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# G6 PD DEFICIENCY: A REVIEW OF AYURVEDIC ASPECTS AND PREVENTIVE MEASURES

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## ABSTRACT

G6PD (Glucose-6 Phosphate Dehydrogenase) Deficiency was reported from India more than 50 years ago. The prevalence of G6PD deficiency is found in six states of India with an order of incidence observed highest in Madhya Pradesh followed by Gujrat, Karnataka Maharashtra, Uttar Pradesh and Tamil Nadu. Ayurvedic texts provide a detailed description of the aetiology of various foetal malformations. Hereditary (Sahaj or Adibalapravrtta), congenital (Garbhaja or Janmabalapravrtta), and familial (Kulaja) disorders were well defined. One of the genetic components described in Ayurveda is Bija which is a part of Shukra and Shonita. The combination of procreative elements described in ayurveda as *Shad Garbhakara Bhavas* (*Matrija, Pitrij, Atmaja, Rasaja, Satmyaja, Sattvaja*) is required for healthy offspring. Moreover, the precise specificity of Bija (genes) and their effect has also been taken into account. As a result of deeds of previous birth, defects in *Garbhasaya* (uterine factors), *Kala* (age or time of conception), and *Aahar vihar* (mother's food and lifestyle) vitiated doshas cause defects in genes which causes numerous anomalies which expressed in the form of defects in shape, complexion, and sense organs of the body.

**KEYWORDS:** *Bija dushti, Bijabhagavayava*, Congenital disease, G6PD.

## INTRODUCTION

Genetic disorders include a wide spectrum of bodily structural or function defects that are apparent at birth or later stage of life and they have major medical, social, or aesthetic ramifications for the affected person usually necessitating medical care. One of these the G6PD (Glucose-6 Phosphate Dehydrogenase) Deficiency was reported from India more than 50 years ago. The prevalence varies from 2.3 to 27.0% with an overall prevalence of 7.7% in different tribal groups. The prevalence of G6PD deficiency is found in six states of India with an order of incidence observed highest in Madhya Pradesh (13.8%) followed by Gujrat (10.8%), Karnataka (12.0%), Maharashtra (7.0%), Uttar Pradesh (5.6%), and Tamil Nadu (1.5%).[1] These inborn deformities have been frequently recorded from the Vedic era. Ayurveda describes them in the form of genetic illnesses caused by *Bija* (abnormalities of Ovum and Sperm), while explaining the morbidity of sperm, ovum, *Bija* (chromosome), *Bijabhaga* (genes), and *Bijabhagavayava* (DNA). Glucose-6-phosphate dehydrogenase (G6PD) deficiency is a common X-linked inheritance disorder, affecting nearly 400 million individuals worldwide. It is characterized by an enzyme defect that plays an important role in preserving erythrocyte integrity against oxidative stress and damage. This predisposes G6PD deficient individuals to hemolysis when exposed to certain triggers such as fava beans and oxidant drugs. Hemolytic attacks may sometimes result in an increase of bilirubin levels that leads to kernicterus in infants or hemoglobinuria with acute renal failure in adults.[2] According to Acharya Sushrut, *Soumyata* is the main component of *Shukra*, which comprises all of 5 *Mahabhuta*. As "*Ritu*" (Season), "*Kshetra*" (Field), "*Ambu*" (Water) and "*Bija*" (*Shukra* and *Shonita*) combined in proper and favorable way they give rise to the sprout. Similarly, the proper combination of *Ritu* (Luteal or ovulatory phase), *Kshetra* (Favorable intra-uterine environment), *Ambu* (Proper nutritional factors) and *Bija* (Availability of healthy Sperm and Ovum) is responsible for healthy offspring.[3] There is no exact description of G6PD found in Ayurveda, but some of the Ayurvedic concepts highlighted in this paper below will be helpful in understanding the etiopathogenesis of disease.

**AYURVEDA AND G6 PD DEFFICIENCY**

Ayurveda is unique in many ways; one such concept is described by Acharya Charaka regarding the nomenclature of disease. Human body is physiologically and pathologically regulated by three *Doshas* only, all the disease originates on the basis of various causes and anatomical location of vitiation of *Doshas*.[4] In that case a physician should proceed to diagnose and treat a disease on the basis of *Roga prikriti* (Involvement of *Doshas*), *Adhisthana* (Organ or Systemic involvement), and *Samuthana* (Progression of disease) symptoms of the disease and should not be ashamed of not knowing name of disease. This whole concept of disease diagnosis and treatment is known as *Anukta Vyadhi*.[5] This concept of *Anukta Vyadhi* is based on *Aaptopadesha Pramana* (Undoubtable words of an experts) considering all this description the G6PD Deficiency can be associated with *Bijadushtijanya Panduroga*. Based on the points mentioned in the classics, a comprehensive picture of this disease can be made in the light of modern medical knowledge.

**Concept of *Bijadushtijanya Vikara* (genetic disorders)**

Ancient Acharyas were aware of the genetic foundation for a number of ailments. They discussed the potential causes of *Bijadushti* (defective gene mutation) and also suggested potential outcomes in the form of the formation of *Vikrita Avayava* (defective organ), *Tridosha Prakopa* (vitiation of all three *Doshas*), and structural defects linked to origin of defective *Bija* or *Bijabhaga*. Also, certain diseases, such as *Arsha* (piles), *Prameha* (diabetes mellitus), *Kushth*a (skin disorders), and others have hereditary underpinnings. They are inclined toward *Asadhya* and *Kastsadhya* (incurable of difficult to cure) nature of disease.[6] While describing *Bijadushtijanya Vikaras*, Acharya Charaka stated that vitiation of specific *Doshas* is responsible for defect in particular *Bija* (sperm or ovum) or *Bijabhaga* (chromosomes), Which lead to *Avayava janya vikriti* (organ specific deformity).[7] One such example is *Tranputrik* and *Vaarta*, who have masculine and feminine physical appearances, respectively. Based on a recent comparison, these characteristics roughly correlate to Klinefelter syndrome and Turner's syndrome. Even the traits listed in *Shandi Yonivyapad* are similar to Turner's disease and its emergence as a result of *Bijadosha*.[8]

Defective mutations are the primary contributor to many disorders; however, the underlying cause of these mutations is yet unknown. Acharyas discussed the *Maatru-Pitru Apachaara*, *Daiva*, *Poorvakrita Ashubha Karma*, and *Prakopa* of *Vaataadi Dosha* as potential causes of *Bijadushti* (defected mutation). Additionally, they have listed potential outcomes such as the formation of *Tridosha Prakopa, Vikrita Avayava* corresponding to biochemical abnormalities or functional abnormalities, and structural flaws associated with origin of *Bija* or *Bijabhaga*.[9]

In Ayurveda, the chromosomes with genes that symbolize the organs produced in the future are described as *Bija* and *Bijabhaga*. The *Bija* a division of sperm or ovum responsible for the production of a specific organ; the closest term in contemporary genetics is the Chromosome and *Bijabhaga* a component of *Bija*; the most relative term in modern genetics is the Gene. When *Doshas* vitiate and causes defect in these components, the corresponding derived *Avayavas* (organs) get deformed. The classical term Ayurveda with nearest possible correlation of genetics and G6PD are shown in the table below (Table No. 1).[10]

**Table No. 1: Classical term of ayurveda with nearest possible correlation of genetics and G6PD.**

| TERM IN AYURVEDA | TERM IN GENETICS | TERM FOR G6PD |
|---|---|---|
| *Bija* | Sperm, Ovum and zygote | Sperm, Ovum and zygote |
| *Bija-bhaga* | Chromosomes | X-linked recessive |
| *Bijabhaga-avyava* | Gene locus: Promoter region, Exons, Introns | Xq28 chromosome band |

Some other illnesses showing similarity with G6PD Deficiency has been described by Acharyas Such as Sushrutacharya described *Karmajavyadhi*, when a person engages in improper behavior, the guilt or unpleasant emotion may even affect gametogenesis, which may be passed on to the following generation. The genetic information is therefore kept in the gamete based on the *Dharmadharma* (good and bad deeds) we commit. In order to lessen the impact of *Karmaphala* (outcome of deeds), Buddha also suggested performing good deeds. Other group of ailments is known as *Adibalapravitta* diseases are caused by flaws in either the *Shukra* and *Shonita* and expressed as *Prameha*, *Arsha*, *Sthoulya*, *Ashtanindita purusha* and *Kus*tha.[11] One of the main causes of foetal malformations is a result of a couple's unlucky deeds of past life i.e. *Karmaphala*, in this condition *Daivavyapasraya Chikitsa* plays a role in lessening the intensity of disease.[12] Congenital malformations are thought to be caused by *Shukra and Vayu* abnormalities, as well as vitiated *Vayu* situated in the shukra.[13] According to Ayurveda literature the factors which can contribute to genetic disorders can be summarized as follows.[14]

- Inadequacy in the *Garbhakara bhavas* i.e., *Maatrija*, *Pitrija*, *Atmaja*, *Satvaja*, *Rasaja*, *Satmyaja*
- Defect in *Shukra* and *Shonita*.
- *Bija*, *Bijabhaga* and *Bijabhagavayava*
- *Kala* of conception and condition of uterus.
- Diatic regimen of the mother during pregnancy.
- Presence of diseases condition in parents.
- Characteristics of *Mahabhutas* which comprising foetus, etc.

Additionally, Marriages in two identical "*Gotras*" should be avoided according to Ayurveda, because it causes congenital abnormalities. Some diseases have been reported to be more common in offspring as a result of marriages between close relatives.[15] Because families those transmit a recessive disease the majority normal people are likely to be heterozygous than normal homozygotes. High traditional consanguineous marriages (in certain tribes, races, and religions) increase the incidence of autosomal disorders recessive disorders. Indian tribal groups have their own characteristic genetic structure. All this act as unique a gene pool that arose in the natural environment for thousands of years. That is why they are special health problems and genetic abnormalities such as sickle cell anemia, thalassemia, glucose-6-phosphate dehydrogenase and erythrocyte enzyme deficiency.[16]

**Pathophysiology of *Bija dusti* and genetic abnormalities as per Ayurveda:** Although it is difficult to explain exact cause of *Bija disti*, even then Sushruta gas explained this concept as *Putipuyanibham Shukra* and *Ksirna Shukra*. Out of which *Putipuyanibham Shukra* can be correlated with Bacteriosermi which affects the normal fertility process by any of these following mechanisms: deterioration of spermatogenesis, decreased sperm motility, altered acrosome reaction, altered morphology, formation of reactive oxygen species leading to increased DNA fragmentation index, formation of antisperm antibodies due to breach in the blood-testes barrier, and genital tract obstruction due to inflammation and fibrosis. The sperm DNA fragmentation index (DFI) reflects the integrity of and the damage to the DNA, the genetic material of the sperm, thereby detecting potential sperm damage.[17] The *Kshirna Shukra* can be correlated with the factors affecting sperm count health, as one study covering both well-known and newly discovered genetic abnormalities that are connected to reproductive treatment. About 7% of men with idiopathic spermatogenic failure have chromosomal abnormalities; these are mostly numerical/structural in azoospermia men and translocations/inversions in oligospermic men.[18]

Further Ayurveda explains the cause behind delivery of an abnormal child with deficiency or excess of organs or deranged sense organs. The self along with subtle *Bhutas* and with speed like that of *Mana* transmigrate form one body to the other according to past deeds. It cannot be seen without divine visual sense. In the body, *Bhutas* are sixteen (out of four *Bhutas* each being of four types) such as caused by maternal nutrition, the self, mother(ovum) and father(sperm). The Bhutas derived from mother and father are represented by ovum and sperm in foetus. Four *Bhutas* are derived from past deeds which having merged with the self-enter into the foetus because the self with the genetic character always transmigrates himself from one body to the other. According to past deeds, form arises from (the past) form and mind from (the past) mind. Whatever difference is observed in physique and psyche is caused by *Rajas* and *Tamas* as well as the past deeds. Due to defect of genes, the self, past deeds, uterus, *Kala* and mother's food and behavior, the vitiated *Doshas* produce various abnormalities in physiology, shape, and sense organs.[19]

## PREVENTIVE MEASURES TO AVOID GENETIC DISORDERS

The Ayurvedic classics outline the following procedures for resolving *Bijapushti* and other underlying reasons for reproduction. The measures that must be taken can be taken both before and during pregnancy. *Ayurveda* is concerned with both physical and mental wellbeing. To preserve mental and physical health, competent counselling based on Ayurvedic principles is essential. Ayurveda advices from one month prior to conception - *Shali* rice with *Ghrita* (ghee) and milk should be consumed by the male and the female should consume *Tila Taila* and *Masha* (Black gramme) in their diet. Black grammes are a good source of folic acid, proteins, and fibres in the preconception diet as a result, it aids in the prevention of neural tube abnormalities, additionally it reduces oxidative stress due to its powerful antioxidant properties. Rice has more carbs, and rice bran includes easily digested Vitamin B complex, milk contains calcium and Ghee has the ability to provide vigor, improve tonicity, and nourish the body.[20]

## DISCUSSION

*Dosha, Dhatu, and Mala* are roots of the life out of which *Dhatus* and *Malas* are the structural units and *Doshas* are functional unit. The *Doshas* are referred to as *Asrayees*, while *Dhatus* are referred to as *Asrayaas* of *Dosha*. *Anushukra dhatu* (primordial germ cell) is required for the development of *Shukra dhatu* (Testosterone, Estrogen, and Sperm). *Shukra* represents the seventh *Dhatu* and *Rasa dhatu* takes around one month to synthesize *Shukra dhatu* in males. The *Shukra* of the male and *Shonita* of female are in charge of determining *Garbhotapatti and Prakriti* and required for conception in purest and healthiest form; which can be attain by above mentioned methods.[21]

Today, medical science has reached several milestones and is still evolving. Several observational studies have been undertaken to better understand the Congenital diseases are risk factors. Some of the emphasized variables responsible for congenital illnesses are chromosomal abnormalities, mutations with autosomal or X-linked inheritance, vascular disruption, multifactorial inheritance/familial, environmental influences, and twinning difficulties. Other major risks outside chromosomal abnormalities include maternal pregestational diabetes, hypothyroidism, various acquired maternal illnesses, prescription medicines, and high dose radiation during pregnancy.[22] Each condition might be caused by many mutations in the same or distinct genes (genetic heterogeneity). The same mutation can result in several outcomes. Traits (phenotypic diversity), even within the same family, due

to other genetic or environmental variables interfering. Furthermore, several epigenetic factors function during differentiation processes, which may alter genic expression.[23,24] The Pedigree chart indicating X-linked inheritance pattern of G6PD deficiency is shown here in Fig. 1.

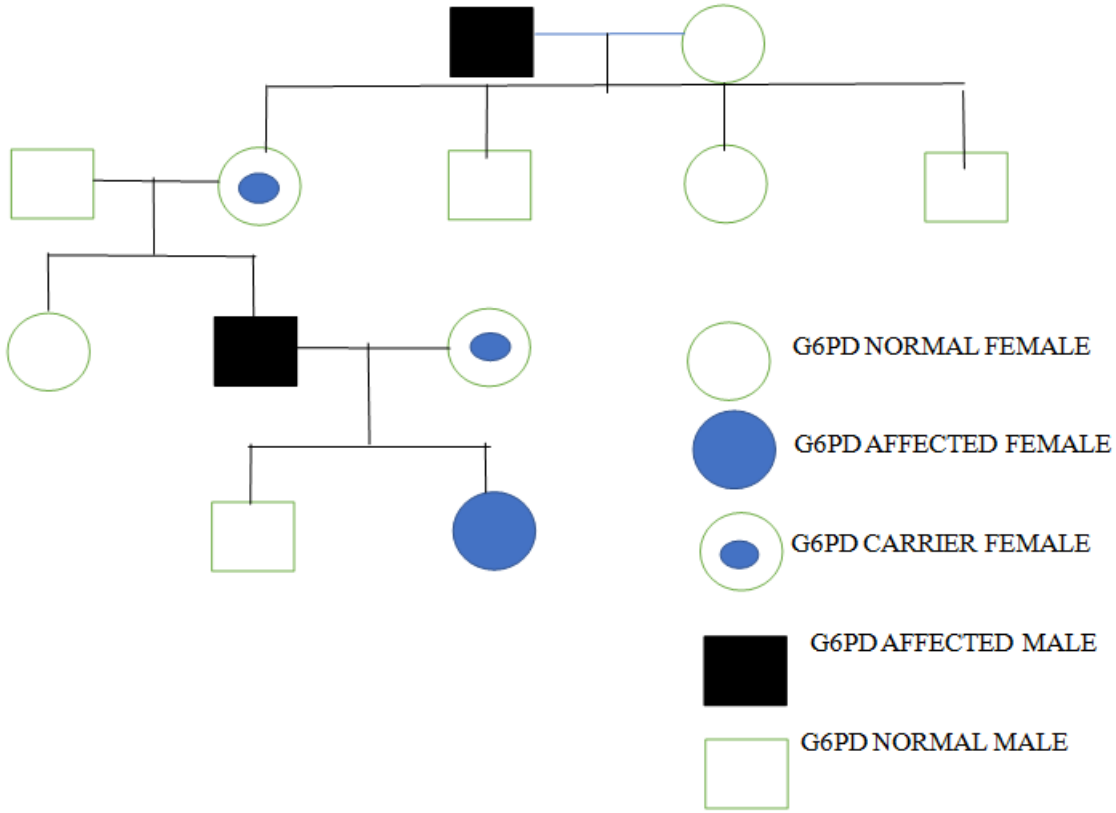


**Fig. 1. X-linked inheritance pattern of G6PD deficiency**.

## CONCLUSION

Ayurveda suggests that the prevalence of congenital or genetic disorders is controlled by various approaches such as; Diet related to *Garbhini Paricharya* to prevent *Garbhopghatkar Bhava* and *Tridosha Prakopa*. Better pregnancy planning like *Garbha Sanskar* can also prevents it, healthy offspring can also be achieved by following the rules of *Ayurveda*. Different fetal abnormalities developed at different stages and can be easily prevented or controlled at early stages with proper *Ausadhi* (Medications/Intervention), *Aahar* (diet) and *Vihara* (daily routine) mentioned in Ayurveda.

*Anuvamshiki Siddhanta* discusses that factors like *Bija* (Chromosomes), *Bijabhaga* (Genes) and *Bijabhagaavayava* (DNA) are called responsible causes heredity. Disadvantages of these factors causes malformations of the growing fetus, infertility and sexual perversions. This theory can be associated with the concept of inheritance. Thus, information related to the concept of heredity can be used for the prevention of hereditary defects and genetic counseling.

This includes both prevention and control the emphasis is on preventive issues that must be addressed first conception and early pregnancy for optimal results. Before marriage, and during pregnancy, genetic counseling can play an important role in the prevention of genetic disorders. Tips to avoid consanguineous marriage, marriageable age, and fertilization must follow to produce healthy offspring. However, further study is required to confirm this. The current study makes the assertion that Ayurvedic classics provide a framework for future research initiatives.

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