

## OPHTHALMIC IDEAS IN ANCIENT INDIA

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The article gives details of descriptions on structure and working of eye, eye diseases and their treatment, sense organs and their seats in the body, mechanism and paths of perception of five senses in general and those of vision in particular, as gleaned from ancient Indian philosophical and medical works. It also examines specimens from these literatures to appreciate as to how the ophthalmic ideas evolved in India in the period and its further extension. The distinctive features of ophthalmic<sup>1</sup> science that developed in the west have also been discussed.

**Key words:** Ancient philosophers, *Mahābhārata*, *Carakasamhitā*, *Suśrutasamhitā*, *Bhelasamhitā*, *Aṣṭāṅgahṛdayasamhitā*, Commentaries, Sense organs, Visual perception

### Introduction

In the literature on ancient Indian medicine one often comes across articles that narrate ophthalmology and cataract surgery as described in *Suśrutasamhitā*. Nineteenth and twentieth century Indian and European doctors witnessed ancient procedure of cataract surgery being carried out by wandering *vaidyas*, *hākims* or barbers, and they wrote down its detailed accounts. Moreover, several twentieth century Sinologists mentioned Chinese ophthalmic works attributed to Nāgārjuna and thereby pointed at the medieval transmission of ophthalmic knowledge to China. These cases underscore ancient Indian ophthalmic tradition, its continuance up to modern times and its transmission to neighboring countries. India indeed had a long tradition of ophthalmic study and practice starting from the legendary Nimī through Suśruta and Nāgārjuna of second to fourth century AD, Vāgbhaṭa of sixth century AD and so on up to pre-modern times.

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On the other hand, the advent of modern science of ophthalmology is essentially a western phenomenon. Naturally, the foremost questions that arise are ‘Did ancient Indian ophthalmology contribute in the shaping of modern science of ophthalmology?’ ‘What was the input by Suśruta and other ancient Indian scholar-practitioners?’ ‘Did ophthalmology progress in India after its significant growth as seen in *Suśrutasaṃhitā*?’ or, ‘How did ancient ophthalmic knowhow in the west differ from its Indian counterparts?’, and ‘Did it possess any special characteristics that enabled its transformation to scientific ophthalmology as we see today?’

When the contemporary practitioners of Ayurvedic ophthalmology treat eye diseases and also when they write textbooks on the topic, they invariably include modern scientific information on anatomy, physiology, pathology etc for diagnosis and treatment. Although present-day students and practitioners of Ayurveda, no doubt, need to incorporate the latest information on the subject in their study and practice, it fails to underline historical progress of Indian ophthalmology as well as its limitations. A historian of medicine needs to know how the discipline grew over centuries in India and elsewhere. He needs to pinpoint how ophthalmic philosophy i.e. ideas related to both the theoretical and practical aspects grew with time till the modern discipline was defined. These ideas include understanding of anatomical parts of the eye, their construction and working, sense organs and their respective seats, mechanism and paths of perception and also causes and classification of diseases and their treatment.

This article provides an overview of ophthalmic philosophy that developed in India since antiquity till pre-modern times as against the western development on the subject. We divide the article in three main sections. Section one focus on ophthalmic ideas in Ancient Indian non-medical literature drawing references to ophthalmology in classical works like *Atharvaveda* and *Upaniṣads*, medieval philosophical literature, Buddhist literature and popular Sanskrit literature. Section two draws from ophthalmic ideas in ancient Indian medical literature of *Carakasamhitā*, *Suśrutasaṃhitā*, *Bhelasaṃhitā* and later Ayurvedic works and commentaries. Section three provides an outline of the evolution of ophthalmic theory in other world civilizations.

## 1. OPTHALMIC IDEAS IN ANCIENT INDIAN NON-MEDICAL LITERATURE

### 1.1 *Atharvaveda and Upaniṣads*

Indian ophthalmic tradition began much before Suśruta's time and references to structure and working of eye, eye diseases and their cure are found in Vedic literature. *Atharvaveda*, composed by seventh - eighth century BC, contains verses referring to eye diseases.<sup>2</sup> Exact nature of these diseases is not clear and the cures suggested consist both of magical spells and plant preparations.

*Upaniṣadas* form a part of *Vedānta* texts that were traditionally supposed to be composed in the post-Vedic period and are ascribed a date between 1000 BC to 200 AD. The very first attempt to hypothesize relation between morphological components of the eye and natural and mythological forces expressed in terms of primary elements is seen in the *Upaniṣadic* literature. In fact, it is an attempt to explain anatomy and working of the eye.

तमेताः सप्तक्षितय उपतिष्ठन्ते तद्या इमा अक्षन्लोहिन्यो राजयस्ताभिरेन ऊँ  
रुद्रोऽन्वायत्तोऽथ या अक्षन्नापस्ताभिः पर्जन्यो या कनीनका तयाऽऽदित्यो यत्कृष्णं  
तेनाग्नि यत्शुक्लं तेनेन्द्रोऽधरयैनं वर्तन्या पृथिव्यन्वायत्ता द्यौरुत्तरया नास्यान्नं  
क्षीयते य एवं वेद।<sup>3</sup> (*Bṛhadāranyaka Upaniṣad*, 2.2.2)

“Through these pink lines in the eye *Rūdra* attends on it, through the water that is in the eye - *parjanya* (rain), through the pupil - the sun, through the dark portion - the fire, through the white portion - *Indra*, through the lower eyelid - the earth attends to it, through the upper eyelid - the heaven.”

### 1.2. Medieval Philosophical Literature

Medieval Indian philosophers searched into causes behind various physical phenomena occurring in nature and their relationship with man. They endeavored to go beyond earlier writers who sought the causes in mythological and supernatural forces. Using observation, reason and logical argument as well as intuition the philosophers put forth hypotheses regarding principles governing these phenomena. In the process they defined a range of entities both abstract and concrete. Having known that man perceives nature by means of his five sense organs - nose, tongue, skin, ears and eyes;

sensing the smell, taste, touch, sound and color respectively; they further gave a thought to the means and mode of each kind of perception. *Tejas* was defined as an entity that possesses color and touch but no taste or weight. Since eyes only apprehend color and not smell, taste, touch nor sound; a causal relation between the organ of sight and *tejas* was conjectured as the *paramāṇus* (atoms) of *tejas*, very small amounts of other *bhūtas* or elements (*pṛthvī*, *āpa*, *vāyu* and *ākāśa*) along with certain *adr̥ṣṭa* (unknown/invisible factors) produce the organ of sight'.<sup>4</sup>

There were numerous conjectures regarding identity of the seat as well as mechanism of all perceptions including visual. The Buddhists considered eye ball as the seat of visual perception. They deduced that visual perception takes place when the organ of sight, the eye, helped by external matter which is light (*āloka*), and a desire to apprehend the object and also the past deeds (previous knowledge of the object), contacts the object. They considered eye ball as the organ of sight because all eye diseases are cured by treatment of eye ball alone.

*Nyāyaśāstra*, the school of philosophy invoking the doctrine of 'nyāya', propounded that direct perception (*pratyakṣa*) takes place only when there is contact between a sense organ and its analogous object. Since eye ball does not come in contact with the object Buddhists of 'Vaibhāṣika' school concluded that the sense organ of sight and hearing cognize their respective objects without coming in contact with them and the perception regarding their size, distance, direction etc takes place. Moreover, objects at different distances and sizes are perceived simultaneously.

*Nyāya-vaiśeṣika* philosophers did not agree with the view that eye ball is the visual organ. They argued that visual organ is produced by ultimate particles of *Tejasa*, and eye balls are only means through which rays centered in the *Tejasa* particles constituting the organ of sight, gradually expanding in wider circles (here they give example of a lamp wick) come in contact with the object. Hence the *Nyāya-vaiśeṣikas* concluded that the visual organ does not come in contact with the object when cognition takes place.

*Vaiśeṣika* philosophers further refuted simultaneous perception of objects placed at unequal distance from the viewer:

शाखाचन्द्रमसोस्तुल्यकालग्रहणाच्च यदि हि गत्वा गृहणीयात् निकटस्थमाशु  
गृहणीयात् दवीयस्तु चिरेणेति न तुल्यकालमुपलम्भयेत्

तुल्यकालग्रहणत्वासिद्धमेवच तदभिमानस्य कालसन्निकर्षणोपपत्तेः अचिन्त्योहि  
तेजसो लाघवातिशयेन वेगातिशयो यत प्राचीनचलचूडावलम्बिन्येव मयूखमालिनि  
भवनोदरेष्वालोक इत्याभिमानो लौकिकानाम्

टीका: तुल्यकालेति शाखाग्रहणानन्तरमेव चन्द्रग्रहणम् तयोस्तुल्यकालत्वधीर्भ्रम इत्यर्थः

(*Kiraṇāvali*<sup>5</sup>, *Udayanācāryaviracita* 1,2,3)

The idea was that *tejas* being light and its velocity so great that it becomes difficult to mark the difference of moments in its movement:

ततो न तैजसमिति तदसत अधिष्ठानसंबंधार्थग्राहित्वस्य प्रदीपेनानैकान्तिकत्वात्  
पृथुतरग्रहणस्यापि पृथ्वागतया तद्वदेवोपपत्तेः (*Kiraṇāvali*<sup>6</sup>)

Here they give example of sun-rays that travel at a great speed and spread over the entire world simultaneously in a single moment. As water falling into Ganges becomes Ganges water, ocular *tejas* was supposed to mingle with solar *tejas* to become one and thus could contact with external *tejas*, near or remote, simultaneously.

(i) Udayana (10<sup>th</sup> century AD) objected to this view by asking how, in that case, objects behind the wall cannot be apprehended<sup>7</sup>:

कुड्यान्तरितानुपलब्धेरप्रतिषेधः (*Kiraṇāvali*, 45)

(ii) He noted that when a piece of glass, mica or crystal is kept in between the eye and the object, one can still see objects<sup>8</sup>:

काचाभ्रदलस्फटिकाद्यन्तरितोपलब्धेश्च (*Kiraṇāvali*)

(iii) In this case the object definitely does not come in contact with the eye and hence the eye is *aprāpyakāri* or that which can perceive without coming in contact with the object<sup>9</sup>:

यदिहि प्राप्तं गुण्हीयात् प्रतिघातिना स्फटिकाद्रिव्येण विष्टम्भादप्राप्यं प्रसर्पत तृणादिकं  
नाददीत तस्मादप्राप्यकारि (*Kiraṇāvali*)

Thus there indeed was a dilemma, if the eye is *prāpyakāri* (the one which perceives only when it comes in contact with the object) then how is it that it can see the object when a piece of glass is between them, moreover, if it is *aprāpyakāri* then how is it that it cannot see the object behind the wall? The commentator, Konda Bhaṭṭa in his seventeenth-century commentary,

as quoted by Misra, explained that a forty year old person cannot see objects without the use of glasses. Konda Bhatta concluded that the bilious *tejas* that prevents real contact in old age is removed by the glasses.<sup>10</sup>

The above statement by Udayana is interesting since it mentions glass, mica or crystal in its application very similar to spectacles. In all probability, the property of glass when placed near the eye enabling it to see better was known. It does not infer though that spectacles were known and made from glass in India at this time. Earlier P K Gode surmised in his article that the Portuguese introduced spectacles in India and that the Indians did not know about spectacles or even the use of glass as an instrument for magnifying an image although they knew its application of focusing light rays which they employed in burning wood or paper (Gode 1969).

There was much debate as to whether two eye balls ought to be considered as two sense organs or just one. Vatsyāyana (5<sup>th</sup> century AD) was for two organs of sight; and others corroborated for the observation, when one eye ball is destroyed the other can still see:

चक्षुरद्वैतविचारप्रकारणम सव्यदृष्टस्येतरेण प्रत्यभिज्ञानात्-7

नैकस्मिन्नासास्थिव्यवहिते द्वित्वाभिमानात्-8

एकविनाशे द्वितीयाविनाशान्नैकत्वम्-9 (*Nyāyavārttikam*<sup>11</sup>)

Uddyotakara (7<sup>th</sup> century AD), on the other hand, argued that visual perception of a person with two eyes is better than the one with only one eye. He moreover added that the ancients always said there are five sense organs! Later writers held this view. Dharmapāla's commentary of *Ālamḅanaparīkṣā* of Dignāga, the text restored in Sanskrit from its Chinese and Tibetan versions, elaborated the double-moon cognition as not the real entity but an illusion due to defect of senses when eye is disturbed by cataract or other diseases or even pressed by a finger at one corner. The Chinese text states 非實有故 譬如二月由眼根亂 識似二月起二月非 識境界實 無有故 聚亦如此(The reason does not lie in real entity. For example, the reason of double moon is defect in the eye. To consider the double moon (cognition) as arising from (actual) double moon is wrong. The cognition is not based on reality. It is the accumulation (of cataract) that leads to this state.)<sup>12</sup>

Thus seemingly remote philosophical discussions contributed markedly to the theories of vision. The terms employed by the philosophers were used by later Ayurveda writers as well e.g. *tejaparamāṇu*, *rūpagrahaṇa* etc.<sup>13</sup>

### 1.3 Buddhist Literature

Buddhism being intimately concerned with deliverance from sufferings there are innumerable references to medicine in Buddhist literature. *Nirvāṇa* is considered as a state of relief from all sufferings and it is equated to *ārogya* (a state of no illness). The one who leads humanity to it, i.e. Buddha is equated to a physician and called 'Medicine Teacher or *Bhaiṣajyaguru*'.

Buddhist philosophy used medical terminology as a metaphor in explaining its various doctrines. Also analogy of Buddha removing the screen of ignorance using a probe of wisdom to the surgeon who removes cataract with a metallic probe is often found in Buddhist literature. It goes a long way to demonstrate that ophthalmic surgeries were very much a part of ancient Indian medicine at the time of writing of these Buddhist works. Even a symbolic cataract operation was imitated at the time of initiation of monks. The master would say,

"The Buddha, the king of physicians or *Vaidya-Rāja* clears away the membrane of ignorance with a golden probe." (*Vairocanasūtra*: Tatz 1985)

Buddhist philosophers also participated with philosophers of other schools in academic discussions on various topics like the five senses and sense organs, especially the seat of visual perception being the eye ball, as seen earlier.

### 1.4 Popular Sanskrit Literature

References to *añjanās* or eye ointments both literal and figurative are very common in ancient literature. In *Siddhāntakaumudī* of fourteenth century AD, the opening verse pays respect to the great grammarian Pāṇini and uses the well-known metaphor:

अज्ञानान्धस्य लोकस्य ज्ञानाञ्जनशलाकया चक्षुरुन्मीलितं येन तस्मै पाणिनये नमः ।

'I salute that Panini who opened eyes using a probe bearing the ointment of knowledge, of those who were blinded due to ignorance.'

There are innumerable references to eye as one of the five sense organs in Sanskrit historical classics e.g. *Mahābhārata*.<sup>14</sup> The fundamental concept of contribution of primary elements in the construction of human body and also relation of eye to the primary element 'fire' is time and again expressed in it<sup>15</sup>.

तद्वत्सोमगुणा जिह्वा गन्धस्तु पृथिवीगुणः । श्रोत्रं शब्दगुणं चैव चक्षुरग्नेर्गुणस्तथा ।  
स्पर्शं वायुगुणं विद्यात् सर्वभूतेषु सर्वदा ॥ (*Mahābhārata Śāntiparvan*, 32)

'Likewise, the tongue takes the characteristics of *soma* or moon, smell that of *pṛthvī* or earth, ears that of *śabda* or sound and eyes that of *agni* or fire, touch that of *vāyu* or wind, this is to be understood about all creatures at all times.'

A metaphor of 'eye of knowledge' is frequently used in *Mahābhārata* too.

चतुर्विधं प्रजाजालं संयुक्तो ज्ञानचक्षुषा भीष्म दक्षसि तत्त्वेन जले मीन इवामले ।  
(*Mahābhārata Śāntiparvan*, 21)

'Bhishma, you see the four kinds of subjects collectively, using the true principles with your eye of knowledge, as a fish sees in clear water.'<sup>16</sup>

*Śṛimatbhāgavadgītā* goes a step further to use the popular metaphor which states 'the probe of knowledge will open the eye and clear the vision', an obvious allegory to cataract surgery that clears the eyesight using a *śalākā* or metallic probe.

The idea that *mānas* or mind controls all perceptions and it is separate from bodily organs, moreover it is not corporeal is expressed in *Mahābhārata*. Thus,

चक्षुः पश्यति रूपाणि मनसा न तु चक्षुषा ।  
मनसि व्याकुले चक्षुः पश्यन्नपि न पश्यति ।

तथेन्द्रियाणि सर्वाणि पश्यन्तीत्यभिचक्षते । (*Mahābhārata Śāntiparvan*, 16)

'Eyes see objects using mind and not (only) eyes. When the mind is troubled, the eyes will not perceive even though they see. Similarly it is viewed in the case of all sense organs.'<sup>17</sup>

Also,

इन्द्रियानां हि सर्वेषामीष्वरं मन उच्चयते ।  
एतद्विषन्ति भूतानि सर्वाणीह महाशयाः । (*Mahābhārata Śāntiparvan*, 18)

‘Among all sense organs mind is called the ruler, it is believed by all wise people here.’<sup>18</sup>

Also,

मनः सत्वगुणं प्राहुः सत्वमव्यक्तजं तथा ।  
सर्वभूतात्मभूतस्थं तस्मात्बुद्ध्येत बुद्धिमान् ।

(*Mahābhārata Śāntiparvan*, 33)

‘The mind takes characteristics of *satva*. *Satva* is *avyakta* i.e. non-corporeal. Among all realms it belongs to the realm of *ātma* i.e. soul or spirit. This should be understood by a wise person.’<sup>19</sup>

References to eye, eye diseases and their treatment and visual perception that appear in popular Sanskrit literature express their presuppositions that were based on natural as well as supernatural and non-corporeal phenomena. References in the philosophical literature suggest that the philosophers based their conjectures on their own observations and they tried to find causes only in the physical reality. They observed that if one eye is damaged then the other could still see, but not as distinctly as with two. Ideas with respect to binocular vision were being formed in this way. Moreover they inferred that actual visual perceiver is not the eye but something else; eye is only a means to it. The ancients further argued that if we count two eyes and two ears as separate sense organs then the total number adds up to seven and it contradicts the age old belief of sense organs being five (*pañcendrīya*) in number; and therefore untrue. They recognized that the illusory double moon cognition was an outcome of eye defects. Dependence of visual perception on willingness to perceive probably suggested that the so-called ‘non-corporeal’ mind as the seat of perception. This came in the way of envisaging ‘brain’, a corporeal, physical entity within the body itself as the true seat of perception for quite some time. Case of *Bhelasaṃhitā* is the only exception which is discussed later. The philosophical ambiance definitely influenced contemporary medical philosophy and vice versa.

## 2. OPHTHALMIC IDEAS IN ANCIENT INDIAN MEDICAL LITERATURE

### 2.1 *Carakasamhitā*

*Carakasamhitā* is the earliest complete work on *Kāyācikitsā* or internal medicine. Along with *Suśrutasaṃhitā* and *Aṣṭāṅgahṛdayasaṃhitā* it is one

of the three major treatises of Ayurvedic medicine. It is ascribed a date between 100 BC to 100 AD. Caraka defined various terms used in the formulation of basic concepts of Ayurveda in its first chapter viz. *Sūtrasthāna*. He gave considerable thought to five senses, sense organs and their locations in the body, knowledge perceived by respective sense organ and also the substance or primary element they are made of. Specific terms were ascribed to these concepts to make further discussion comprehensible as well as precise. Caraka thus defined five groups or *Pañcapañcaka*, five *Jñānendriyas* or sense organs viz. eyes, ears, nose, organs of taste and touch; *Indriyadravyas* that each organ is made of as five primary elements, *bhū*-earth, *jyoti*-fire, *āpa*-water, *vāyu*-wind, and *kha*-empty space.<sup>20</sup>

तत्र चक्षुः श्रोत्रं घ्राणं रसनं स्पर्शनमिति पञ्चेन्द्रियाणि

पञ्चेन्द्रियद्रव्याणि – खं वायुर्ज्योतिरापो भूरिति (CS Sū 8.8-9)

Also,

महाभूतानि खं वायुराग्निरापः क्षितिस्तथा शब्दः स्पर्शश्च रूपं च रसो गन्धश्च तद्गुणाः  
(CS Śā. 1.25)

In *Śārīrasthāna*, Caraka defined five *karmēndriyas* or organs of action as hands, legs, rectum, reproductive organs and organ of speech, thus ten *iṅdriyas* altogether.<sup>21</sup>

हस्तौ पादौ गुदोपस्थं वागिन्द्रियमथापि च, कर्मेन्द्रियाणि पञ्चैव पादौ गमनकर्मणि

(CS Śā. 1.25)

Caraka also defined five *iṅdriyabuddhis* or knowledge acquired by five kinds of sense organs.<sup>22</sup>

इह खलु पञ्चेन्द्रियाणि, पञ्चेन्द्रियद्रव्याणि, पञ्चेन्द्रियाधिष्ठानानि, पञ्चेन्द्रियार्थाः, पञ्चेन्द्रियबुद्ध्यो भवन्ति, इत्युक्तमिन्द्रियाधिकारे—(CS Sū, 8.3)

Caraka mentioned in the *Cikitsāsthāna*, the chapter on Diagnosis, that ninety six eye diseases were differentiated by then. Caraka refrained from elaborating the topic since he considered it to be a privilege only of the specialist of the field (which he was not).<sup>23</sup>

नेत्रामयाः षण्णवतिस्तु भेदात्

तेषामभिव्यक्तिरभिप्रदिष्टा, शालाक्यतन्त्रेषु चिकित्सितं च, पराधिकारे तु न विस्तरोक्तिः  
शस्तेति तेनात्र न नः प्रयासः—131 (CS Ci 26.130-131)

Caraka included factors other than physical to explain the phenomenon of visual perception when he stated ‘Conscious perception arises from the fusion of *ātman* (self), mind, senses and sense organs’.<sup>24</sup>

## 2.2 Suśrutasaṃhitā

Suśruta’s compendium *Suśrutasaṃhitā* was made some two thousand years ago. Suśruta based his ophthalmic philosophy on several premises as discussed below.

### 2.2.1 Eye and five primary elements

The first was the longstanding theory related to the characteristics of primary elements that define their function in human body. It was delineated by ancient philosophers including the Buddhists as well as earlier medical authors like Caraka.

महाभूतानि खं वायुराग्निरापः क्षितिस्तथा ।

शब्दः स्पर्शश्च रूपः च रसो गन्धश्च । (CS Śā. 1.27)

‘The *Mahābhūtas* or primary elements like *kha-ākāśa* or empty space, *vāyu*-wind, *agni*-fire, *āpa*-water and *kṛiti*-earth, their characteristics are sound, touch, form, moistness and smell respectively.’<sup>25</sup>

Likewise, *Suśrutasaṃhitā* stated,

आन्तरिक्षस्तु—शब्दः शब्देन्द्रियं सर्वच्छिद्रसमूहो विविक्तता च; वायव्यास्तु—स्पर्शः स्पर्शेन्द्रियं सर्वचेष्टासमूहः सर्वशरीरस्पन्दनं लघुता च; तैजसास्तु—रूपं रूपेन्द्रियं वर्णः सन्तापो भ्राजिष्णुता पक्तिरमर्षस्तैक्षण्यं शौर्यञ्च; आप्यास्तु—रसो रसनेन्द्रियं सर्वद्रवसमूहो गरुता शैत्यं स्नेहो रेतश्च, पार्थिवास्तु—गन्धो गन्धेन्द्रियं सर्वमूर्तसमूहो गुरुता चेति । (SS Śā. 1-18)

‘The properties of *ākāśa* (ether) are sound, the sense of hearing, porosity and different evolution of veins. The properties *vāyu* (wind) are touch, the skin, all functional activities of the organism, throbbing of the whole body (*spandana*) and lightness. The properties of *teja* (fire or heat) are form, the eyes, colours, heat, illumination, digestion, anger, generation of instantaneous energy and valour. The properties of *āpa* (water or liquid) are taste, the tongue, fluidity, heaviness, coldness, oliginousness and semen. The properties or modifications of *pṛthvī* (the earth matter or solid) are smell, the nose, embodiment and heaviness.’<sup>26</sup>

### 2.2.2 Five kinds of *pitta*

*Suśrutasaṃhitā* differentiated ‘*pitta*’<sup>27</sup> into five kinds and stated that *ālocaka* kind of *pitta* helps in the visual perception. *Pitta* or fire considered as a manifestation of the fiery principle (*tejas*) in a living organism. According to its location and function, *pitta* in the body is of five kinds.

1. *Rañjaka Pitta* – Colour-producing fire: location in liver and spleen
2. *Pācaka Pitta* – Digestive fire: stomach and intestines
3. *Sādhaka Pitta* – Motion-giving fire: heart
4. *ālocaka Pitta* – Vision-giving fire: pupils of eyes
5. *Bhrājaka Pitta* – Lustre-giving fire: skin<sup>28</sup>

### 2.2.3 Anatomy of the eye

The premise related to various parts of the eye is based on the common observation that eye has eyelids, eye lashes, the white and black parts and the pupil at the center. For their apparent circular shape, Suśruta defined these five parts as five circles/wheels or *maṅḍalās*. They were called *pakśma*, *vartma*, *śukla*, *kṛṣṇa* and *dr̥ṣṭi* or eyelashes, eyelids, conjunctiva, cornea and pupil respectively. Again, Suśruta divided the substance that eye was made of into five parts viz. muscles, blood, black and white parts and empty channels (e.g. tear ducts). He linked them to five principal elements as follows,

पलं भुवो अग्नितो रक्तं वातात् कृष्णं सितं जलात्। (SS.Utta.1.11)

आकाशात् अश्रुमार्गात् च जायन्ते नेत्रबुद्धते। (SS.Utta.1.12)

‘In eye-ball, muscular, red, black and white portion and lachrymal passages originate from earth, fire, wind, water and the empty space respectively.’<sup>29</sup>

### 2.2.4 *Dr̥ṣṭi* (Vision or pupil)

In Ayurvedic works *dr̥ṣṭi* usually means vision but sometimes it can be taken as pupil, crystalline lens, or retina although there is no direct reference to suggest they had the knowledge of retina and its function.<sup>30</sup> Suśruta described *dr̥ṣṭi* as ‘of the size of half of the grain of a lentil (*masūradalamātram*)’.<sup>31</sup>

मसूरदलमात्रां तु पञ्चभूतप्रसादजाम् ।  
 खद्योतैस्फुल्लिङ्गभामिद्धां तेजोभिरव्ययैः ॥  
 आवृत्तां पटलेनाक्ष्णोर्बाह्येन विवराकृतिम् ।  
 शीतसात्म्यां नृणां दृष्टिमाहुर्नयनचिंतकाः ॥ (SS.Utta.7.3-4)

‘Of the size of half of the lentil grain (*masūradalamātram*), originated from the essence of five *bhūtas* or elements, resembling a glow worm and spark, shining with constant light, covered with the outermost layers of the eye, hole shaped and suited to cold’

It is possible that Suśruta was referring to the lens when he used this term and by that he perhaps meant to point out curvatures of two sides of the lens. He could have just said ‘*masūra*’, if he were only referring to size and not shape.

### 2.2.5 Paṭala (Structure of eye)

In addition, Suśruta perceived the structure of the eye in terms of layers or *paṭalas*.<sup>32</sup> *Suśrutasaṃhitā* expressed the location and progress of ‘*dr̥ṣṭi*’ kind of diseases as the disease entering successive layers or *paṭala* from first to fourth.

तेजोजलाश्रितं बाह्यं तेष्वन्यत् पिशिताश्रितम् ।  
 मेदस्तृतीयं पटलमाश्रितं त्वस्थि चापरम् ॥ (SS.Utta.7.18)

The layers were understood as that of *tejojala*, *piśita*, *meda* and *asthi* i.e. blood-water, flesh, muscles-fat and bones respectively.

Further,

चतुर्थं पटलं गतः – रुणद्धि सर्वतो दृष्टिं लिङ्गनाशः स उच्चते । (SS.Utta.7.19)

‘When the disorder advances to the fourth layer, vision is obstructed completely, it is known as *Liṅganāśa* (cataract)’.<sup>33</sup>

Suśruta described how eyeball is supported by an arrangement of blood vessels, muscles etc.

सिराणां कण्डराणां च मेदसः कालकस्य च ॥  
 गुणाः कालात् परः श्लेष्मा बन्धनेऽष्णोः सिरायुतः । (SS.Utta.7.19½-20½)

‘Excellent essences intermingled of blood vessels, ligaments, fat and bone play important role in supporting the eye-ball particularly mucus along with blood vessels.’

### 2.2.6 Sense organs and Perception

Suśruta expressed ideas related to perception of senses in its chapter on ‘the body’ viz. *Śārīrasthāna*. He states, ‘Sounaka says that probably the head of the fetus is first developed since head is the only organ that makes the functions of all the organs possible. Kritavirya says it is the heart that is first developed since heart is seat of *mana* and *buddhi* (mind and intellect)’.

As to whether it is the head or heart that perceives senses and controls the sense organs was a debatable point, as we see in the statements made by various ancient scholars.

### 2.3 *Bhelasamhitā*

*Bhelasamhitā* is a rare seventh century AD treatise that is chiefly devoted to *kāyācikitsā* or internal medicine and is written by an unknown author.<sup>34</sup> Although it largely depicted Caraka’s tradition it is also similar to *Suśrutasaṃhitā* in many ways as will be apparent below.

*Bhelasamhitā* essentially used Caraka’s terminology to define entities like sense organs, their locations, knowledge perceived by them etc, and further developed on Caraka’s theory. *Bhelasamhitā* described two types of *ālocakapitta*, one is *cak-urvaiṣeṣika* (exclusively for eyes) and the other, *buddhirvaiṣeṣika* (exclusively for intelligence or mental perception). They were supposed to be located between the eyebrows and were operational in visual perception.

While discussing insanity or *unmāda* and its causes *Bhelasamhitā* corroborates *Suśrutasaṃhitā* in considering head and not heart as the location for all perceptions. *Bhelasamhitā* stated that *doṣas* situated between the skull and the palate, upper surface of the mouth cavity, successively affect *mana*, *citta* and *buddhi*, suggesting the seats for these entities as situated above the palate and below the skull.<sup>35</sup>

मनसाश्चित्तबुद्धीनां स्थानान्येतानि कर्म च सन्दूषितानां तेषां तु शृणु हेतुमतः परम

उन्मादसम्प्राप्तिः ऊर्ध्वं प्रकृपिता दोषाः शिरस्ताल्वन्तरे स्थिताः मनः सन्दूषयन्त्याशु ततश्चित्तं विपद्यते

चित्ते व्यापदमापन्ने बुद्धिर्नाशं नियच्छति ततस्तु बुद्धिर्व्यापत्तौ कार्याकार्यं न बुध्यते

(Bhela. Ci, 8.9-11)

Thus the location of the seat of *Buddhi*, or brain in modern terminology, is stated as underneath the skull and above the palate. In this way, *Bhelasamhitā* astonishingly predicted the actual location of brain. Moreover, the *Bhelasamhitā* in fact related the seats of all the three entities *Manasa*, *Citta* and *Buddhi* to brain. Thereby *Bhelasamhitā* differentiated perceptions comprehended by *Manasa*, *Citta* and *Buddhi* and attributed all the three to brain.<sup>36</sup>

मनश्चित्तबुद्धिनां स्थानादि

शिरस्तात्वन्तरगतं सर्वेन्द्रियपरं मनः

तत्रस्थं तद्धि विषयानिन्द्रियाणां रसादिकान्, समीपस्थान विजानाति त्रीन् भावांश्च नियच्छति  
(*Bhela. Ci*, 8.2-3)

Similar thoughts on the seat of *buddhi* were seen in other works too but they were less elaborate. We will come to that by and by.

#### 2.4 Evolution of Ophthalmic Theory in later Ayurvedic Works

Let us see whether philosophical concepts of Suśruta's ophthalmology changed over the next thousand years when many more Ayurvedic works and their commentaries came up.

Among post-Suśruta works dealing with ophthalmology *Aṣṭāṅgahrdayasamhitā* by Vāgbhaṭa, is of foremost importance for its substantial ophthalmic content. Vāgbhaṭa was a sixth century figure and he is acknowledged also as author of an earlier work *Aṣṭāṅgasamgraha*. Like *Suśrutasamhitā* the last chapters called *Uttarasthāna* of both *Aṣṭāṅgasamgraha* and *Aṣṭāṅgahrdayasamhitā* are devoted to *Śālākyaatāntra* (minor surgery using a probe) that included ophthalmology (Grade 1983). Vāgbhaṭa simply discussed the essentials of the contents of *Uttaratañtra* of Suśruta in its ophthalmic section. He did not describe the structural aspects at all but only symptoms for diagnosis of diseases and their treatment.

As to the ideas of visual perception *Aṣṭāṅgasamgraha* adopted the traditional view that it is the *atīन्द्रīya* (which means 'beyond bodily organs' or non-corporeal) mind that governs the ten bodily organs, five organs of action and five sense organs.

पंच बुद्धीन्द्रियाणि श्रोत्रं स्पर्शनं दर्शनं रसनं घ्राणं च— तेषां समभागतया क्रमाद्विषयाः  
शब्दस्पर्शरूपरसगन्धाः— पंच बुद्धीन्द्रियाधिष्ठानानि कर्णो त्वगक्षिणि जिह्वा नासिके च — पंच

कर्मेन्द्रियाणि वावपायूपस्थपाणिपादसंज्ञकानि—तान्यापि च वचनोत्सर्गहर्षादानगमनार्थानि—अतीन्द्रियं  
तु मनः सर्वार्थरन्वयात—तद्योगेन चेन्द्रियाणामर्थप्रवृत्तिः— बुद्धिकर्मेन्द्रियोभयात्मकत्वाच्च  
(Aṣṭ S. Śā, 5.25)

*Mādhavanidāna* (6/7<sup>th</sup> century AD), *Śārṅgdharasaṃhitā* (13<sup>th</sup> century AD), *Bhāvaprakāśa* (16<sup>th</sup> century AD), etc. although include ophthalmology as a section, the subject matter is fewer (Sastri 2009, Mishra 1938, Parsuramsastri 2005). *Mādhavanidāna* and *Bhāvaprakāśa* are selective and discussed only a fraction of Suśruta's extensive material viz. diagnosis and therapeutics respectively. Ugraditya of 9<sup>th</sup> century AD wrote an extensive work named *Kalyānakāraka* (Sastri Parswanath, 1940). Although he dealt with almost all topics of Suśruta's ophthalmology, including surgical treatments in a separate chapter, it is less elaborate. Lastly, *Śārṅgdharasaṃhitā* merely listed eye diseases on the basis of their location and added few common methods of treatment. *Śārṅgdharasaṃhitā* did not refer to eye surgery at all. Innumerable commentaries of each of the above major Ayurvedic works came up in successive centuries. Some of them made significant remarks on the structure and working of the eye.

Dalhana a 12<sup>th</sup> century commentator of *Suśrutasaṃhitā* who wrote *Nibāṇdhasaṃgraha*, also called *Dalhaṇaṭīkā*, commented on the position of the eye as follows.

तेषां एव धातूनां पटलाश्रयणामुपधातूनां च कर्मतो नयनेऽस्तित्वं दर्शयान्नाह –  
सिराणामित्यादि सिरादीनां कालकास्थिपर्यन्तानां परा गुणा यथोत्तरमुत्कृष्टाः प्रसादाः  
अष्णोर्बन्धनेऽन्योन्यसंहननेऽधिकृताः तथा कालकात् परः कालकास्थः सकाशात्  
श्लेष्मा सिरायुतोऽक्ष्णेर्बन्धने पर उत्कृष्टोऽधिकृत इति पिण्डार्थः सिराणामित्यत्र  
बहुवचनस्याद्यर्थवचित्वाद्धमनीनामपि ग्रहणम् कण्डराणामित्यत्र कण्डराशब्दः स्नायुवाचकः  
अन्ये तु सिरादीनां मेदःपर्यन्तानां गुणाः प्रसादाः कालकस्याक्ष्णोः कृष्णभागस्य  
बन्धनेधिकृताः तथा कालात् परः कृष्णभागाद्यः परः शुक्लोभागतस्य बन्धने सिरायुतः  
श्लेष्मा । (SS.Utta.1.19; 20.1)

'Due to the action of *dhātus* and *upadhātus* that are located in *paṭalas* the eye exists (is held at one place). The attributes of blood vessels that stretch up to the bones and beyond result in excellently tying the eye (eyeball in the cavity) and connecting the parts to each other and make the setting as it is. Further the *śleṣma* which is near and in the bones (choroid) that has blood vessels binds the eye and superbly holds it in its place. This is the overall meaning. Since *sirā* is used here in plural one may take it to mean *dhamanī* too. *Kaṇḍarā* means *snāyu* here. Other

blood vessels that go up to *meda* part their attributes result into securely binding the *kālaka* (choriod?) to the eye and the black part, the blood vessels that are beyond *kālaka* and the white part beyond the black part etc, the *sleşma* having blood vessels in it is effective.<sup>38</sup>

Above passage suggests the possibility that Dalhana knew the compact structure of blood vessels, ligaments, muscles etc that holds the eye ball in its place. His presumption regarding *sirā* and *dhamanī* being separate entities suggests that, possibly *sirā* referred to veins and *dhamanī* to arteries, since the root ‘*dmā*’ of the word *dhamanī* means ‘to blow’ (a possible reference to the pumping of heart), although the terms were earlier used indiscriminately for any blood vessel.

#### 2.4.1 Location of lens

Dalhana called the innermost i.e. *asthi* as the first *paṭala*, the second *paṭala* as *meda* and the third *paṭala* as *māñsa/piśita* and the fourth as *tejojalāśrita*.<sup>39</sup>

अभ्यन्तरे सर्वाभ्यन्तरे कालकास्थाश्रिते प्रथम पटले ।  
द्वितीयं पटलं मेदःश्रितम् ॥  
तृतीयपटलं मांसाश्रितम् ॥  
चतुर्थं पटलं तेजोजलाश्रितं प्राप्तो यदा सर्वतो दृष्टिं रुणद्धि तदा लिंगनाश उच्यत  
इति सम्बन्धः ॥ (SS.Utta.7.7; 7.11; 7.15)

It is exact reverse of Suśruta’s definition. Why did he change the order? Dalhana probably knew the location of the cataract opacity to be the lens which is in the outer part. It was probably to respect Suśruta’s statement that the incidence of cataract is a result of the *doṛa* entering the fourth *Paṭala*. Dalhana preferred to call it the fourth *paṭala* thus reversing Suśruta’s order. Dalhana further explains that the outer *paṭala* is called *tejojalāśrita* since it contains the blood vessels carrying blood with the *ālocaka pitta* or vision-giving fire also called *teja*.

अत्र तेजःशब्देनालोचकतेजः समाश्रयं सिरागतं रक्तं बोधव्यम्—

Earlier, *Suśrutasamhitā* and *Aṣṭāṅgahṛdayasamhitā* believed cataract i.e. *liṅganāśa* to be a *dr̥ṣṭi* kind of disease<sup>40</sup>;

षड् लिङ्गनाशाः षड्भिरे च रोगा दृष्टाश्रयाः षट् च षडेव व स्युः ।  
तथा नरः पित्तविदग्धदृष्टिः कफेन चान्यस्त्वथ धूमदर्शी ।  
यो ह्रस्वजात्यो नकुलांधता च गंभरसंज्ञा च तथैव दृष्टिः । (SS.Utta.7.33;34.1)

‘Six *liṅganāśas* are six diseases located in *dr̥ṣṭi*. Also a man gets six other diseases of the *dr̥ṣṭi* like *pittavidaghadr̥ṣṭi*, another due to *kapha* (i.e. *kaphavidaghadr̥ṣṭi*), *dhūmadar̥ṣi*, and that called *hr̥svajādya*, *nakulāñdhatā* and *gambhīra* are *dr̥ṣṭi* kind of diseases.’-

विना कफलिङ्गनाशान् गम्भीरां ह्रस्वजामपि ।

षट् काचा नकुलान्धश्च याप्याः शेषास्तु साधयेत् ।

द्वादशेति गदा दृष्टौ निर्दिष्टाः सप्तविंशतिः ॥33॥ (Aṣṭ H. Utta.12.33)

‘All *liṅganāśas* except for the one due to *kapha*, *gambhīra* and also *hr̥svaja* are to be excluded (from treatment for they are incurable), six *kāca* kind of diseases and *nakulāñdha* are pallieable, the rest twelve should be treated for they are curable. Thus twenty seven diseases of *dr̥ṣṭi* are defined.’<sup>41</sup>

However, Śārāṅdhara, who wrote *Śārāṅdharasamhitā* in 13<sup>th</sup> century AD separated *liṅganāśa* from *dr̥ṣṭigata* diseases. He separated seven *liṅganāśa* diseases from eight disease of *Dr̥ṣṭi* kind.<sup>42</sup>

लिङ्गनाशः सप्तधा स्याद्यातात्पित्तात्कफेन च ॥65॥

त्रिदोषैरुपसर्गेण संसर्गेणासृजा तथा ।

अष्टधा दृष्टिरोगाः स्युस्तेषु पित्तविदग्धम् ॥66॥

अम्लपित्तविदग्धं च तथैवोष्णविदग्धकम्

नकुलान्धं धूसरान्धं रात्र्यान्यं ह्रस्वदृष्टिकः ॥67॥

गम्भीरदृष्टिरित्येते रोगाः दृष्टिगताः मताः । (Śārāṅg. S.)

‘There are seven kinds of *liṅganāśas*, due to *vāta*, *pitta* and *kapha*. Moreover there are due to three *doṣas*, and then *upasarga*, *samsarga* and *asr̥ja*. There are eight kinds of *dr̥ṣṭi* diseases. *Pittavidagdhaka*, *amlapittavidagdhaka*, also *ur̥ṇavidagdhaka*, *nakulāñdha*, *dhūsarāñdha*, *rātryāñdha*, *hr̥svadr̥ṣṭika*, *gambhīrādr̥ṣṭi*; these diseases are called *dr̥ṣṭigata* diseases.’

Adhamalla, the 14<sup>th</sup> century commentator of *Śārāṅdharasamhitā* too corroborated Śārāṅdhara. Indu in his 12<sup>th</sup> century *Śaśirekhā* commentary of *Aṣṭāṅgahr̥dayasamhitā* was the first to put forth this viewpoint (Indu, 1956). He stated that in the case of *liṅganāśa* the *doṣa* comes out of *dr̥ṣṭimaṅḍala* and stations itself in the outer *paṭala*. It matures and as a result, the vision is lost, irrespective of time, night or day.<sup>43</sup> In this way, Indu, Śārāṅdhara and Adhamalla believed *liṅganāśa* as disease of the lens and not of the innermost part called *dr̥ṣṭi*.

‘सुजातं दृष्टिमण्डलान्निर्गत्य बाह्यपटलान्तरे सुष्ठु परिणतत्वात् स्पष्टतां गतं निष्प्रेक्षं सम्पूर्णलिङ्त्वाद्रात्रिन्दिवविशेषरहितावलोकनम्। (Aṣṭ H. Uttā.14.1)

‘Since a well-developed (cataract) comes out of the *dr̥ṣṭiṃaṇḍala* and stations itself effectively inside the outer *paṭala*, it appears marked. (As a result) since the damage to the (visual) faculty is complete the eyesight is lost and there is no difference between day and night as far as vision is concerned.’

#### 2.4.2 About *netratvak* (eye-skin) or layers in the eye

Suśruta recorded four kinds of *kṛṣṇāgatarogāh* i.e. diseases of the black part of the eye, they are *savraṇasūkra* (corneal ulcer), *avraṇasūkra* (corneal opacity), *akṣipākātyaya* (keratitis) and *ajakājāta* (staphyloma). Suśruta categorically stated that the corneal ulcer is curable when it is not near the pupil, not deep or not exuding any pus, is painless and is not of *yugmasūkra* (twin *sūkras*:*savraṇasūkra* and *avraṇasūkra*) kind.<sup>44</sup> Suśruta did not relate the severity of corneal ulcers to *paṭala* or the layers to which disease has reached as he does in the case of *dr̥ṣṭi* kind of diseases.<sup>45</sup> *Aṣṭāñgahṛdayasaṃhitā*, on the other hand, mentions three *paṭalas* or layers in the eye and explains severity of *krataśūkra* i.e. corneal ulcer on that basis. Modern Ayurvedic ophthalmologist identifies them as epithelium, stroma and endothelium. Although one may think it farfetched, yet present day prognosis supports these observations viz. when the disease penetrates the third layer it is incurable. Up to the second layer there is less pain too.<sup>46</sup>

Suśruta while discussing *avraṇasūkra* (corneal opacity) mentions the word *dvitvak* (second layer of the skin) and so does Nimi as quoted by Dalhana.<sup>47</sup> Dalhana refers to a verse that lists characteristics of the corneal opacity that has reached the second layer of the eye as told by Videha, another name for Nimi. Thus,

चोषोष्णस्रावदाहास्तु कृष्णे च पीडिकोद्रम, व्यक्तमुद्रफलाकारम् शुक्रं द्वित्वगतं भवेत्।  
(SS.Uttā. Dalhaṇṭika, 5.5)

‘The one that gives out drying, hot exudation, a burning sensation, and a boil on the black part of the eye, resembles a lentil grain that opacity is called as having entered the second layer.’<sup>48</sup>

Indu, the commentator of *Aṣṭāñgahṛdayasaṃhitā* explains three *paṭalas* that Vāgbhaṭa mentions as *dr̥ṣṭapaṭala* i.e. skin of the eye. Furthermore, Indu says that due to being in the outer layer it can be cured although with

difficulty. When second *paṭala* is pierced the disease is palleable and incurable in the case of third *paṭala*.

तत् बहिःस्थितत्वात् कृच्छसाध्यं द्वितीयपटलव्यधाद्याप्यं स्यात्। पटलम् नेत्रत्वक्, तत्र याप्ये पूर्वापेक्षया तोददिमत्वं सूचिविद्धं समकृष्णभागता च नेत्रस्य स्यात्। यदा तृ तदेव तृतीयमपि पटलं व्याप्नोति तदा व्रणैर्निचितं साध्यं क्षतशुक्लम् स्यात्।<sup>49</sup> (*Ast.H. Utta.*, 10.24-25)

It is hard to know what he exactly meant by it. How could he know layers in the skin of the eye without a microscope? Although conceptual, this is in agreement with what the modern Ayurvedic ophthalmologist claims as quoted above. Probably it is a case of intuition hitting upon truth as one finds every now and then in ancient medicine.

### 3. OUTLINE OF OPHTHALMIC IDEAS IN OTHER WORLD CIVILIZATIONS

Egyptian papyri dated second millennium BC contained references to medicine and ophthalmology. Together with names of eye diseases and medicines prescribed, they expressed elements of magic and superstition. Hippocrates, the ancient Greek medical writer (5<sup>th</sup> century BC) freed ophthalmology from false notions. Alcmaeon, a predecessor of Hippocrates, used to experiment cutting open body organs and scrutinize them. In the process he discovered optic nerve and brain. He believed that there were three layers in the eye and fluid at the center that was connected to the brain and they together played a role in ocular perception. Contradictory theories were proposed to explain its path. Plato in fifth century BC proposed that a visual substance emerges from the eye to reach the object, and rays from the object combine with it to produce vision. On the contrary, the early atomists believed that small particles come out of objects and reach the eye. Aristotle (4<sup>th</sup> century BC), a student of Plato, proposed that one gets the sense of vision owing to the influences emanating from objects, and not as a result of rays emerging from the eye. Yet Ptolemy (90-168 AD), a Roman who wrote in Greek, in his treatise on light agreed with the view that objects are seen by rays emerging from the eye.

Alexandrians in second - third century BC considered lens as the seat of vision. Celsus (25 BC-50 AD) who was a Roman medical writer and compiler believed that the lens was situated at the center of the eye. A century later Galen (129-216 AD) recognized two separate chambers of the eye that were filled with similar fluid, the nature of optic nerve, retina and cornea and believed the lens to be the seat of vision but he rightly considered

it to be situated in the front part. He stated that rays from the brain passed through the optic nerve, retina, lens and cornea to the object and returned the same path to transmit the perception to the brain.

Arabian ophthalmology flourished between 8th to the 12th century. Al Razi or Rhazes (850-932 AD) and Ibn Sina or Avicenna (958-1037 AD) were prominent physicians of the period. The Arabs invented newer techniques for eye surgery, e.g. Abul Quasim Amar (10th century AD) designed a hollow needle for sucking out soft cataracts which were difficult to press. Ibn al-Haytham (10th century AD) called as the 'father of optics' made important contributions to ophthalmology. He was the first to give correct explanations of the process of sight and visual perception in his *Book of Optics*. He also hinted that retina is involved in the process of image formation.

When the eye was equated with an optical instrument by Kepler, the famous sixteenth century astronomer, ideas about the role of various parts in visual perception became clear. Microscopes came by the seventeenth century when the true structure of the eye became known. Actually, invention of compound microscope in the 19<sup>th</sup> century brought about revolution in the understanding of anatomy of the eye and also path of visual perception.

#### 4. INDIA AND OTHER WORLD TRADITIONS

Summary of ophthalmic ideas put in a tabular form will be of interest.

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/popular Tradition	World Traditions	Topics
Before 1000BC 1000 BC to AD 200	<i>Upaniṣadas</i> and <i>āraṇyakas</i>	<i>Atharvaveda</i>  <i>Nyāyaśāstra</i>	Egyptian papyri	<ul style="list-style-type: none"> <li>- Contained references to medicine and ophthalmology.</li> <li>- References to eye diseases and remedies like magical spells and plant preparations</li> <li>- References to morphological components of the eye and their functioning attributed to natural and mythological forces</li> <li>- <i>Tejas</i>, defined as an entity that along with small quantities of other</li> </ul>

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/popular Tradition	World Traditions	Topics
200 BC-200 AD		<i>Mahābhārata</i>	Alcmaeon Hippocrates Early atomists Plato Aristotle Ptolemy	<p>matter produces the organ of sight Conjectured that visual perception takes place when the organ of sight, the eye, helped by external matter which is light (<i>āloka</i>), and a desire to apprehend the object and also the past deeds (previous knowledge of the object), contacts the object.</p> <ul style="list-style-type: none"> <li>- Conjectured that direct perception (<i>pratyakṣa</i>) is due to contact between a sense organ and its analogous object.</li> <li>- Experimented cutting open body organs and scrutinize them, discovered optic nerve and brain, believed in three layers in the eye and fluid at the center that was connected to the brain and they together played a role in ocular perception.</li> <li>- Propounded four elements theory, water, fire, earth and air. Use of collyria</li> <li>- Small particles come out of objects and reach the eye.</li> <li>- Proposed that a visual substance emerges from the eye to reach the object, and rays from the object combine with it to produce vision.</li> <li>- One gets the sense of vision owing to the influences emanating from objects, and not as a result of rays emerging from the eye.</li> <li>- Objects are seen by rays emerging from the eye.</li> <li>- Contribution of primary elements in the construction of the human body and also relation of eye to the primary element 'fire', states that the eyes see objects using mind and not (only) eyes.</li> </ul>

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/popular Tradition	World Traditions	Topics
200 AD to 400 AD	<i>Caraka samhita</i>	<i>Śrīmatbhaga vadgītā</i>		<p>The mind takes characteristics of <i>satva</i>. <i>Satva</i> is <i>avyakta</i> i.e. non-corporeal. Among all realms it belongs to the realm of <i>ātma</i> i.e. soul or spirit.</p> <ul style="list-style-type: none"> <li>- Reference to cataract surgery- the probe of knowledge will open the eye and clear the vision</li> <li>- Defined five organs of action, five sense organs and their relation to five primary elements, five kinds of knowledge perceived by specific organs, locations of five sense organs, states that there are ninety six eye diseases, refers to the specialists of ophthalmology, states that conscious perception arises from the fusion of the <i>ātman</i> (self), mind, senses and sense organs.</li> </ul>
		<i>Suśrītasamhitā</i>	Alexandrians	<ul style="list-style-type: none"> <li>- Lens is the seat of vision.</li> <li>- Defines five wheels or <i>maṇḍalas</i> of the eye, five parts of the eye viz. muscles, blood, black and white parts and empty channels and relates them to five elements, defines four <i>paṭālas</i> in the eye viz. <i>tejojāla</i>, <i>piāita</i>, <i>meda</i> and <i>asthi</i>, and states <i>Liṅganāā</i> (cataract) to be the outcome of disorder advancing to the fourth layer.</li> <li>States that the lens is <i>Masūradalamātram</i> signifying curvatures of two sides of the lens.</li> <li>States that the eyeball is supported by an arrangement of blood vessels, muscles etc.</li> <li>States that one of the five <i>pittas</i> is <i>ālocaka pitta</i> –and it is the vision-giving fire.</li> </ul>
		Buddhist <i>Sūtras</i>		<ul style="list-style-type: none"> <li>- Eye ball is considered as the organ of sight</li> </ul>

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/ popular Tradition	World Traditions	Topics
			Celsus Galen	- Lens is situated at the center of the eye. Recognized two separate chambers of the eye that were filled with similar fluid, the nature of optic nerve, retina and cornea and believed the lens to be the seat of vision, considered it to be situated in the front part. Stated that rays from the brain passed through the optic nerve, retina, lens and cornea to the object and returned the same path to transmit the perception to the brain.
400 AD to 800 AD		Buddhists of 'Vaibhāṣika'		- Conjectured that the sense organ of sight and hearing perceive without coming in contact with the objects and objects at different distances and sizes are perceived simultaneously.
		Vātsyāyana		- Suggested two eyes as two different organs of sight. There are two organs of sight because when one eye ball is destroyed the other can still see.
		Vairocanasūtra		- Reference to cataract surgery- The Buddha, the king of physicians or <i>Vaidya-Rāja</i> clears away the membrane of ignorance with a golden probe."
		<i>Dignāg</i>		- Double moon cognition is not real entity.
		Dharmapāla's commentary of <i>Dignāga</i>		- The double-moon cognition is not the real entity but an illusion due to defect of senses when eye is disturbed by cataract or other diseases or even pressed by a finger at one corner.
		Uddyotakara		- Visual perception of a person with two eyes is better than the one with only one eye.
	<i>Aṣṭāṅgaḥṛdayasaṃhitā</i>			- Differentiated 90 eye diseases, mentioned three <i>paṭalas</i> or layers in the eye, stated that the curability of eye diseases depends upon the layer it is located in.

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/ popular Tradition	World Traditions	Topics
800AD to 1000AD	<i>Bhela-samhitā</i>			<ul style="list-style-type: none"> <li>- Described two types of <i>alocakapitta</i>, one is <i>caḡsurvaiāeṣika</i> (exclusively for eyes) and the other, <i>buddhirvaiāeṣika</i> (exclusively for intelligence or mental perception). <i>The doṣas</i> situated between the skull and palate successively affect the <i>manas</i>, <i>citta</i> and <i>buddhi</i>, (thus suggesting the location of brain).</li> </ul>
		<i>Nyāya-vaiṣeṣika</i>		<ul style="list-style-type: none"> <li>- Eye balls are only the means through which the rays centered in the <i>Tejasa</i> particles constituting the organ of sight, visual organ does not come in contact with the object when cognition takes place.</li> </ul>
		<i>Vaiṣeṣika</i>		<ul style="list-style-type: none"> <li>- <i>Tejasa</i> being very light and its velocity so great that it becomes difficult to mark the difference of moments in its movement.</li> </ul>
1000AD to 1400AD		Udayana		<ul style="list-style-type: none"> <li>- Stated when a piece of glass, mica or crystal is kept in between the eye and the object, one can still see objects.</li> </ul>
			Abul Quasim Amar Ibn al-Haytham	<ul style="list-style-type: none"> <li>- Designed a hollow needle for sucking out soft cataracts</li> <li>- Correct explanations of the process of sight and visual perception, involvement of retina in the process of image formation.</li> </ul>
	Dalhana			<ul style="list-style-type: none"> <li>- Differentiated between <i>Sirā</i> and <i>Dhmanī</i>, knew the compact structure of blood vessels, ligaments, muscles etc that holds the eye ball in its place, knew the location of the cataract opacity to be the lens.</li> </ul>
	Indu, commentator of <i>Aṣṭāṅgahṛdayasamhitā</i> ,			<ul style="list-style-type: none"> <li>- <i>Liṅganāā</i> or cataract is not a <i>Dṛṣṭi</i> kind of disease but that of the lens.</li> </ul>

Period	Ancient Indian Medical Tradition	Ancient Indian Philosophical/popular Tradition	World Traditions	Topics
1400AD to 1800AD	<i>Śārngdhar-asamhitā</i> and Adhamalla, commentator of <i>Śārngdhar-asamhitā</i> Konda Bhatta		Kepler	<ul style="list-style-type: none"> <li>- Stated that a forty year old person cannot see objects without the use of glasses, the bilious <i>tejasa</i> that prevents real contact in old age is removed by the glasses.</li> <li>- Eye is equated with an optical instrument</li> <li>Stated the role of various parts in visual perception.</li> </ul>

### 5. CONCLUDING REMARKS

A review has been made to have an idea of the intuitions, philosophical dogma, observations and communications that played a role in the endorsement of correct information in the field of ophthalmology.

Ancient Indians understood anatomy of the eye only as much that can be perceived from the exterior. There is no indication that they had any notion of retina or optic nerve.<sup>50</sup> This is probably because their knowledge were not based on practical dissection. They of course had some idea of lenses for quite some time, correct idea about its location came only by 12<sup>th</sup> century AD as seen in the commentaries.

Ancient Indian philosophers contributed substantially in the development of ideas of visual mechanism. Contribution of outer source of light and cognitive power was known all along but there was confusion as to the seat of perception. Brain as a physical entity was not recognized, again for the lack of dissection.<sup>51</sup> They came closer to the modern knowledge when *Nyāya-vaiśeṣika* philosophers perceived the idea 'the visual organ is

produced by the ultimate particles of *tejas* and the eye balls are only the means through which the rays centered in the *tejas* particles constituting the organ of sight— come in contact with the object’, furthermore, ‘*tejas* being very light and its velocity so great like sunrays that it becomes difficult to mark the difference of moments in its movement’.

Despite ignorance in internal structure of the eye, they succeeded marvelously in classifying eye diseases on the basis of location as seen from outside. They performed surgeries like cataract, pterygium, trichiasis and entropion too just like their counterparts in Greece. Diseases like glaucoma were treated by relieving ocular pressure by inserting a needle or by means of leech.<sup>52</sup> Being unaware of inner parts of the eye they could not fathom the causes of diseases like optical atrophy or retinal detachment and attributed them to supernatural causes.<sup>53</sup>

Mind in ancient Indian philosophy was supposed to belong to the realm of *ātmā* (soul/spirit) which is considered as separate from body and not corporeal. Perhaps this philosophy discouraged any search for brain as a physical entity and the very idea of a seat or path of visual perception remained more or less an abstract phenomenon.

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#### NOTES AND REFERENCES

1. By this word I mean a study of eye diseases and their treatment as a separate field of learning, writing and practice, not necessarily modern in its attitude and content.
2. *Atharvaveda*, 6.16.1to3
3. *Bṛhadāraṇyaka Upaniṣad*, 2.2.2.
4. Misra, 1936. p 281
5. *Kiraṇāvali*, p. 286
6. *Kiraṇāvali*, p. 286
7. *ibid*

8. *ibid*
9. *ibid*
10. Mishra, 1936, p289. The author quotes a Konda Bhatta, a commentator of Udayana.
11. Dvivedi, 1986, p 262. Also see *Shree Gautamamunipraṇitanyāyasūtrāṇi*, Anadasrama Sanskrit Granthavali no 91, published by Anada Mudranalaya, 1922.
12. Dharmapala states, ‘‘Like the double moon’ - The second moon does not cause to raise up for consciousness of the second moon (As it does not exist in substance) If so, what is the cause of representing that image (in consciousness)? ‘Because of the defect of senses’. When the eye has its sight disturbed by cataract and other diseases, then the appearance of double moon appears and that, too, not as a real entity’ - *ālaṃbanaparīkṣā* edited by Aiyaswami Shastri, The Adyar Library Series No. 32, Vasanta Press, Adyar, Madras, 1942, P. 69. This text is restored in Sanskrit from their Chinese and Tibetan versions. Susumu Yamaguchi and Henry Meyer translated it from Chinese and Aiyaswami translated the French/English version into Sanskrit. The Chinese text states - T31n1619\_p0883a02(02)e 非實有故 譬如二月由眼根亂  
T31n1619\_p0883a03(07)e 識似二月起二月非 識境界實無有故 聚亦如此
13. *Dalhanatīkā SS.Utta.8.3*
14. Sukthankar & Belwalker,1954,p. 61
15. *ibid* p. 1132
16. *ibid* p. 229
17. *ibid*
18. *ibid*
19. *ibid* p. 230
20. CS. *Sū.* 8.8.9 Also, CS. *Śā.*1.28
21. CS. *Śā.*1.25
22. CS. *Sū.* 8.3
23. Trikamji 1941, p 60.
24. CS. *Sū* 8. 8 to 14.
25. CS. *Śā*1.27.
26. SS. *Śā* 1-18,
27. *Pitta* is commonly taken as bile, it is the *pācaka pitta* or Digestive fire in Suśruta’s definition.
28. SS. *Sū* 21.9-13 Also see Ray, Priyadarajan, 1980, p14
29. SS *Uttā*1.11; Chaudhury, 1993, p30

30. Chaudhury, 1993, p. 342
31. *SS.Utta.7.3,4*
32. For that matter the Nimi also refers to *paṭala*. Because of the ambiguity regarding his date, we consider here Sushruta as the earliest expert of Ayurvedic ophthalmology.
33. *SS.Utta 7.15,16*
34. The Sanskrit text of *Bhelasamhitā* is quoted from the PDF files uploaded by the Department of Maharishi Vedic Science of the Maharishi Vedic University. I thank them for making this rare text available to scholars. ([isl.mum.edu/vedicreserve/bhela\\_samhita.htm](http://isl.mum.edu/vedicreserve/bhela_samhita.htm))
35. *Bhelasamhitā, Ci*, chapter 8
36. *ibid*
37. *Aṣṭāṅgasaṃgrha, Śāristhāna*, 5.25; Sharma, 1867, p. 222.
38. *SS.Utta.1.19, 20.1*
39. *SS. Uttā. 7.7; 7.11; 7.16*
40. Sharma, 2005, p 144; *SS.Utta.7-33, 34.1*
41. Garde (1983) p 388; *AST, Uttā.12.33*
42. Parashuramasastri, 2005, p 122.
43. *AST Uttā. 14.1*
44. *SS.Utta. 5.5*
45. *SS.Utta. 7.15,16*
46. Choudhury,1993, p. 206
47. *SS. Uttā. Dalhaṇatikā, 5.5.*
48. Sharma, 1992, p 343.
49. *Śāsilekhā*, 1956; *Uttā,10.24,5.*
50. Sparse references to *Rūpagrahaṇa* (*SS. Uttā.Dalhaṇatikā 8-3,4*) and '*Pratibimba* (*AST, Kairalivyākhyā, Uttarasthāna 12.7,8*) leave one intrigued as to the extent of their imagination though.
51. The case of *Bhelasamhitā* is a possible exception.
52. *SS.Utta. 8.8* – 'Those called *Adhimañtha* should be treated with venesection.', Garde (1983) p 393 - *AST Uttā, 13.81*
53. *SS.Utta.7.42*

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