

# Understanding of Post Covid Mucormycosis through the Lens of Ayurveda

## Review Article

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## Abstract

Mucormycosis is fungal disease caused by fungus Mucor. It has been seen as a life-threatening complication of disease Covid-19. It has 70 times higher prevalence rate in India as compared to the world, having only few but expensive treatment options. The triggers of Mucor infection in Covid-19 patients are immune deficiency and hyperglycaemia caused by the use of corticosteroid, which favours Mucorales tissue Penetration. Mucormycosis has mainly six different types viz pulmonary, rhino-orbital-cerebral, gastrointestinal, widely disseminated, cutaneous, & miscellaneous infection, the commonest clinical presentation is rhino-orbito-cerebral in Covid-19 pandemic. Ayurveda though an ancient science of healing, has strength to treat newer diseases from several decades. Mucormycosis disease is not mentioned in Ayurveda text directly, it is Un uttered disease (*Anukta Vyadhi*) but it can be treated with help of basic principles of Ayurveda. By understanding the pathogenesis, it can be stated that, it is an *Abhishangaja Vyadhi* (disease caused by Virus/ Bacteria/ Parasite) and categorised as *Raktapitta Pradhan Tridoshaja Vyadhi* (disease caused by vitiation of all three humors with *rakta pitta* predominance). Prevention of Mucormycosis can be achieved by following daily (*Dincharya*) and seasonal (*Ritucharya*) regimens. The treatment protocol include *Krimighna* (Antimicrobial), *Tridoshashamak* (normalise all three humors) and *Raktashodhaka / Pittashamak* (blood purifier), *Agnideepak* (improve digestion) & *Aampachak* (improve metabolism), *Pramehhar* (treatment of diabetes/hyperglycaemia) and *Rasayana* (Rejuvenation) drugs.

**Key Words:** *Abhishangaj vyadhi, Anukta Vyadhi, Mucormycosis, RaktaPitta Pradhan Tridoshaj Vyadhi.*

## Introduction

In Covid-19 pandemic, Mucormycosis comes abruptly and rapidly as a one of the most fatal & serious complication, and rare Mucor infection becomes known to everyone as a Black Fungus. The data regarding exact incidence of Mucormycosis in India is not known but the prevalence is around 70 times higher than that in Global Data which makes everyone to think to overcome from this fatal disease.(1) Mucormycosis has a distinct tendency for invasion of endothelial cells & vasculature causing host tissue infraction & necrosis (2,3) which is likely important in spreading of the disease from primary site of infection. This is an important reason for high mortality. Another major reason is few & highly expensive therapeutic options available for treatment. Mucorales invasion and

progression of infection from one site to another is too fast, needs an emergency management and surgery, which is frequently required owing to the angio-invasive and necrotic character of infection (4) and antifungal treatment.

According to primary site of infection, Mucormycosis has mainly six different types viz pulmonary, rhino-orbital-cerebral, gastrointestinal, widely disseminated, cutaneous, & miscellaneous infection(5), the commonest clinical presentations are rhino-orbito-cerebral & pulmonary. (2,3)

## Understanding Post-Covid Mucormycosis

Prior to the pandemic, common causes of Mucor infection included haematological diseases such as leukaemia, diabetes, diseases with immune-compromised pathology, or receiving treatment that reduces immunity, such as in solid organ transplants, among others; Covid-19 is one of them. Understanding the relationship between Covid-19 and Mucormycosis, as well as the pathogenesis behind it, requires knowledge of Covid-19 treatment protocols and complications.

COVID-19, caused by Novel Corona virus, is a new disease to world. Because of that there is no perfect proven protocol of medicine available. To treat

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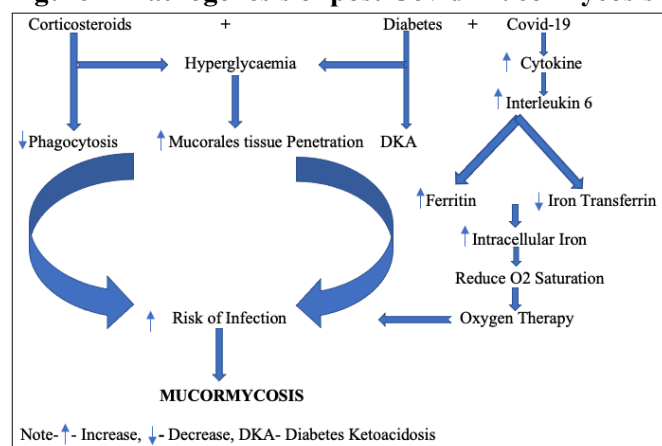
Covid-19, various types of medications are used, which includes antiviral, antibiotics, antimalarial, corticosteroids, multivitamins, zinc and in some patient's anticoagulants and oxygen therapy as per requirement. All medications are saving thousands of people's lives in pandemic but sometimes overmedication or diseased fate causes complications.

### Etiological Factors

Following are some complications of Covid-19 which may cause Mucormycosis (6,7,8)

- Diabetes, especially with diabetic ketoacidosis
- Altered Neutrophil Lymphocyte Ratio / Cytokine Storme
- Long-term corticosteroid use
- Intravenous drug use/ Oxygen therapy use
- Too much iron in the body (iron overload or hemochromatosis)

**Figure- 1 Pathogenesis of post Covid Mucormycosis**



### Pathogenesis of Post Covid Mucormycosis

As shown in Figure No. 1, Covid-19 treatment includes the use of corticosteroids responsible for decreased phagocytosis, which means decreased immunity. Also, there is an increased blood sugar level, which creates favourable conditions for tissue invasion by Mucorales of Mucor fungus. In some patients with COVID 19, an abrupt increase in blood levels of cytokines and interleukin-6 is responsible for an increased level of ferritin and decreased iron transferrin, leading to decreased intracellular iron despite a higher level of ferritin in the blood. Low levels of intracellular iron reduce oxygen saturation, and oxygen therapy is required. There was a tremendous increase in the hospitalisation of patients during the second wave of the COVID 19 pandemic for oxygen therapy, which may have hampered infection control norms like the use of uncleaned humidifiers with contaminated water or uncleaned O<sub>2</sub> tubing or face masks in patients with decreased immunity, leading to increased chances of Mucor infection(9). (Refer Figure No. 1)

### Mucormycosis & Ayurveda

In Ayurveda, mucormycosis is not described directly, i.e., it is not possible to give a standard name to this disease. *Aacharya Charak* said that if standard

nomenclature of any disease is not possible, then one should initiate treatment after acquiring complete knowledge of the nature of the disease as well as its pathogenesis, location, and etiological factors(10). Hence, to treat or prevent Mucormycosis, there is a need for an in depth understanding of the disease in terms of ayurvedic principles.

### Towards Principles of Ayurveda

*Aacharya Sushruta* has described that a person is healthy (*Swastha*), whose characteristics of humors (*Dosha*), digestion and metabolism (*Agni*), body constituents(*dhatu*), and wastes (*mala*) are in normal state and who is mentally relaxed, & spiritually calm(11). If this balance is disrupted, the person becomes vulnerable to infection. Mucor is a fungus that can be found everywhere, but it can only cause Mucormycosis when a person's immunity is compromised.

The most important thing to do to avoid disease is to maintain one's health. Ayurveda describes in detail about maintenance of health/immunity, with Digestion and Metabolism being the most important factor (*Agni*).

*Agni* (all the entities in the body involved for digestion and metabolism) is important for lifespan, growth, strength, health, and supreme force (*Ojas*), which refers to a person's immunity. As a result, if *Agni* (digestion and metabolism) is disrupted, a person is more prone to become ill. (12)

### Prevention of Mucormycosis

Prevention of disease, which implies protecting the health of healthy individuals is the most important holistic approach of Ayurveda (13). For this, there is in detailed explanation of *Dincharya* (daily regimen) (14) and *Rutucharya* (seasonal regimen)(15). Most common routes of Covid-19 and Rhino-orbital cerebral Mucormycosis infections are Nasal and Oral, thus everyday actions that improve the strength of clearing these infections will be beneficial in disease prevention. Some of the following must-do everyday activities may aid in the prevention of Covid-19 / Mucormycosis: (Refer table No.1)

- **Danta dhavan** (brushing teeth) – Brushing teeth with medicated powder or stick is helpful for oral cavity disinfection, improving appetite, and maintaining oral hygiene.(16)
- **Gandusha** (Gargling) is the practise of filling the mouth with medicated water or oil (oil pulling) & holding it there for few minutes. The amount of oil or decoction used in this procedure should be such that the person is unable to move it inside the oral cavity until there is excessive salivation, tears from the eyes and or mucous / watery secretions through the nose, which helps in expulsion of infection from oronasal cavity. It is beneficial in the prevention of diseases of the oral cavity, throat, jaw etc. (17)
- **Kavala** (Holding fluid inside the mouth/ Oil Pulling) is the act of holding small amount of

medicated water in one's mouth, moving it around briskly & spitting it out immediately. It helps in pacification of symptoms like loss of appetite, bad taste of mouth excessive salivation, local infections and dirt removal. (17)

- **Nasya** (drug administration by nose) - *Nasya* is the instillation of medicated oil or ghee through the nose in a specific manner. It is the most significant therapy for the prevention and cure of *Urdhvajatrugat* (above-the-neck) illnesses. (18)

**Table No.1: Daily regimen and drugs which can be useful**

Sr.No.	Daily Regimen	Drugs
1	<b>Danta dhavan</b> (Brushing teeth)	<i>Arka</i> (Calotropis procera (Ait) R.Br.), <i>Nyagrodh</i> (Ficus bengalensis Linn.), <i>Khadir</i> (Acacia catechu Willd.), <i>Karanj</i> (Pongamia pinnata Pierre.), <i>Arjun</i> (Terminalia arjuna W.&A.) (16)
2	<b>Gandusha</b> (Gargling)	Sesame oil ( <i>Til tail</i> ), Meat Soup ( <i>Mamsa ras</i> ) (17)
3	<b>Kavala</b> (Holding fluid inside the mouth)	Sesame oil ( <i>Til tail</i> ), Meat Soup ( <i>Mamsa ras</i> ) (17)
4	<b>Nasya</b> (Drug administration by nose)	<i>Anutail</i> (19)

**Pathogenesis of Mucormycosis**

- Etiology - Decreased immunity, *Prameha* (Diabetes / Hyperglycemia)
- Involved *Dosha* and *Dushya* - Covid-19 or Mucormycosis can be considered as *Bhutabhishangaja vyadhi* that is diseased caused by *Virus/ Fungus/ Bacteria/ Parasite (Bhuta)*. *Abhishangaja* diseases causes vitiation of all three

*Dosha along with Rakta. (20) Although there are mainly six types of Mucormycosis based on the site of infection, the most common is rhino-orbito-cerebral(1,2,3). Keeping the signs and symptoms of rhino-orbito-cerebral Mucormycosis in mind, Dosha-Dushya involvement can be stated as Raktapitta Pradhan Tridosha Dusti. (Refer table no.2)*

**Table No. 2- Signs and symptoms of Rhino-orbito-cerebral Mucormycosis and Dosha- Dushya involvement**

Sr.No.	Signs	Dosha	Dushya
1	Perinasal swelling / Periorbital edema ( <i>Shotha/Shoph</i> )	<i>Kapha</i> (21)	<i>Ras</i> (Plasma/ Lymph)
2	Erythema ( <i>Rag/ Aaraktata</i> )	<i>Pitta</i> (21) + <i>Rakta</i> (22)	<i>Rakta</i> (Blood)
3	Cyanosis ( <i>Shyava</i> )	<i>Vata</i> (21) + <i>Rakta</i> (22)	<i>Rakta</i> (Blood)
4	Eschars - Palatal or nasal or skin overlying the orbit ( <i>Kotha</i> )	<i>Pitta</i> (21,23)+ <i>Rakta</i> (22)	<i>Mansa</i> (Muscle), <i>Meda</i> (Fat)
5	Destruction of the turbinates ( <i>Kotha</i> )	<i>Pitta</i> (21,23)+ <i>Rakta</i> (22)	<i>Asthi</i> (Bone)
6	Facial numbness / Proptosis / Cranial nerve palsy ( <i>Supti / Suptata</i> )	<i>Vata</i> (24)+ <i>Kapha</i> (25)	<i>Majja</i> (Nervous tissue)

Involved *Dosha- Tridosha + Rakta*

Involved *Dushya- Ras* (Plasma/ Lymph), *Rakta* (Blood), *Mansa* (Muscle), *Meda* (Adipose tissue/ Fat), *Asthi* (Bone), *Majja* (Nervous tissue). As disease progresses there is an involvement of *Uttarottar dhatu* (deeper tissue), making things more and more challenging.

**Seat of Manifestation (*Adhishtan*)** - As per primary area of infection (Rhino- orbital, Skin, Pulmonary / Lung, Intestinal etc.)

**Prognosis** – Newly Diagnosed - Difficult to treat, Chronic - Incurable

**Towards treatment Principles of Mucormycosis**

Mucormycosis is one of the complications of Covid-19. It is not prevalent in all Covid-19 patients; only those with lowered immunity, diabetes or who are taking corticosteroids have higher risk of obtaining Mucor infection, as shown in figure 1.

As per Ayurveda, treating disease entails *Agni Chikitsa* (digestion and metabolism) normalization of vitiated humors (*Dosha*), elements/body constituents (*Dhatu*), wastes (*mala*) (26). It can be accomplished in

two ways viz *Shaman Chikitsa* (Pacification therapy) & *Shodhan Chikitsa* (Purification therapy) (27).

**Shaman Chikitsa** (Pacification therapy)

*Shaman Chikitsa* (Pacification therapy) increases immunity, which can speed up the healing process and control blood sugar, which can slow the progression of sickness. It may also assist to reduce current drug reliance and improve disease prognosis.

*Shaman Chikitsa* of Mucormycosis can include *Agni Chikitsa*, which is *Agnideepak* & *Aampachak* (improve digestion & metabolism), *Krimighna* (Antimicrobial/ Antifungal), *Tridoshashamak* (normalise all three humors), *Raktashodhaka* & *Pittashamak* (blood purifier to control inflammation), *Pramehhar* (treat diabetes/ hyperglycemia), *Vranahar* (tropical purification of site) & *Rasayana* (Rejuvenation) to improve immunity.

Ayurveda has an unique approach to treat diseases, believing in personalised medication, that varies from person to person, however some common drugs/ formulation are listed here that may be useful in treatment of Mucormycosis.(Refer table No.3)



**Table No. 3- Type of treatment regimen and single drugs along with formulations which can be useful**

Sr. No.	Treatment	Example- Single drugs	Formulations
1	<i>Agnideepak</i> (improve digestion) & <i>Aampachak</i> (improve metabolism),	<i>Sunthi</i> ( <i>Zingiber officinale</i> Rosc.), <i>Ajmoda</i> ( <i>Trachyspermum roxburghianum</i> (DC) Craib.), <i>Amalaki</i> ( <i>Emblica officinalis</i> Gaertn.), <i>Haritaki</i> ( <i>Terminalia chebula</i> Retz.), <i>Marich</i> ( <i>Piper nigrum</i> Linn.), <i>Pipalli</i> ( <i>Piper longum</i> Linn.), <i>Chavak</i> ( <i>Piper chaba</i> Hunter.), <i>Chitrak</i> ( <i>Plumbago zeylanica</i> Linn.), <i>Twak</i> ( <i>Cinnamomum zeylanicum</i> Breyn.) etc. (28)	1. <i>Shadangodak</i> (29) 2. <i>Sutshekar Ras</i> (30)
2	<i>Krimighna</i> (Antimicrobial),	<i>Hingu</i> ( <i>Ferula narthex</i> Boiss.), <i>Vidang</i> ( <i>Embelia ribes</i> Burm.f.), <i>Chakramarda</i> ( <i>Cassia tora</i> Linn.), <i>Nimba</i> ( <i>Azadirachta indica</i> A.Juss.), <i>Ajmoda</i> ( <i>Trachyspermum roxburghianum</i> (DC) Craib), <i>Kantakari</i> ( <i>Solanum nigrum</i> Linn.), <i>Nirgundi</i> ( <i>Vitex nirgundo</i> Linn.), <i>Shigru</i> ( <i>Moringa oleifera</i> Lam.) (31)	1. <i>Pancha Nimb Churna</i> (32) 2. <i>Krimikantak Ras</i> (33)
3	<i>Tridoshashamak</i> (normalize all three humors)	<i>Bruhati</i> ( <i>Solanum indicum</i> Linn.), <i>Patha</i> ( <i>Cissampelos pareira</i> Linn.), <i>Kantakari</i> ( <i>Solanum surattense</i> Burm.f.), <i>Yashti</i> ( <i>Glycyrrhiza glabra</i> Linn.) (34)	1. <i>Sanshamani Vati</i> (35) 2. <i>Arogyavardhini Vati</i> (36)
4	<i>Pramehhar</i> (treatment of diabetes/ hyperglycemia),	<i>Haridra</i> ( <i>Curcuma longa</i> Linn.), <i>Daruharidra</i> ( <i>Berberis aristata</i> DC.), <i>Asana</i> ( <i>Pterocarpus marsupium</i> Roxb.), <i>Amalaki</i> ( <i>Emblica officinalis</i> Gaertn.), <i>Haritaki</i> ( <i>Terminalia chebula</i> Retz.), <i>Bibhitak</i> ( <i>Terminalia bellirica</i> Roxb.), <i>Jambu</i> ( <i>Syzygium cumini</i> (Linn) Skeels.), <i>Kadira</i> ( <i>Acacia catechu</i> Willd.) etc. (37)	1. <i>Chandraprabha vati</i> (38) 2. <i>Pramehantak ras</i> (39) 3. <i>Nyagrodhadi churna</i> (40)
5	<i>Raktashodhaka</i> (blood purifier)/  <i>Pittashamak</i> (normalize Pitta)	<i>Manjishtha</i> ( <i>Rubia cordifolia</i> Linn.), <i>Sariva</i> ( <i>Hemidesmus indicus</i> R.Br.), <i>Chopchini</i> ( <i>Smilax china</i> Linn.), <i>Guduchi</i> ( <i>Tinospora cordifolia</i> Willd.), <i>Nimba</i> ( <i>Azadirachta indica</i> A.Juss.) (41) <i>Shatavari</i> ( <i>Asparagus recemosus</i> Willd.) <i>Kamal</i> ( <i>Nelumbo nucifera</i> Gaertn.), <i>Parpatak</i> ( <i>Fumaria vaillantii</i> Loisel.) <i>Chandan</i> ( <i>Santalum album</i> Linn.) <i>Ushira</i> ( <i>Vetiveria zizanioides</i> (Linn.) Nash.), <i>Durva</i> ( <i>Cynodon dactylon</i> Pers.) (42)	1. <i>Gandhak Rasayan</i> (43) 2. <i>Amrutasthak kwath</i> (44) 3. <i>Laghu manjistadi Kwath</i> (45)
6	<i>Rasayana</i> (Rejuvenation)	<i>Chavanprash</i> , <i>Drakshavaleha</i> , <i>Indukantam Grutam</i> , <i>Aravindasava</i> , <i>Hridra Khanda</i> and many <i>Rasayana</i> (Rejuvenation therapy) (46)	1. <i>Dhatri rasayan</i> (47) 2. <i>Guduchyadi rasayan</i> (48) 3. <i>Rasayan Churna</i> (49)
7	<i>Vranahar</i> (Wound healing)	<b>Shodhan (Purification)-</b> <i>Kutki</i> ( <i>Picrorhiza kurroa</i> Royle ex Benth.), <i>Apamarga</i> ( <i>Achyranthes aspera</i> Linn.), <i>Nimba</i> ( <i>Azadirachta indica</i> A.Juss.), <i>Vacha</i> ( <i>Acorus calamus</i> Linn.), <i>Patol</i> ( <i>Trichosanthes dioica</i> Roxb.), <b>Ropan (Healing)-</b> <i>Nyagrodha</i> ( <i>Ficus bengalensis</i> Linn.), <i>Lajjalu</i> ( <i>Mimosa pudica</i> Linn.), <i>Udumbar</i> ( <i>Ficus glomerata</i> Roxb.), <i>Ashwatha</i> ( <i>Ficus religiosa</i> Linn.), <i>Plaksha</i> ( <i>Ficus lacor</i> Buch-Ham.), <i>Triphala</i> , <i>Lodhra</i> ( <i>Symplocos racemose</i> Roxb.), <i>Priyangu</i> ( <i>Callicarpa macrophylla</i> Vahl.) (50)	1. <i>Triphala Kwath</i> (51) 2. <i>Vrana shodhan tail</i> (52) 3. <i>Vranantak ras</i> (53)

### Shodhan Chikitsa (Purification therapy)

*Shodhan Chikitsa* (Purification therapy) is well-known for its ability to purify and detoxify the entire body, as well as its ability to produce rapid results in any medical condition. Classical Purification (*Shodhan*) is entirely dependent on a person's Strength (*Bala*). Because the strength of patients with Post Covid Mucormycosis is very low, light daily purgation (*Nitya virechana*), can be used instead of actual Purification (*Shodhan*) which gradually aids in detoxification of the entire body. *Nasya* (installation of drug through the nose) and *Dhoompan* (inhalation of medicated fumes) using drugs with the properties of wound decontamination, can be beneficial for wound cleansing and healing.

### Discussion

*Agni Mandya* (decrease in digestive power) is a major factor in the development of any ailment, including death, according to Ayurveda. Agni is energy that keeps a person alive and disease-free if they are in a normal state. Agni is the source of person's longevity and health, as well as their immunity. In Ayurveda first line of treatment of any disease is *Agnichikitsa*. Then with the help of understanding causes & involvement of *Dosha-Dushya*, further treatment can be decided.

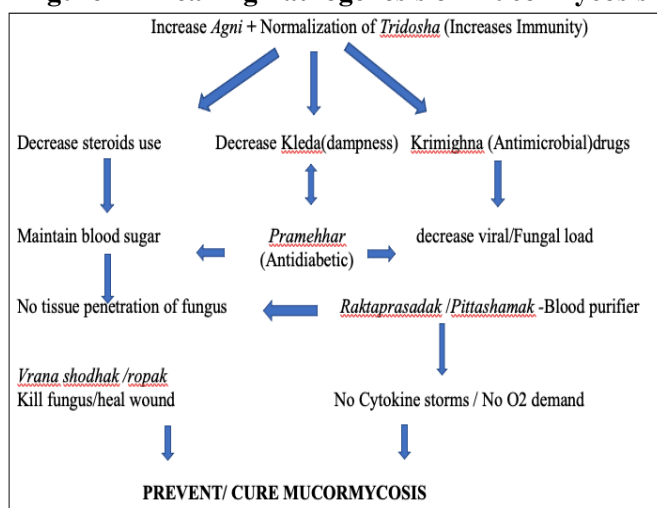
Following are the steps involved in treatment of Mucormycosis

- *Agni chikitsa* (improve digestion and metabolism) to
- *Krimighna* (Antifungal) as Mucormycosis caused by *Mucor fungus*,

- *Pramehagna* (Antidiabetic treatment) as Hyperglycaemia and dampness (*Kleda*) is important in rapid fungal growth,
- *Tridosha Shamak* (normalize all three humors) - explained in pathogenesis that it is *Tridoshaj vyadhi*.
- *Rakta-Pitta Prasadak* (blood purifier) controls inflammation (54) and normalize increase level of Serum ferritin, CRP, ESR, or cytokines.

Treatment based on Ayurvedic principles aids in the improvement of disease conditions by strengthening immunity, reducing the need for steroids. Anti-diabetic medications keep blood sugar levels stable, preventing Mucor fungus from penetrating tissue and halting fungal growth. Infection control can also be achieved with the help of blood purifiers by lowering levels of inflammatory markers. Mucormycosis can be prevented or cured by combining effects of all (Refer figure No.2)

**Figure -2 Breaking Pathogenesis of Mucormycosis**



## Conclusion

Mucormycosis is one of the dreadful effects of the Covid-19 pandemic on humans. Prior to the pandemic, it was a rare disease with few expensive therapeutic options. However, due to the Covid-19 pandemic, its prevalence has increased which arise the demand for non-expensive treatment options. Ayurveda has the ability to prevent Mucormycosis with the help of daily (*Dinacharya*) in which *Danta dhavan* (brushing teeth) *Gandusha* (Gargling) *Kavala* (Holding fluid inside the mouth/ Oil Pulling) and *Nasya* (drug administration by nose) may be useful.

Treatment according to Ayurveda varies patient to patient, but by understanding the pathogenesis of Mucormycosis, it can be stated that, it is *Rakta pitta Pradhan Tridoshaj Vyadhi*, having *krimi* (Fungus) as an *Agantuj Hetu* (external factor/cause) and hyperglycaemia as a *Nija Hetu* (internal factor) which supports tissue penetration of Mucor fungus. So treatment protocol includes *Krimighna* (Antimicrobial), *Tridoshashamak* (normalise all three humors), *Raktashodhaka / Pittashamak* (blood purifier) and *Pramehhar chikitsa* (treatment of diabetes/ hyperglycaemia) to break down the pathogenesis.

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