

A Critical Review of Netra Sharir of Ayurveda in the Modern Perspective

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Abstract

The Indian system of *Ayurvedic* medicine has described three basic physiological constituents of human body, viz., *dosha*, *dhatu* and *mala*. *Acharya Sushruta* was a great surgeon in ancient India known today as the “Father of *Shalya Tantra* (Surgery)” for inventing and developing surgical procedures. *Acharya Sushruta* has elaborately described the defining characteristic of *Shalakya tantra*. It comprises of the disease of *shalakya tantra* as narrated by king of *Videha* (the author of *Nimi Tantra*). *Acharya Sushruta* first ever has described the anatomy of eye in relation to their shape, size of various anatomical components. *Acharya Sushruta* has also described the *Netra roga* in a very systematic manner. In the *Uttara tantram*, *Sushruta* recites an elaborated classification of eye disease complete with signs, symptoms, prognosis and medically surgical interventions. In the foetus, the parts of eye are originated from *akasha*, *vayu*, *agni*, *apa* and *prithvi mahabhuta*. *Acharya Sushruta* has described all anatomical structures of the eye in terms of *madala*, *patala*, *sandhis*, *peshi*, *marma*, *sira* and *Dristi*. *Susruta* delineated fine anatomical divisions mandala of eye. Different *Acharyas* have their own view in the *utpatti* (origin) of *Netra* during *garbhawastha kala*. Increased demand of *Ayurveda* science in the present society is required to understand the depth of *Ayurvedic* principle in an easy mode. Hence an effort has been made to ascertain and establish the knowledge regarding anatomical structure of *netra sharir*.

Keywords: Ayurveda, Netra, Field of vision, Mandala, Patala, Sandhi.**Copyright @ 2020:** This is an open-access article distributed under the terms of the Creative Commons Attribution license which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use (NonCommercial, or CC-BY-NC) provided the original author and source are credited.

INTRODUCTION

Acharya Susruta has described *urdhva-jatrugata roga* elaborately which deals with the causes, diagnosis and curative procedures of the diseases pertaining to the body above the clavicles, i.e., ear, eye, mouth, nose. *Acharya Susruta* has described gross ocular anatomy in first chapter of *uttara-tantra*. In this article we intended to identify the anatomical considerations of the eye are described in many topics like *Netra utpatti* (embryology development of the eye), *Netra –sharir* (anatomical considerations of the eye), *Panchbhautika* concept of embryogenesis of the eye, Measurements and appearance of the eyeball, Sources of origin of its constituents the eyeball, Colors of eye and Effect of *Tejo dhatu* on eye, *Mandala*, *Sandhi* (junctional area), *Patala* (layer of eyeball), concept of *Dristi* and *Akshi Bandhana* (contents of orbit that binds the eyeball). So, there is a need of proper understanding the anatomy in modern prospective. It cannot be characterized by a single entity at all the time because *Ayurveda* is the science based on the concept of structure and functional understanding. For this study, the basic materials have been collected from the *Ayurvedic* classics with the available commentaries, as

well as text books of modern science have been referred for better understanding of the concept and its comparison with modern science.

Field of Vision

According to *Astang-Hridaya Samhita* the eyes of *kaphaj prakriti* people are red at the angle, unctuous, wide, long with well-designed white and black spheres (sclera and cornea) with more eyelashes. *Acharya Susruta* has mentioned the eyes of *kaphaj prakriti* people are red at the angle, white eyes. In the classical text of *Ayurveda* it has been mentioned there are different types of eyes based on the dominance of *dosha* in the *prakriti* like small eye, big eye, round eye, elongated eye, sunken eye, rough eye, steady gaze eye, unsteady gaze eye, normal and healthy eye and these are the factors which can influence the field of vision.

The field of vision is the visual area seen by an eye at a given instant [1]. Visual field testing is a common procedure in almost every eye practice. The visual field is a three-dimensional area of a subject's surroundings that can be seen at any one time around an object of fixation. The visual field can be divided into

central and peripheral field. The extent of normal visual field with a 5mm white color object is superiorly 50°, nasally 60°, inferiorly 70°, and temporally 90°. The field for blue and yellow is roughly 10° less and that for red and green color is about 20° less than that for white. The part of the external world visible to one eye when a person fixes his gaze on one point is called the field of vision for that eye. To diagnose blindness in specific portions of the retina, one charts the field of vision for each eye with an instrument called Lister perimetry. The process of charting the monocular field of vision is called Perimetry. It is employed for the diagnosis of various lesions of the visual pathways [2]. All visual fields are designed to measure the entire peripheral vision. In fact, most commonly ordered visual fields only test the central portion of a patient's field of vision. The amount of the field tested depends on which test you perform.

NETRA UTPATTI (Embryology Development of the Eye)

In the foetus, the parts originated from *akasha mahabhuta* are- sound, auditory sensation, lightness, fineness and space; the parts from *vayu mahabhuta* are – tangibility, sense of touch, roughness, impulsion, structuring of body tissues and maintaining of movements of the body and *dosha*; the parts belonging to *agni mahabhuta* are visible form, vision, brightness, digestion and heat; those belonging to *apa mahabhuta* are taste, sense of taste, coldness, softness, unctuousness and moisture; those belonging to *prithvi mahabhuta* are odour, sensation of smell, heaviness, steadiness and material form[3].

Acharya Sushruta has explained the subtle form of all the *Indriyas* is present during the formation of *Garbha*. Eleven *indriyas* are originated from the *vaikarika ahamkara* with all its qualities with the help of *taijas ahamkara*. These eleven *indriyas* are as follows: ear, skin, eye, tongue, nose, speech organ, hand, sex organ, rectum, feet and mind. The former five are the organ of perception the next five are effector organ and the mind are common to both. The five *tanmatras* are created out of *bhootadi ahamkara* with all its qualities with the help of *tejas ahamkara*. These *tanmatras* are as follows; *sabda, sparsh, rupa, ras* and *gandha tanmatra*. These *tanmatra* possess special qualities of sound, touch, vision, taste and odour. From these *tanmatras* the *bhutas* like *akash, vayu, agni, jal* and *prithvi* respectively are originated. *Netras* are *agni* predominant sense organ [4]. All the *indriyas* become unambiguous during the third month. *Charaka* and *Kashyap* has opined the same that the genesis of all sense organs including eyes and organogenesis occurs in third month of intrauterine life. According to *Janaka* of *Videha*, sense organs existence the seat of senses is first formed. After discussion with the various expert of *Ayurveda* on the topic of formation of embryo, detailing the manner in which the foetus is formed in the uterus of the mother and the mode of manifestation of its

various organs *Punarvasu Atreya* concluded that all the sense organs are developed simultaneously [5]. Both *Charaka* and *Sushruta* consider *Indriyas* as *Atmaja bhava*. The clearness of senses (*Indriya prasada*) is attributing of *Satmyaja bhava*.

Acharyas Vagbhata opined *Indriyas* are developed from the essence part of *kapha, raktavaha srotas* and *mahabhutas*, after the digestion of its own *agni*. *Vagbhata* explained in detail about the embryological development of each part of the eye, *Shukla Mandala* is developed from the essence of *Kapha* and it is *Pitrija Bhava*, *Krishna Mandala* developed from *Rakta* and it is *Matraja Bhava*. *Dristhti Mandala* is developed from both *kapha* and *rakta* and it has both *pitrija and matrija bhavas* [6].

Panchbhautika Concept of Embryogenesis of the Eye: The anatomy of the eye is described on the basis of *panchabhautika* composition like, *netrabudbuda* (eyeball), *pala* (muscles of eye) are made of *prathivi, rakta* (blood) is made of *agni, krashna* (black portion or cornea) is made of *vayu, sita* (white portion or sclera) is made of *jala, asrumarga* (channels of tears or lacrimal ducts) is made of *akasha mahabhutas*[7].

NETRA –SHARIR (Anatomical Considerations of the Eye)

Acharya Sushruta first ever has described the anatomy of eye in relation to their shape, size of various anatomical components. *Sushruta* has explained seventy-six different kind of eye diseases and their treatment in *uttara tantra* of *Sushruta Samhita* in 2nd AD.

Situation: *Shira* (head) is chief among all organs. It is the region of the body where vital centres and all senses (*indriya*) of a living-being are located. *Acharyas* have considered it is the principal organ among all organs and organelles. Two eye orbits are positioned in the head, which accommodate two *Netras*, one *Chakshurindriya*. Two ocular openings are present over the head among the nine external openings of the body which communicate with the external world.

Shape: *Acharya Sushruta* has described the shape and dimension of *Nayana Budbudam* (eye ball) as *Suvrittam* and *Gostanakaram*. *Suvrittam* means spherical from all sides. *Gostanakaram* means shaped like that teat of the cow (oval shape).

Measurements of Eyeball- *Acharya Sushruta* has given the term *Nayana budbuda* for eye ball. *Sushruta* has explained the dimension of eyeball in terms of *angula* and one *angula* is equivalent to the central part of the patient's own thumb. Two *angula* is the antero-posterior diameter of the eyeball. Vertical and horizontal diameter is two and half *angula*. Shape of the eyeball resembles with the teat of a cow and

arising from all the *bhutas* (*akasha, vayu, agni, jala, prathivi*) with their attributes. In modern perspective, dimension of an adult eyeball is as follows- anteroposterior diameter 24mm, horizontal diameter 23.5mm, vertical diameter 23mm, circumference 75mm, volume 6.5ml and weight 7gm [8].

Colors of Eye and Effect of *Tejo Dhatu* on Eye- In fetal life, *tejo dhatu* is responsible for vision if *tejo dhatu* doesn't reach the *drashti bhag* (visual apparatus), the child is congenitally blind (amblyopia). Color of the eye is depending, whether, *tejo dhatu*

combines with *rakta, pitta, kapha* or *vayu*. When *tejo dhatu* goes to the visual apparatus with the *rakta*, the child would have *raktaksha* (red eyes); if it goes with *pitta*, then *pingaksha* (yellow eyes); if with *kapha* then *shuklaksha* (white eyes); and if with *vata* then the eyes would be *vikrutaksha* (deformed eye)[9].

In *Upanishada* period, ocular anatomy was depicted in philosophical manner. In *Brihad Aranyaka Upanishada* different structures of eyeball were said to be evolved from different Gods as follows.

Table-3: Shows different structures of eyeball evolved from different goddesses [10].

S.No.	God Name	Part of Netra	Part of eyeball
1.	<i>Rudra</i>	Reddish part of eye ball	Blood vessels
2.	<i>Parajanya</i>	Liquid portion	Aqueous & Vitreous humour
3.	<i>Aditya</i>	<i>Kaninika, Ashrumarga</i>	Lacrimal apparatus
4.	<i>Agni</i>	Blackish portion	Cornea and iris
5.	<i>Indra</i>	Whitish part	Conjunctiva and sclera
6.	<i>Prithvi</i>	<i>Adho Vartma</i>	Lower eyelid
7.	<i>Akasha</i>	<i>Urdhva Vartma</i>	Upper eyelid

Mandala

Acharya Sushruta has enumerated the anatomical parts of the eye consists of *mandals* are five in number and *sandhi* and *patala* are six in number.

1. **Pakshma Mandala:** This is the first and outermost *mandala* of the eye formed by the *pakshma* or eyelashes. *Pakshmani* means *chakshua achadana romani*[11]. *Pakshma* are situated in lid margins called *pakshmathaya* or *pakshma sadana*. *Pakshma* is a form of *kesa* and considered as *upadhatu* of *majja* and *mala* of *asthi*. It serves to heighten the protection of the eye from dust and foreign bodies.

2. **Vartma Mandala:** The Upper and Lower eyelids together form a circular structure in front of the eyeball called as *vartma mandala*. The eyelids are mobile tissues curtains placed in front of the eyeballs. *Vartma Mandala* is also known as *Aksi Kosha* considering its protective function. There are two *tarunasthi* in the eye lids [12]. It is of elliptical space between the upper and lower eyelids. The eyelids feature a row of eyelashes along the eyelid margin. The two eyelids meet each other at medial and lateral angles (two *sandhis* as *kaninika* and *apanga*). The *nimesha-unmesha* function (blinking) is controlled by *vyana vayu*[13]. The movement of the *vartma (nimesha-unmesha)* is regulated by motor nerves are facial (orbicularis muscle), oculomotor (levator palpebrae superioris muscle) and sympathetic fibers. Sensory nerve supply is derived from branches of trigeminal nerve such as lacrimal, supraorbital and supra ocular nerves for upper lid and infraorbital nerve with infra- trochlear branch for lower lid. Each eyelid consists (from anterior to posterior) of following many layers:

i. The skin

- ii. The subcutaneous areolar tissue
- iii. The layer of striated muscle
- iv. Submuscular areolar tissue
- v. Fibrous layer
- vi. Layer of non-striated muscle fibres
- vii. Conjunctiva

3. **Shukla Mandala:** This *mandala* is present exactly inside of the *vartam mandala* and beyond the *krishna mandala*. The *shukla mandala* appears white in color. The *shukla mandala* can be allied with the scleral part of the external fibrous coat of the eyeball. Sclera forms the posterior five-sixth opaque part of the exterior fibrous tunic of the eyeball. Its entire outer surface is covered by Tenon's capsule. In the anterior part it is also covered by bulbar conjunctiva. Thickness of sclera varies considerably in dissimilar individuals and with the age of the person. It is normally thinner in children than the adults and in females than the males. Sclera is thickest posteriorly (1mm) and progressively becomes thin when traced anteriorly. Lamina cribrosa is a sieve-like sclera from which fibres of optic nerve pass. Sclera consists of following three layers:

- I. Episcleral tissue
- II. Sclera proper
- III. Lamina fusca

4. **Krishna Mandala:** The *krishana mandala* of eye (cornea) is forms one-third of the transverse extent of the eyeball. In modern perspective, cornea is forms anterior one-sixth of the outer fibrous coat of the eyeball. The *krishna mandala* can be similar with the cornea; seems as blackish because of the iris. Cornea is a transparent, avascular, watch-glass like structure. The uveal tissue constitutes the

middle vascular coat of eyeball. From anterior to posterior it can be separated into three parts, namely, iris, ciliary body and choroid. Iris is the anterior most part of uveal tract. Iris is a tenuous circular disc corresponding to the diaphragm of a camera. The definitive color of iris be contingent on the anterior limiting layer. In blue iris this layer is thin and contains few pigment cells. While in brown iris it is thick and compactly pigmented.

The physical basis of eye color is determined by the distribution and content of melanocyte cells in the uveal tract of the eye. The iris consists of several layers: the anterior limiting layer and its underlying stroma are the most important for appearance of the eye color [14]. The two primary physiological functions of the cornea. first, functions of the cornea are to act as a major refracting medium; and Second, functions of the cornea to protect the intraocular contents. The stroma of the iris contains collagenous fiber, pigment cells, sphincter pupillae muscle and dilator pupillae muscle.

5. ***Drishti Mandala***: The *drishti mandala* can be similar with the pupil and lens. *Acharya Susruta* has described the diameter of *drishti mandala* (pupil) of eye is one-seventh and one-ninth part of *krashna mandala* (cornea) and the distance between right and left *drishti mandala* (inter-pupillary) are four fingers[15].

Concept of *drishti*

As *Timira* is one among the *Drishti gata roga*, it is quite essential to know more about *drishti*.

Definition of *Drasti* (area of sight/vision)- The *drashti* is of the size of a cotyledon of the lentil, composed of the finest parts of *panchmahabhutas*, gleaming like a glow-worm or a spark, covered by the external coat of the eye and appearing like a hole[16].

The concept of *Drishti* by *Acharya Sushruta* is little different and all the description of *Drishti* given by him points to the pupil i.e.

- *Masura dala matra* [size of a *Masura dala*]
- *Prasada* of *Panchamahaboota*
- Covered by the external *Patala*
- Sparkle like glow worm (*Khadyotavisfulingabha*)
- Constantly irrigated by the cold aqueous
- Shape resembles a hole (*Vivirakritim*)
- Benefited with cold things

SANDHI (JUNCTIONAL AREAS)

Sandhi is the "Junctional Areas" between two *Mandalas*. The *Sandhi* are 6 in number. They are-

1. ***Pakshma-Vartma gata Sandhi***: The junction of *pakshma mandala* (eyelashes) and *vartma mandala* (eyelids) is called as the *Pakshma-vartma gata sandhi* and it is considered as the lid margin. The

lid margin is about 2-mm broad and is divided into two parts by the punctum. The medial, lacrimal portion is rounded and destitute of lashes or glands. The lateral, ciliary portion consists of a rounded anterior border, a sharp posterior border (placed against the globe) and an inter-marginal strip (between the two borders). The grey line (which marks junction of skin and conjunctiva) divides the inter-marginal strip into an anterior strip bearing 2-3 rows of lashes and a posterior strip on which openings of meibomian glands are settled in a row.

2. ***Vartma-Shukla gata Sandhi***: The junction of *vartma mandala* (eyelids) and *shukla mandala* (sclera) is known as *Vartma-shukla gata sandhi*. It is considered as conjunctiva fornix. Conjunctival fornix conjoins the bulbar conjunctiva with the palpebral conjunctiva. It can be subdivided into superior, inferior, medial and lateral fornixes. The conjunctiva contains Mucin secretory glands like goblet cells, crypts of Henle, glands of manz. These glands secrete mucus which is important for wetting the cornea and conjunctiva. Accessory lacrimal glands like glands of Krause, glands of Wolfring.
3. ***Shukla - Krishna gata Sandhi***: The junction of *Shukla mandala* (cornea) and *Krishna mandala* (sclera) is known as *Shukla-krishna gata sandhi*. This junctional area can be considered as the corneoscleral junction and limbus. A 3-mm ridge of bulbar conjunctiva round the cornea is called limbal conjunctiva. In the area of limbus, the conjunctiva, Tenon's capsule and the episcleral tissue are merged into a dense tissue which is strongly adherent to the underlying corneoscleral junction. At the limbus, the epithelium of conjunctiva becomes continuous with that of cornea.
4. ***Krishna - Drishti gata Sandhi***: The junction of *krishna* and *drishti mandala* is known as *Krishna-drishti gata Sandhi*. This junctional area can be similar with the iris part in *krishna mandala*, this *Sandhi* can be explained and the central free margin of the iris, which rests on the anterior capsule of the lens, can be considered as the *Krishna-drishti gata Sandhi*. The peripheral border or root of the iris attaches to the ciliary body while its central or free margin forms the rim of the pupil.
5. ***Kaneenika Sandhi***: *Dalhana* describes this *Sandhi* and it can be taken as the inner or nasal canthus of the eye. The Canthus is either corner of the eye where the upper and lower eyelids adjoin. More specifically, the inner and outer canthus is respectively, the medial and lateral ends of the palpebral fissure. The palpebral fissure is the elliptic space amid the medial and lateral canthi of the two open lids. The inner

canthus (medial palpebral commissure) is prolonged for a short distance toward the nose, and the two eyelids are divided by a triangular space, the lacus lacrimalis. The inner canthus has two structures-

- i. **Plica semilunaris**-It is a pinkish crescentic fold of conjunctiva, present in the medial canthus. Its lateral free border is concave. It is a vestigial structure in human beings and represents the nictitating membrane.
- ii. **Caruncle**- The caruncle is a small, ovoid, pinkish mass, situated in the inner canthus just medial to the plica semilunaris. In reality, it is a piece of modified skin and so is enclosed with stratified squamous epithelium and contains sweat glands, sebaceous glands and hair follicles.

6. **Apanga Sandhi**: Acharya Dalhana describes *Apanga sandhi* and it can be considered as the outer canthus of the eye. It is one of the *marma* points. The outer canthus (lateral palpebral commissure) is more acute than the medial, and the eyelids here lie in close contact with the bulb of the eye.

PATALA (Layers of Eyeball)

Acharya sushruta has described the *patala* are most important structure of *netra sharir*. It can be appeared like as a layer of the eyeball or film or coating over the eyes. The two *patala* are present in the eyelids and the other four *Patala* in the internal eye ball. Out of them the first *Patala* (outermost) subsists in the *tejas* and *jala*, second *Patala* in the *mansa* (muscle), third *Patala* in the *meda* (fat), fourth *Patala* in the *asthi*. Their thickness of entire *patala* is equal to one-fifth of pupil. The pathogenesis of *Drishtigata roga*, has delineate in terms of involvement of successive *patala*. The prognosis of the disease also depends upon the involvement of respective *patala*. *Acharya Sushruta* has considered the different *akshi patala* and their constituting factors as shown below:

i & ii. Patala (Two Vartama Patala): The upper and lower eyelids are divided by a horizontal furrow (sulcus) into an orbital and tarsal part.

- iii. **First Bahya Patala (Tejojalashrita)**: It is the outermost first *patala*, supported by *tejas* & *jala*. The outermost *patala* can be appeared like as the aqueous humour. *Acharya Dalhana* has described the outermost *patala* as *tejojalashrita*. According to *Dalhana*, the word *teja* means *alochaka pitta* and so *siragata rakta* can be occupied as *teja*. *Jala*, according to him implies *rasa dhatu* of skin. So, it can be considered that the first *patala* is the *ashraya* for *rasa* and *rakta dhatu*s. The aqueous humour is a clear watery fluid filling in the anterior chamber (0.25 ml) and posterior chamber (0.06 ml) of the eyeball.

It plays a significant metabolic role by providing substrates and by removing metabolites from the avascular cornea and lens. The composition of aqueous humour in anterior chamber differs from that of the aqueous humour in posterior chamber because of metabolic interchange. The physiological processes concerned with the dynamics of aqueous humour are its production, drainage and maintenance of intraocular pressure.

- iv. **SECOND PATALA**: The location of second *patala* is inner side of the *bahya patala*. It is the seat of *pisita* (muscles). The second *patala* can be taken as ciliary body. Both iris and ciliary body are mesodermal in origin and contain muscles tissue. The ciliary muscle is composed of smooth muscle fibres oriented in longitudinal, radial, and circular directions. Interweaving occurs between fibre bundles and from layer to layer, such that various amounts of connective tissue are found among the muscle bundles. The **longitudinal muscle fibres (of Brücke)** lie adjacent to the supra ciliaris and parallel to the sclera. Each muscle bundle looks like a long narrow V, the base of which is at the scleral spur, whereas the apex is in the choroid.
- v. **THIRD PATALA**: This *patala* is seat of *meda* (fat). The third *patala* can be appeared like as vitreous humour. The Vitreous humour is an inert, transparent, jelly-like structure that fills the posterior four-fifth of the cavity of eyeball and is about 4 ml in volume. It is a hydrophilic gel that primarily serves the optical functions. In addition, it mechanically stabilizes the volume of the globe and is a pathway for nutrients to attain the lens and retina. The vitreous body can be separated into two parts; the cortex and the nucleus (the main vitreous body).
- vi. **FOURTH PATALA**: This *patala* is seat of *asthi* (bone). The fourth *patala* can be appeared like as crystalline lens and retina. The lens is a transparent, biconvex, crystalline structure placed amid iris and the vitreous in a saucer shaped depression the patellar fossa. The Retina, the innermost tunic of the eyeball, is a thin, delicate and transparent membrane. It is the almost highly-developed tissue of the eye. It seems purplish-red due to the visual purple of the rods and underlying vascular choroid.

Structure of the Lens-

1. Lens capsule
2. Anterior epithelium
3. Lens fibres
4. Suspensory ligaments of lens

Retina consists of following ten layers (arranged from outward to inward):

1. Pigment epithelium
2. Layer of rods and cones
3. External limiting membrane
4. Outer nuclear layer
5. Outer plexiform layer
6. Inner nuclear layer
7. Inner plexiform layer
8. Ganglion cell layer
9. Nerve fibre layer (stratum opticum) and
10. Internal limiting membrane.

This description can be considered as a misunderstanding from *Dalhana*. Actually, he had misinterpreted the word *abhyantara* given by *Sushruta* in the description of *prathama patalagata timira* and considered the first *patala* as the *abhyantara* (innermost) *patala*. According to some other scholars, the *patala* can be taken as the layers of the cornea. There is one other view in which the *patala* are taken as different layers of the lens itself. To justify this, they say that the lens is the only structure where the changes of the disease *timira*, *kacha* and *linganasha* are taking place. They assume the anterior lens capsule as the first *patala* and nucleus as the fourth *patala*.

According to some other views, the *patala* can be taken as different layers of retina. There is third *patala* participation for the diseases *pittavidagdha drishti* and *kaphavidagdha drishti*. These are the diseases where patients complain of day blindness and night blindness respectively. As these diseases occur due to degeneration of rods and cones. The *Patala* can be taken as different layers of retina. But, by taking the retina as *patala*, we cannot explain the clinical entity *timira*. However, there is another view that, all these *patala* are seated in *dristi mandala*. Their thickness is one fifth of *dristi mandala*. This will lead to concept of dividing *dristi mandala* in to four distinct layers; each layers of retina representing *patala*.

Contents of Orbit That Binds the Eye Ball (Akshi Bandhana)-

The both eyeballs are held in position by the inherent properties of the *sira* (veins, arteries and nerves), *kandara* (tendons and ligaments), *meda* (orbital fat), *Kalkaasthi* (fascia that is attached to the bony cavity) and *Sleshma bandana* (especially the eye ball is supported by the orbital fat) *kapha* as well as by the lining mucous membrane along with its vessels next to the cartilage. The vessels, ligaments, bones and joints if the living beings have strength because they are covered by the muscles [17].

According to *Sasilekha* commentary of *Acharya Indu*, the first *patala* consists of *sira guna*, the qualities of *teja* and *jala* are also seen here. The second *Patala* has *kandara guna* which is derivative of *mamsa dhatu*. The third *Patala* has *meda guna*; exact visual

perception takes place in this *patala* as *dristi* is seated in *medas*, *kalakasthi* remains outside *meda*.

Extra Ocular Muscles of the Eyes: The muscles of the globe can be divided into two groups: the involuntary intrinsic muscles and the voluntary extrinsic muscles. The intrinsic muscles- the ciliary muscle, the iris sphincter, and the iris dilator are located inside the eye; these muscles control the movement of internal ocular structures. The extrinsic muscles are six extraocular muscles; it is attached to the sclera and control movement of the globe. The Rectus muscles are superior, inferior, medial and lateral. The oblique muscles include superior and inferior. The extraocular muscles rotate the eyeball round vertical, horizontal and antero-posterior axes. Medial and lateral rectus muscles are virtually parallel to the optical axis of the eyeball, so, they have got only the main action. While superior and inferior rectus muscles make an angle of 23° and reflected tendons of the superior and inferior oblique muscles of 51° with the optical axis in the primary position, so, they have subsidiary actions in addition to the main action.

Sira (Veins, Arteries and Nerves)-

Acharya Dalhana describes *sira* are plural word and it means can be considered as the orbit has a single ophthalmic artery but two ophthalmic veins.

Sira (Veins): *Acharya Susruta* has described both the eye have 38 *siras*[18]. Among them *vata* is carried in eight *sira*, *pitta*, *rakta* and *kapha* are carried in ten *sira* each. *Acharya vagbhatta* has explained total number of 56 *siras* present in the both eyes. Among them two *siras* each are responsible for lid movement (*nimesha-unmesha*) and these six *siras* should not be opened during *sira vyadha*. The superior and inferior ophthalmic veins primarily drain into the cavernous sinus. On its course the superior and inferior ophthalmic veins give off several side branches: central retinal vein, anterior and posterior ethmoid veins, lacrimal vein, superior and inferior vortex veins, anterior ciliary veins, supraorbital and infraorbital vein, superior, inferior, lateral and medial muscular veins branches.

Dhamani (Arteries): The two *dhamanis* helps in visual perception, two for the flow of tears [19]. The ophthalmic artery is a branch of the internal carotid artery that supplies all structure in the orbit. The ophthalmic artery originate in the cavernous sinus, enters the orbit via the optic canal, then turns medially and continues along the medial wall of the orbit, dividing at the medial end of the upper eyelid into terminal branches- supratrochlear artery and dorsal nasal branches. On its course the ophthalmic artery gives off several side branches: central retinal artery, lacrimal artery, ciliary arteries, supraorbital artery, anterior and posterior ethmoidal arteries, meningeal branch, medial palpebral arteries and muscular branches. There are

rupa vaha dhamani to transmit visual perception and *asruvaha dhamani* for the flow of tears one in each eye.

Cranial Nerve Innervation of Ocular Structure-
The orbital structures are innervated by cranial nerves optic nerve (II), oculomotor nerve (III), trochlear nerve (IV), trigeminal nerve (V), abducens nerve (VI), and facial nerve (VII). The Motor functions of the striated muscles are controlled by oculomotor nerve, trochlear nerve, abducens nerve and facial nerve. The trigeminal nerve transmits the sensory supply from the orbital structures. The optic nerve carries visual information.

Kandara (tendons and ligaments) of the Eyeball: The *kandara* can be considered as trochlea of superior oblique and suspensory ligament of eyeball. The trochlea of superior oblique is a pulley like structure in the eye. The tendon of the trochlea of superior oblique passes through, it is situated on the superior nasal aspect of the frontal bone, it is the only cartilage found in the normal orbit. The suspensory ligament of eyeball (Lockwood's ligament) forms a hammock stretching below the eyeball between the medial and lateral check ligaments and enwrapping the inferior rectus and inferior oblique muscles of the eye.

Snyau, Peshi: There is a *snayu* of *prithu* type in the eyes. Two *peshi* are situated in both eyes and which circular (*Mandala*) in shape.

Meda and Sleshma Bandana (Orbital fat) of the Eyeball: The *Meda* and *Sleshma Bandana* can be considered as Orbital fat of both eyelids. The Orbital fat

lies posterior to the orbital septum and anterior to the levator aponeurosis (upper eyelid) or the capsule-palpebral fascia (lower eyelid). In the upper eyelid, there are two fat pouches: nasal and central. In the lower eyelid, there are three fat pockets: nasal, central, and temporal. These pockets are surrounded by thin fibrous sheaths that are forward continuations of the anterior orbito-septal system.

Kalkaasthi of the Eyeball: The *Kalkaasthi* can be considered as tenon capsule. The Tenon capsule also known as the fascial sheath of the eyeball (*fascia bulbi*), it is a thin membrane which envelops the eyeball from the optic nerve to the corneal limbus, separating it from the orbital fat and forming a socket in which it moves. The inner surface of the Tenon capsule is smooth and is separated from the outer surface of the sclera by the peri-scleral lymph space.

Marma (Vulnerable Area): There are three *marma* related to eye i.e. *Apanga*, *Aavarta* and *Shringataka*. The two *apanga marma* are situated on the outer side of the orbit, below the lateral end the of the eye-brows. The injury of *apanga* and *avarta marma* to them cause blindness or diminished vision. The *apanga marma* and *avarta marma* is a type of *shira marma* and half *angula* in size. The *Avarta marma* is above the end of the eyebrows. The *Sringataka marma* are the merging of vessels providing nutrition to sense organs like nose, ear, eye and tongue. It is type of *sira marma* and four *angula* in size and injury to this also results in immediate death.

Structure or Entities as per Ayurvedic text	Correlation of Structure or Entities as per Modern text
Pakshma mandala	Eyelashes.
Vartma mandala	Upper and Lower eyelids.
Shukla mandala	Sacral part of the external fibrous coat of eyeball.
Krishna mandala	Cornea and iris.
Drishti mandala	Pupil and lens.
<i>Pakshma-Vartma gata Sandhi</i>	Lid margins of eyelashes
<i>Vartma-Shukla gata Sandhi</i>	conjunctiva fornix
<i>Shukla – Krishna gata Sandhi</i>	Corneoscleral junction and limbus.
<i>Krishna - Drishti gata Sandhi</i>	central free margin of the iris, the anterior capsule of the lens.
<i>Kaneenika Sandhi</i>	Inner canthus of the eye, Plica semilunaris and caruncle.
<i>Apanga Sandhi</i>	outer canthus of the eye.
Two <i>Vartama Patala</i>	Orbital and tarsal part of the eyelids.
<i>Tejojala-ashrita Patala</i>	Aqueous humour
<i>Mamsa-ashrita Patala</i>	Ciliary body, choroid
<i>Medoa-ashrita Patala</i>	Vitreous humour
<i>Asthi-ashrita Patala</i>	Crystalline lens and retina

DISCUSSION

In this literary study we collected various data from the *Ayurvedic* classics with the available commentaries, as well as text books of modern medical sciences, various articles for better understanding of the *netra sharir* and its comparison with contemporary science. *Acharyas* have explained *prakriti* also

influences eyes in terms of size, shape of eyes, appearance of eyes, dryness or roughness of eyes, color of eyes, lashes of eyes, movement of eyes and some specific features of eye. These relates to the constitutional variations of the individuals. *Acharya Sushruta* has described “*Sarvendriyaanam Nayanampradhanam*[20]”. *Acharya Sushruta* first ever

has described the anatomy of eye in relation to their shape, size of various anatomical components. *Sushruta* has explained seventy-six different kinds of eye diseases and their treatment in *uttara tantra*. The *Netra* execute both physiological functions *roopagrahana* and *buddhigrahana* as it is the seat of *Alochaka pitta*. It is predominant of *tejo mahabhuta* so, there is always dread of *kapha* to eye.

The shape of *netra* is like *svrittam* means spherical from all sides and *gostanakara* means shaped like that teat of the cow (oval shape). *Acharya Sushruta* described the anatomical parts of the eye consists of *mandals* are five in number and *sandhi* and *patala* are six in number [21]. *Sandhi* is the “Junctional Areas” between two *Mandalas*. The *Sandhi* are 6 in number. *Acharya sushruta* has described the *patala* are most important structure of *netra sharir*. The first *patala* is the seat of *tejas* and *jala* and it can be taken as cornea and aqueous humour; the second *patala* is the seat of *mamsa* and it can be taken as iris and ciliary body. The third *patala* is the seat of *medo* and it can be taken as vitreous humour, it is a jelly like structure which resembles *medas*. The fourth *patala* is the seat of *asthi* and it can be taken as lens and retina, as it is the seat for *linganasha*.

These are the parts where *doshas* get localized and produce various types of *netra rogas*. When *doshas* invade gradually deeper in the *patala* it causes *timira*, *Kacha* and *Linganasa*. *Netra* also consists of *Akshi bandhana*, *sira*, *pesi*, *dhamani*, *marma*, *snayu* and other accessory parts. Thus, whole of *patala Mandala*, *Sandhi*, *Akshi bandhana*, *sira*, *pesi*, *dhamani*, *marma*, *snayu* completes the *netra sharira*.

To conclude, we can say that *Patala* were described by Ancient Acharyas in order to show the severity of the diseases when they involve deeper tissues and no single structure can be correlated with specific *Patala* accurately. *Patala* can be taken as different structures in different contexts.

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