



## Editorial

## Contributions of ancient Indian knowledge to modern medicine and cardiology



## Keywords:

Ancient Indian medical knowledge

## 1. Preamble

Prof. Rakesh Yadav, the Editor-in-Chief of Indian Heart Journal, during his conversation with Prof. Jagat Narula asked, “We have often claimed that earliest application of systematic medicine began in India and that Sus'ruta and Charaka Samhitas were the oldest sources of medical knowledge. What is not clear is as to how did the knowledge spread to the Western world and how did the Indian medicine influence modern medicine? Or even more specifically how has ancient Indian medicine influenced cardiology in particular?” With a chuckle Narula responded, “Immensely! What more, the name HEART itself is derived from Hridaya!! We knew about the anatomy and physiology of heart many hundreds of years ago.” Working with Dr. Raj Vedam and Prof. Tabassum Pansare, Prof. Narula tries to substantiate his claims herein.

## 2. Origins of Indian medicine

Ancient Indians made great advances in medicine, as exemplified in the classic works by Sus'ruta and Charaka among others. In addition to authoritative texts, through an interesting pedagogical approach in ancient India, the wisdom, morals and learning were passed down as stories.<sup>1</sup> The wisdom became apparent provided one could unlock the metaphors inherent in the folklore. Failure to appreciate the metaphors kept understanding at the mythical level.

As narrated by Sitaram Ayyagari, a Vedic scholar, the story of Karkati from Yoga Vasistha,<sup>2</sup> a compendium made over several periods of time, and dated variously by different people to the Ramayana period, spread the message of healthy lifestyle and hygiene. In this metaphorical story, the protagonist, Karkati, was a monster who assumed gigantic form and consumed humans with insatiable hunger, except those protected by chants, medicinal herbs, austerities, and good deeds. The demon had obtained “*anAyasi-Ayasi*” boon, became an iron pin-like entity through which it could suck blood of people who consumed uncooked foods, ate untimely,

were gluttonous, had loose morals and dwelled in unhealthy places. The needle-tip entity entered through nostrils and ears, made it to the heart, disrupted sleep, affected other organs and attacked only intemperate people.

Even cursory reading suggests the importance of prudent diet, hygiene, and good mental and physical health as the moral hidden within this story. It is remarkable that in ancient times, the sages discussed deep knowledge of processes that caused ill-health, and spelled out even the likelihood of genetic transmission mechanisms. This story is an exemplar of how wisdom was encoded using metaphors within ancient stories in India using metaphors.

## 3. Chronology of Ancient Indian Medical Knowledge

The earliest corpus of medical works is embodied in the *Atharvaveda*, transmitted from antiquity in oral form. *Atharvaveda* contains sections that discuss longevity, treatment of ailments, cures for specific diseases, eradication of germs, antidotes to poison, prudent food habits and healthy lifestyle.<sup>3</sup> As exemplified in Patanjali's *Yoga Sutras* (fountainhead), exhorting good thoughts, good works, *asanas* (yoga poses), *pranayama* (control of breathing process), and meditation to attain healthy body and mind, and eventually *Samadhi* (meditative contemplation to attain higher consciousness). Philosophical notions coexisted with medical knowledge with no conflict. The roots of *Ayurveda* are in *Atharvaveda*, viewing ill-health as due either to unwholesome lifestyle, or due to *Karma-phala* (fruits of deeds committed).

*Ayurveda* viewed the human health in terms of three *doshas* (fundamental energies or governing principles of body) comprising 5 elements – *Vata* [air (*Vayu*) + space/ether (*Aakash*)], *Pitta* [fire (*Agni*)], and *Kapha* [earth (*Prithvi*) + water (*Jala*)], imbalance of which gave ill-health, and sought correction to the ideal. The universe was considered composed of the *Pancha Mahabhootas* (5 great elements) and the physiological functions controlled by the *doshas*. The human body was defined as comprising *saptadhatus* (7 fundamental principles/tissues) – *Rasa* (tissue fluids), *Rakta* (blood), *Mamsa* (muscle), *Meda* (fat), *Asthi* (bones), *Majja* (marrow), and *Shukra* (reproductive tissue).<sup>4</sup> Praying to divinities for healing and for good health was common in northern India by worshiping Sheetala Mata or Ma Durga, and in southern India by worshiping Mariamman. The iconography presents Sheetala Mata carrying a broom and carrying pots, illustrating the importance of cleanliness; the water was kept stored in bronze or copper pots for its antiseptic properties as was the use of herbal healing powers of turmeric and neem leaves.<sup>5</sup>

#### 4. Archeological record of medical practice

The early evidence of medical practices in India can be traced through the archaeological finds. A 9000-year-old tooth was found in Baluchistan<sup>6</sup> with apparent drilling to remove rotten dental tissue, and several skulls were recovered from Mehrgarh and Harappa Cemetery dating to 2300 BCE showing trepanation and the bone healing. In yet another find, near Baluchistan in the Burnt City dating to 2800 BCE, a skeleton with a bitumen prosthetic eye was retrieved from a grave.<sup>7</sup>

The use and construction of surgical instruments has been found in the medical compendium, *Sus'ruta Samhita* (code of practice), unsatisfactorily dated variously between 600 and 200 BCE by Western scholars. Surgical instruments made of copper were recovered from Taxila dating to this early period.<sup>8</sup> One of the earliest extant scripture of Indian medicine was recovered from the Xinjiang province, the Bower Manuscript – a birch bark document written in *Gupt Prakrit* (a vernacular), from about 200 CE. One might wonder how *Sus'ruta's* date was fixed. Rudolf Hoernle, an osteologist, who translated the Bower Manuscript, also attempted to date *Sus'ruta* by studying the bone and altar descriptions in the *Satapatha Brahmana* (100 paths of *vedic* commentary).

#### 5. Date of *Sus'ruta*

Hoernle used Buddhist sources to place *Sus'ruta* to the East at Kasi, and Charaka as a physician in the court of King Kanishka.<sup>9</sup> He noted that *Charaka Samhita* counted 360 bones of the human body in 30 categories in contrast to 300 bones in 23 categories in *Sus'ruta Samhita*. He stated that *Atreya's* theory of the skeleton as found in *Bheda Samhita* concurred with Charaka and counted 360 bones of the human body in 30 categories, even though there were significant differences in the categories and the bones that were counted. Hoernle claimed that the reference to 360 bricks in a Vedic altar mentioned in *Satapatha Brahmana* in 4th and 12th paragraphs of 5th chapter in the 10th section is in relation to bones of the human body.

Placing the author of *Satapatha Brahmana-Yajnavalkya*, in the court of Videha King *Janaka*, a contemporary of Kasi King *Ajatasatru*, Hoernle proposed the time-period of 500 BCE for *Yajnavalkya*, citing Weber's works as a reference.<sup>10</sup> Hoernle noted that *Yajnavalkya* was aware of both descriptions of human skeletons proposed by *Sus'ruta* as well as *Atreya* and *Charaka*, and noted a strong influence of *Sus'ruta's* description of bones, marrow and fat (absent in *Atreya-Charaka's* description) in the description provided by *Yajnavalkya*. Hoernle claimed that *Sus'ruta* was aware of *Atreya's* bone classification, but introduced his own pointing out the differences from *Atreya's* method of exposition. Using Buddhist *Jataka* (newborn/birth) records that mention medicine as taught in the famous universities of Taxila and Kasi in the time of the *Buddha*, Hoernle placed *Atreya* at Taxila and *Sus'ruta* as his younger contemporary in Kasi, in the 6th century BCE. Given that *Yajnavalkya* in 500 BCE was aware of *Sus'ruta's* works, the latter was placed in an earlier time-frame to 600 BCE.

Such a dating leaves much to be desired. If one considers the internal evidence in *Satapatha Brahmana*, the astronomy observations encoded in the text lends to much earlier dating. *Dikshit*<sup>11</sup> noted verses 2.1.2(1)-2.1.2(3) that described setting the fires under open star cluster, *Krittika* (or *Pleiades*).<sup>12</sup> One of the statements therein that *Krittika* does not “move away from the eastern quarter” was highlighted as an ancient astronomical observation by *Dikshit*, and is a reference to heliacal rising of *Krittika* on the celestial equator, around 2980 BCE.<sup>11</sup> Therefore, if we pay attention to this evidence of *Satapatha Brahmana* and accept this early date, then *Sus'ruta* must be placed at least about 100 years prior to

*Satapatha Brahmana*, opening the possibility of very ancient date for the master surgeon, with supplements to his work in later periods by his disciples. Such mysteries abound in Indian texts and the origins of systematically practiced medicine could have been more ancient than proposed by the Western investigators who used latest recensions or methods from linguistics.

It is instructive to see what ancient books such as *Sus'ruta Samhita* dealt with. *Sus'ruta Samhita* has 120 chapters in 5 sections, where it discusses anatomy, physiology, pathology, pharmacology, diagnostic medicine, pediatrics, geriatrics, obstetrics and gynecology. *Sus'ruta* describes human anatomy in details and discusses 1120 diseases. *Sus'ruta* also describes surgical methods including excision, incision, suturing, scraping, puncturing, blood-letting, probing, extraction, rhinoplasty, and cataract surgery, and describes 121 surgical instruments.<sup>13</sup>

#### 6. Spread of Indian knowledge

Climate studies indicate that India experienced a multi-century drought about 4000 years ago,<sup>14</sup> triggering a great migration out to the fertile crescent and other areas. Cattle genomics show introgression of the Indian *Bos Indicus* (Zebu) drought-resistant cattle in that time-frame in the Fertile Crescent, indicating an out of India migration.<sup>15</sup> Interestingly, we also see some early medical works of Egypt such as *Smith Papyrus* (1500 BCE), *Ebers Papyrus* (1550 BCE) and *Kahun Papyrus* (1800 BCE) that contain a mix of spells and topics on surgery and medicine, arising in this post-migration period. Royle has discussed plants and materials from India in use in Egypt, hinting ancient transfer of knowledge.<sup>16</sup> We can also see some parallels in the medical works of the *Mittani*, *Hittite* and *Kassite* people, again in the post-migration period.

In ancient Greece, we note the travelers such as *Pythagoras* and *Democritus* who visited India for knowledge and see the impact on their societies. For example, *Hippocrates* (460-370 BCE) who was a student of *Democritus*, proposed a model for the human condition using the elements of air, fire, earth and water, and the conditions of hot, dry, cold and wet, and the humors bile, blood and phlegm, whose prototype appears to be the *Ayurveda dosha* model. With *Buddhist* missionaries active in the area, and the *Selucid* empire stretching from India to Turkey, it is not surprising that knowledge from India spread to these areas. The *Roman* trade as exemplified in the *Periplus of Erythrean Sea* shows that *Indian* medicines, herbs and spices were also part of the trade. In fact, *Dioscorides* (~70 CE) wrote a 5-volume *Materia Medica* with large number of *Indian* herbs. *Greek* and *Nestorian* refugees from the *Byzantine Empire* and *pre-Islamic Persians* were also students of *Indian* medical works at *Gundeshapur* in *Persia*. *Indian* medical works were propagated over the *Silk Route* to *China*, *Southeast Asia* as well as to *Mediterranean lands*, as exemplified by the finding of *Bower Manuscript* in *Xinjiang province*.<sup>17</sup>

The *Islamic* period from 711 CE saw several *Indian* medical works translated to *Persian* and *Arabic* and injected into several cities along the *Abbasid Empire*, stretching from *Sindh* to *southern Spain*. This *medical knowledge* eventually reached *Western Europe* via *translation schools* in *Toledo* in *Spain*, and *Sicily* in *Italy*, where the *Arabic* works were translated to *Latin*, between the 10th and 13th centuries. This allowed *medieval Europe* to ramp up on *Indian* *medical knowledge*, until such time the *European colonialists* got *direct knowledge* from *India*. *Garcia da Orta's* 1534 CE book on *Ayurveda* and herbs was translated to *Latin*. *Dutch* *botanist Hendrik van Rheede* (1636–91) wrote a book with *Ayurvedic* physicians help in *Kerala*. *Johann Koenig* (1768) wrote based on earlier works on *Indian botany*. These instances support the spread of *Indian* *medical knowledge* through the *Old World* in various periods of time.<sup>17</sup>

## 7. Contributions to cardiology

It is believed that the old European terms describing the **Heart** took their roots in the Sanskrit word- *Hridaya*. The search in English encyclopedia for the origin of the word-heart lead to *heorte* that meant breast, soul, spirit, will, desire, courage, mind and intellect. It could also be connected to Proto-Germanic *hertan*, old Saxon *herta*, old Frisian *herte*, old Norse *hjarta*, Dutch *hart*, old high German *herza*, German *Herz*, and Gothic *hairto*.<sup>18</sup> Spelling with -ea- could reflect to origin before c.1500, reflecting what was then a long vowel, and the spelling was retained when the pronunciation shifted. Most of the modern figurative senses were present in old English, including the notion of heart as the seat of inmost feelings, emotions, love and affection, or courage from late 14c.

The Sanskrit word, Hridaya was derived from 3 verbs as per Satpath Brahman and Brihadaranyak. (i) **HRU** for *harati* i.e. to receive from or to abduct, (ii) **DA** for *dadati* i.e. to give or to donate, and (iii) **YA** for either *yagati* i.e. to control through self-generated rhythmicity, or *Yama* i.e. maintaining balance for contraction and relaxation, or to circulate.<sup>19</sup> Therefore, the word hridaya in itself was a comprehensive physiologic expression. The concept of hridaya was illustrated in Charak Samhita within the chapters including *Arthe Dash Mahamully Adhyaya* and *Trimarmiya Adhyaya*. The hridaya was described as the organ engaged in contraction and relaxation ceaselessly during waking and sleep. Described first in *Atharva Veda*, hridaya was considered as an organ system including *sirasthahridaya* i.e. brain and *urusthahridaya* i.e. heart. *Yogvashishtha* also clearly mentioned a thoracic and a cranial hridaya,<sup>20</sup> and expressed the emotional component of the heart.

Genetically, hridaya was considered a maternal organ.<sup>21</sup> It originated from the essence of *shonita* (feminine genotype) i.e. rakta and kapha. A parallel was drawn between the evolution into a muscular organ similar to that of myometrium.<sup>22</sup> A high mitochondrial content of the myocardium also supports maternal origin. *Shukra* or masculinity genotype, responsible for regenerative function, was not considered an important player; cardiomyocytes are not capable of replication. By the fourth month of pregnancy the evolution of the heart was considered completed and began to work in mother's womb<sup>23</sup> when the mother was referred to as *dvihriday* (dual hearted). In the *Garbh Vyakarana* (embryology) *Sharir-opkramnitya* Adhyaya of *Sharir Sthana* in Sus'ruta Samhita, hridaya was described as a type of *sira-marma* (*sira* = vessel, *marma* = vital part)<sup>24</sup> wherein hridaya gave *rasa* (plasma), *rakta* (blood) and *oja* (energy/nutrition) through *srotas* (tracts/vessels) to the entire body.<sup>25,26</sup> Sus'ruta reported hridaya as *Marmasthan*, *Pranayatan* (seat of vitality) or *sadhyapranhar* (a vital organ) based on fatal prognosis of injury to the organ.<sup>27</sup> *Kashyapa* referred to hridaya as *mahamarma* (predominant vital organ),<sup>28</sup> similar to Charaka who attributed the supreme vital organ status to hridaya being the seat of *aatma* (soul) and *manas* (spirituality).

Considered to be a hollow organ, hridaya was referred to as home i.e. *aashaya* or *kostha* by Sus'ruta,<sup>29,30</sup> and *kosthanga* by Charaka and *Vagbhata*.<sup>31</sup> When describing the location, Sus'ruta mentioned the hridaya to be situated between the two breasts, in the chest above the mouth of the stomach.<sup>32</sup> About the size of individual's fist, it was described to be shaped as *adhomukhapundrika*, i.e. an inverted lotus with apex directed downwards.<sup>33</sup> In *Garbh Vyakarana*, Sus'ruta described the development of hridaya with adjoining organs including *pleeha* (spleen), *phuphus* (lung) and *yakrut* (liver), and within *klome* (mediastinum).<sup>34</sup>

## 8. Hridroga and pathophysiology of circulation

In a section on *Kaya Chikitsa Tantra* (physical medicine doctrine), Sus'ruta described symptoms and treatment of heart disease

(*Hidroga*) in the 43rd chapter.<sup>35</sup> The hridroga were reported due to dysfunction of *vayu* (wind or circulation), especially *prana* (air exchange) and *vyana* (omni present air or circulation) *vayu*.<sup>36</sup> Furthermore, hridaya was also associated with *sadhak pitta* (heart-mind balance, consciousness),<sup>37</sup> *avalambak kapha* (i.e. structural integrity of heart and lungs)<sup>38</sup> and *oja* (metabolism or energy distribution).<sup>39</sup>

*Pranavayu* was associated with blood cleansing and acceptance of the *rasa-rakta* complex in the heart (*aadaan*), valve closure, and generating *praspand* (cardiac impulse). *Pranavayu* brought *amberpiyush* (oxygen) with every inspiration and *udanavayu* provided *bala* (energy) to cardiac muscles. The latter was accountable for the force required to propel and circulate (*vyana*) the *rasa-rakta* complex along the *mahadhamanee* (aorta). Defects of *pranavayu* and *udanavayu* could result in enlargement or failing of heart. Sus'ruta described *mandala sandhis* (or the valves) that controlled the unidirectional flow of *rasa-rakta* complex in and out of the heart. In *amavata* (arthritis) valves could become affected. The *vyanavayu* controlled the rhythmicity of the hridaya as well as contraction and relaxation.<sup>40</sup> *Vyanavayu* was considered responsible for the circulation of *rasa-rakta* complex from the heart to the body along three directions i.e. upwards (heart to head and back), horizontally (portal circulation) and downwards (peripheral circulation). *Samana-vayu* indirectly influenced the heart by bringing the nutritive fluid from digestive tract to the heart. On the other hand, whereas *sadhakapitta* could affect rhythmic control of the heart,<sup>41</sup> the *avalambak kapha* accounted for lubrication<sup>42</sup> and could now considered to be associated with pericardial effusion, pleural effusion and pulmonary edema.

## 9. Conclusions

The history of Indian medical systems shows rich contributions over the ages by several physicians and surgeons. In this brief paper, we have outlined the antiquity of Indian medical systems, its impact on the ancient, medieval and modern medicine and suggestion that substantial knowledge about the functioning of the heart existed BCE.

## Declaration of competing interest

None declared.

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