Journal of Biomedical Sciences | ISSN: 2960-9356
Research Article Peer-review, Open Access

Embryological Basis in the Pathogenesis of Vitiligo

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Abstract

Vitiligo (Switra) is a chronic skin condition characterized by the loss of pigmentation due to melanocyte destruction. Despite its prevalence, the exact etiopathogenesis remains complex and poorly understood. This article explores the embryological basis of vitiligo, with a particular focus on neural crest cell migration and its disruption, which may contribute to melanocyte loss. Embryological factors such as abnormal neural crest cell migration, defective melanocyte colonization, and genetic predisposition are highlighted as potential causes. Furthermore, Ayurvedic perspectives are integrated, emphasizing the role of maternal and nutritional factors in the development of the skin, which may predispose individuals to conditions like vitiligo. Ayurvedic concepts such as the influence of Matruja Bhava (maternal factors), Satmyaja Bhava (adaptation factors), and genetic inheritance provide additional insights into the skin's development and its susceptibility to diseases. The article suggests that a deeper understanding of both embryological and Ayurvedic perspectives could pave the way for more effective prevention and management strategies for vitiligo.

Key words: Vitiligo, Embryological basis, Switra.

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INTRODUCTION: Skin is the largest organ and covers the entire human body. This fact makes skin the most important organ, which builds one's identity. Unfortunately, in clinical practice, we see a cluster of

chronic skin diseases like Switra (vitiligo), Charmadala (Atopic Dermatitis), and Ekakusta (Psoriasis). With the inherent complexity of etiopathogenesis and management, these diseases have become of great concern to patients and even dermatologists.

Ayurveda has described the process of skin formation and development with influences of different Doshas and Dhatus in the intrauterine period. The description of skin formation and development in Ayurveda throws light on the role of various factors such as Rasaja, Satmyaja, and Matruhja bhavas[1] with the influence of Pitta, Rakta, and Mamsa; skin is formed like the formation of cream over hot milk.[2] Derangement in this homeostatic milieu may lead to Kha-Vaigunya (area of susceptibility) in the skin.

An effort is made here to explore the embryological basis in the etiopathogenesis of Switra. Recent publications in indexed journals also suggest the predilection of vitiligo patches in embryologically significant locations.

EMBRYOLOGICAL CONSIDERATIONS IN THE DEVELOPMENT OF VITILIGO:

Embryology provides valuable insights into the development and causes of Switra, According to embryological perspectives, Switra is related to the development of the neural crest, which gives rise to melanocytes, the cells responsible for skin pigmentation.[3] During embryonic development, the neural crest cells migrate to various parts of the body, including the skin, hair, and eyes. Any disruptions or abnormalities during this migration process may lead to the destruction of melanocytes, resulting in vitiligo.

Some possible embryological factors contributing to Switra include 1. Abnormal neural crest cell migration: An altered migration pattern of neural crest cells may lead to abnormal melanocyte distribution, increasing the risk of Switra. 2. Defects in skin colonization: An impaired colonization of melanocytes in the skin during embryonic development may predispose individuals to Switra. 3. Genetic Predisposition: There's strong evidence of a genetic component evidenced by a multifold increase in the risk of acquiring vitiligo where there is a family history of vitiligo or other autoimmune diseases. Multiple genes are likely involved, interacting with environmental factors. These genes often relate to immune system function and melanocyte biology. Specific genes implicated include NLRP1, PTPN22, and genes related to the major histocompatibility complex (MHC). 4. Defective development of melanocytes: Melanocytes originate from the neural crest, a transient group of cells in the developing embryo. Defects in neural crest cell migration or differentiation could lead to a lack of melanocytes in certain areas. However, this would typically result in congenital conditions like piebaldism (patches of white skin and hair present at birth due to a KIT gene mutation) or Waardenburg syndrome, which are distinct from vitiligo. Vitiligo involves the destruction of melanocytes that were initially present and functioning, not a failure of melanocytes to develop in the first place.[4]

AYURVEDIC VIEW: In Ayurvedic texts, it is stated that the development of Twacha (skin) occurs in Tritiya masa (third month) of intrauterine life.[5] The development of embryo and fetus is influenced by Matruja Bhava (Maternal factors), Pitruja Bhava (Paternal factors), Rasaja Bhava (Nutritional factors), Satmyaja Bhava (Adaptation factors), Satvaja Bhava (Mental factors) and Atmaja Bhava (Soul and previous deeds). [1]

Twak (skin) is derived from Matruja bhava and thus, the phenotypic expression of skin and its components is more inclined towards the nature of the mother's skin. This may indicate towards some of the genetic components derived from mitochondria or maternal cytoplam play a crucial role in the genesis and development of skin in the intrauterine period. [6] Similarly, there may be a role of maternal genotype on the susceptibility of the progeny towards skin disorders like vitiligo, psoriasis or atopic dermatitis.[7] Satmyaja Bhava (Adaptation factors) is another important influencing factor in the process of development of body complexion, having a direct relation with the characteristics of skin. The optimum quality of Satymaja Bhava can be attained by following of Pathya (wholesome) diet and activity regime

by the mother before and after conception until delivery. Mothers involved in Apathya (unwholesome) diet and activity regime will cause adverse complexional outcomes for the child and obviously, vitiligo may be one of them. This understanding is further validated as Ayurveda opines that, when a pregnant woman follows Kapha vitiating diet and activity regime she gives birth to a baby who suffers from skin diseases like Kustha and Switra.[8] Sushrutha mentioned Kusta as an Adibalapravrutta Vyadhi (disease caused by defective gametes) where the defect is present in Sukra (Sperm) of Shonita (Ovum), which is more likely to be a genetic defect.[9] Dauhrida Apachara (not fulfilling the desires of pregnant women) also can lead to the causation of skin diseases like vitiligo in the progeny,[10] which indicates the influence of deficiency of some essential nutrients leading to the deficient production of factors essential for melanocyte production or pigmentation. This phenomenon can also be attributed to psychological stress experienced by the mother causing free radical-induced or neuro-transmitter-induced damage to melanocytes. Switra is also considered a Papa Karmaja Vyadhi (disease occurring due to sinful deeds).[10] The sinful deeds may be of the present life, which gives a lot of psychological stress and acts as a triggering factor for many diseases like vitiligo which has autoimmune and free radical damage origin. Deeds of past life are purely a matter of belief that should be considered with the real spirit of Vedas. Research in this regard may reveal the possible etiology of many idiopathic disorders including vitiligo.

CONCLUSIONS: Views discussed in this article throw light on a new facet of the pathogenesis of vitiligo, in line with the ayurvedic understanding of the embryological influence on the development of various skin disorders including vitiligo (Switra). Further research on the influence of defective embryological development on the causation of vitiligo will help in framing an effective management of the condition including prevention.

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