

The anatomy of the skin: concepts from ayurveda and computational modelling

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Abstract

Ayurveda used unique methods to understand human anatomy, which included examination of cadavers. Conventional anatomy is based on cadaver dissection with complex tools to understand histology. Computational modelling of the anatomy of the skin based on light attenuation at different wavelengths converted into corresponding chromophores gave a model which resembles that described in Ayurveda. The descriptions of the Ayurveda sages Charaka (*Circa* 500 B.C.) and Sushruta (*Circa* 600 B.C.) in classical Ayurveda are compared with contemporary, conventional anatomy and with the computational model. Such comparisons can facilitate an integrated approach to dermatology.

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Introduction

Sushruta (*Circa* 600 B.C.) is known for detailed descriptions of over a thousand illnesses, as well as plant and mineral remedies which are considered fundamental to present day Ayurveda.¹ The contributions of Sushruta to understanding human anatomy are relevant nowadays, as they show an unusual depth of understanding and accuracy.²

In the text *Sushruta Samhita, Sharirasthana*, there is a systematic description of the methods used to understand and study the human cadaver.³ It is mentioned that the cadaver should be of a person who did not die due to poisoning, chronic illness, or extreme old age.⁴ The rest of the description is as clear; after removing waste matter from the digestive system, the cadaver

should be wrapped in grass and placed in a cage, which should then be kept in dimly lit, slowly flowing water for seven nights. After this the decomposed cadaver should be removed (from the cage) and using fragrant roots of plants the cadaver should be gently rubbed and any part of the body which is removed would be visually inspected in great detail. This method, devoid of present day dissecting tools, was obviously very effective as the descriptions of anatomy given by Sushruta are remarkably accurate and close to present day descriptions. This will be discussed here with particular relevance to the skin.

According to the teachings of the great father of Ayurveda medicine, Charaka, the skin was described as six layers based on the clinical conditions of each.^{5,6} This categorization is mentioned in Table 1.

Table 1: Description of skin layers according to Charaka

S. No.	Skin layer	Functions	Diseases ^{5,6}
1	<i>Udakdhara</i>	Holding the water	Dehydration, wrinkles
2	<i>Asrukdhara</i>	Holding the blood	Nonelevated mole (<i>Tilakalaka</i>), Naevi (<i>Nyacha</i>) and capillary angiona (<i>Vyanga</i>)
3	Seat of <i>Sidhma</i> (dermatitis) and <i>Kilas kushta</i> (leucoderma or vitiligo)	Possible function is pigmentation and immunity/ protection*	Pityriasis versicolor or Tinea versicolor (<i>Sidhma</i>) and Vitiligo (<i>Kilas kushta</i>)
4	Seat of <i>Dadru</i> (Ringworm or Tinea corpora) and <i>Kushtha</i> (Hansens disease or leprosy)	Possible immune function against chronic infections *	Tinea corporis or ring worm (<i>Dadru</i>) and Hansen's disease or leprosy (<i>Kushtha</i>)

5	Seat of <i>Alaji</i> (boil) and <i>Vidradhi</i> (abscess)	Possible immune functions against acute infections*	A type of boil (<i>Alaji</i>) and abscess (<i>Vidradhi</i>)
6	Seat of boils, appearing blackish-red and deep rooted on joints	Related to life or consciousness	Pain in case of injury

*Speculations were made based on diseases observed

Compared to the categorization of Charaka, the Ayurveda surgeon Sushruta mentioned seven layers of the skin. These are (in Sanskrit) *avabhasini*, *lohita*, *shweta*, *tamra*, *vedini*, *rohini*, and *mansdhara*.^[4,6,7] *Avabhasini* is the outermost layer, which is believed to reflect the health of the individual, the health of deeper layers and of the interstitial, nutrient fluid called *rasa dhatu*. *Lohita* indicates the quality of blood (*rakta dhatu*) and it also supports the outer layer. *Shweta* balances the color of the skin. *Tamra* nurtures and protects the upper layers. It is considered a protective barrier. *Vedini* is the layer responsible for sensation. *Rohini* is the layer which supports healing and regeneration. The last layer, *mansdhara* is considered necessary for the skin to appear firm and supple. These details along with the clinical conditions associated with each are given in Table 2.

Table 2: Description of skin layers according to Sushruta

S. No.	Skin layer	Functions	Diseases ^{4,6,7}
1	Avabhasini	Reflecting the health of the individual and maintaining health of deeper layers and of the interstitial, nutrient fluid called <i>rasa dhatu</i> Illuminates all shades of the skin	Pityriasis vesicular (<i>Sidhma</i>) and <i>padmakantak</i> considered as papilloma
2	Lohita	Supporting the outer layer and indicates the quality of blood	Nonelevated mole (<i>Tilakalaka</i>), <i>Naevi</i> (<i>Nyacha</i>) and capillary angioma (<i>vyanga</i>)
3	Shweta	Balancing the color of the skin	<i>Charmadala</i> , <i>Ajagallika</i> and <i>mashaka</i>
4	Tamra	Nurturing and protecting the upper layers	Leprosy (<i>Kushtha</i>) and <i>erysipelas</i> (<i>visarpa</i>)
5	Vedini	Sensation	Leprosy (<i>Kushtha</i>) and <i>Vitiligo</i> (<i>Kilasa</i>)
6	Rohini	Healing and regeneration	Sebaceous cyst (<i>Granthi</i>), <i>lymphadenitis</i> (<i>apachi</i>), tumor (<i>arbuda</i>), <i>filariasis</i> (<i>shlipada</i>) and <i>goiter</i> (<i>galaganda</i>)
7	Mansadhara	Skin to appear firm and supple	<i>Fistula</i> (<i>Bhagandar</i>), abscess (<i>vidradhi</i>) and <i>Piles</i> (<i>arsha roga</i>)

Many of the functions described in Ayurveda texts are comparable to the functions described in contemporary medicine. Contemporary anatomy describes the skin as (i) the epidermis, with six layers; (ii) the dermis with two layers, and (iii) the hypodermis or subcutaneous tissue.⁸ In conventional anatomy three layers of the epidermis, two layers of the dermis and hypodermis (making six layers in all) correspond to six layers described by Sushruta (Table 3). Taking their structure and function into account the following parallels may be considered: (a) *Avabhasini* with *stratum corneum* of the epidermis; (b) *Shweta* with *stratum lucidum* of the epidermis; (c) *Tamra* with *stratum granulosum* of the epidermis; (d) *Vedini* with the papillary layer of the dermis; (e) *Rohini* with the reticular layer of the dermis; and (f) *Mansdhara* with the hypodermis.⁹

Table 3: The correlation between layers described by Sushruta and layers mentioned in conventional anatomy

Name & functions	Ayurveda	Conventional anatomy
Name of the layer	1. Avabhasini	1. Stratum corneum (Epidermis)
Functions of the layer	Reflecting the health of the individual and maintaining	Forms a barrier to protect underlying tissue from infection, dehydration,

	health of deeper layers and of the interstitial, nutrient fluid called <i>rasa dhatu</i> Illuminates all shades of the skin	chemicals and mechanical stress ¹⁰
Name of the layer	2. Shweta	2. Stratum lucidum (Epidermis)
Functions of the layer	Balancing the color of the skin	Responsible for elasticity of the skin Makes the skin water proof ¹¹
Name of the layer	3. Tamra	3. Stratum granulosum (Epidermis)
Functions of the layer	Nurturing and protecting the upper layers	This layer is at the transition of boundary between this layer and stratum corneum, the cells secrete lamellar bodies which contain lipids and proteins. This forms a hydrophobic barrier. This layer has a protective function ¹⁰
Name of the layer	4. Vedini	4. Papillary layer (Dermis)
Functions of the layer	Sensation	This layer contains connective tissue, blood capillaries and Meissner's corpuscles. Hence the papillary dermis provide support, nourishment and deep sensation ¹²
Name of the layer	5. Rohini	5. Reticular layer (Dermis)
Functions of the layer	Healing and regeneration	This layer contains collagenous, elastic, reticular and protein fibers giving it strength and elasticity. The reticular layer also has roots of hair follicles, sebaceous glands, sweat glands, apocrine glands, lymph and blood vessels. The orientation of certain collagen fibers within this layer are important for support and nourishment ¹³
Name of the layer	Mansadhara	Hypodermis
Functions of the layer	Skin to appear firm and supple	The hypodermis acts as an energy reserve ¹⁴

Note: The conventional description does not include all 7 layers of the epidermis

Despite the differences in the number of layers, other parallels can be drawn. For example, within the epidermis are keratinocytes with keratin which acts as an effective barrier; there are melanocytes which influence the pigment or color of the skin; Merkel cells play a role in sensation; and Langerhans cells help fight antigens. The skin is vascular and has other secretions (sebum and sweat, for example).¹⁰ While these structures require present day microscopic methods to study them, Ayurveda descriptions do mention the presence of sensation, as well as protective and nourishing factors. The common features in functions, based on the descriptions of Sushruta and of contemporary medicine are given in Table 3.

Interestingly, computational modelling of the skin also describes seven layers, as were described in Ayurveda.¹⁵ Simulated diffuse reflectance spectra were assumed by a

wavelength independent scattering coefficient for the different skin tissues, using the known wavelength dependence of the absorption coefficient of oxy and deoxy Hb and water. This computational modelling resulted in a three-dimensional media which has seven layers.¹⁵ The physical and structural parameters of internal tissues were comparable with results of *in vivo* measurements of skin reflectance spectra.

According to the computational model, the first layer has desquamating cells containing keratin, and was called the *stratum corneum* (20µm thick). The second layer, called the 'living epidermis' (80 µm thick) contains columnar cells, cells with keratohyalin granules, and a fraction of dehydrated cells.¹⁶ The remaining layers which were speculated to provide support and protection, as well as sensation and pigmentation, have been called the papillary dermis (150 µm thick), upper blood net

dermis (80 µm thick), reticular dermis (1500 µm thick), and deep blood net dermis (100 µm thick). The deepest layer in this model is subcutaneous fat (6000 µm thick).

These layers are approximate but illustrate that the spatial distribution of blood in heterogenous tissues is an important factor, which influences the transport of light in the tissue.¹⁷ It is interesting that computational modeling, conventional and ancient Ayurveda texts (of Sushruta Samhita, Chapter 4 Verse 3) describe the skin ascribing similar functions to the layers, even though the methods used are very different. These common features can be considered important as medical conditions, especially dermatological diseases often do not respond adequately to conventional medicine.¹⁸ It is increasingly apparent that an integrated approach, which combines conventional dermatology and complementary and alternative treatments would be a better alternative. This was proposed by Terence Ryan (1998), who as the Chairman of the International Foundation of Dermatology advocated *Skin Care for All*.¹⁹ The Institute of Applied Dermatology (IAD) in Kerala, India under S.R. Narhari MD has developed an unique integrated approach, combining allopathic treatment with ayurveda to successfully manage lymphatic filariasis, lichen planus and vitiligo.²⁰ The integrated approach has been successful, with a good response rate and no side effects. In order to promote an integrated approach to dermatology, common features between the two knowledge systems, i.e., allopathy and ayurveda is essential. A good starting point would be to demonstrate common features in the anatomy and physiology of the skin layers in both systems. This is the aim of the present study.

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