have a safe threshold below which there is no toxicity. In fact, below a safe threshold toxicity disappears and there is no toxicity at all - and in some cases even benefit exists. Acharya Charaka said that;

It means a highly poisonous substance can prove to be an effective drug if used appropriately; conversely irrelevant or inappropriate use converts a good drug into a highly poisonous material. The situation suggests that possession of complete knowledge of the drug with regards to properties, dose, therapeutic action and pathya (do's and don’ts for diet) that should be followed after medication insures the safety and efficacy of that drug.

DISCUSSION
Toxicity of metals was not only fabulously known but also well documented in many Rasashastra texts, e.g. for the treatment of lead toxicity Acharyas advised to take Swarna Bhasma, Haritaki, and Sita internally for 3 days to remove unwanted effects of improperly processed or unripe Naga bhasma. Rasataranginikara mentioned Vishatinduka as an antidote for Nagadosha. Rasahridaya Tantra mentioned Gomutra, kutki, and Karvellaka Shifa as a remedy for Nagadi Kalankita Rasa (Rasajirna).

Modern research proved that heavy metals are found in everyday existence and are frequently hard to avoid entirely. Most people can excrete toxic heavy metals from the body successfully.[16] However, some people—especially those who suffer from chronic conditions cannot excrete them efficiently enough and a build-up occurs. Recent research also reveals that those who cannot excrete heavy metals efficiently appear to be genetically predisposed to this condition. Research has shown that the APO-E 4/3 and 4/4 genotypes are the worst excretors of heavy metals. Those with this version of APO-E protein abundant in the cerebral spinal fluid surrounding the brain will have the highest affinity for becoming ill from exposure to neuro-toxic heavy metals, especially mercury when it is present in combination with others. Heavy metal may affect the body through various sources. These sources include water, air, food, or absorption through the skin when in contact with those exposed to toxic farming, chemical and toxic exposure in industries, etc. These situations indicate that any medicine should be administered only after complete knowledge of person’s body and condition of disease i.e. by undertaking prakriti (individual personality), dosha-dushhya samurchhana (involved organ and vitiated dosha) and condition of dhatu (seven basic component of body mentioned in ayurveda).

CONCLUSION
The herbo-metallic preparations of ayurveda including Naga bhasma are safe and devoid of any major untoward effects, when manufactured and administered by following specified classical guidelines. The direction given by Acharya Charaka support this theory that is even fatal poison when used with skill and knowledge proves to be a good medicine, and a medicine used ignorantly acts as a poison. For the better
safety of ayurvedic herbo-metallic medicines, it is high time that instead of blindly following the text and prescribing the medicine, one should test it thoroughly for its side effects, dose, duration and toxicity in the target organ of the body. These tests will allow us to form some guidelines regarding contra-indications of our drug, and also unravel the myths and ambiguities about Rasaushadhis. Animal studies are also needed because they give us the guidelines and help us to solve the queries on the extent of use of Rasaushadhis in regards to its safety margins. It does not mean that these guidelines are not mentioned in the text but in some cases it is difficult to evaluate dose and duration of drug in human body in modern era. The findings of animal studies have helped modern medicine a lot to know the pros and cons of the drug. This can also be applied to our ancient formulations to know the extent of dose response it can produce in human body.

REFERENCES