RESEARCH PAPER

Synergistic Potential of Abhrak Bhasma and Triphala Gel in The Management of Oral Submucous Fibrosis: A Mechanistic Review

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ABSTRACT

Background:

Oral Submucous Fibrosis (OSMF) is a chronic, insidious, and potentially malignant disorder primarily driven by the habitual consumption of areca nut and tobacco. Characterized by progressive juxta-epithelial inflammation, fibrosis and mucosal blanching, it significantly restricts mouth opening (Trismus) and induces severe burning sensations. Current conventional therapies, including corticosteroids and hyaluronidase injections, often provide only symptomatic relief with high recurrence rates and side effects.

Objective:

This review explores the synergistic potential of a dual-vector Ayurvedic protocol: the topical application of Triphala Gel and the systemic administration of Abhrak Bhasma (Sahasraputi).

Methods:

Analysis of current available clinical and molecular data regarding the anti-fibrotic, antioxidant, and genoprotective properties of these interventions.

Results:

Topically, Triphala Gel modulates the extracellular matrix by inhibiting TGF-β1 signaling and downregulating markers of cellular senescence, such as p16 and p21, thereby improving mucosal elasticity. Systemically, Abhrak Bhasma, a nano-mineral Rasayana, functions as a potent biological response modifier. Molecular evidence indicates its capacity to enhance DNA Base Excision Repair (BER) and upregulate adaptive antioxidant enzymes, effectively mitigating the genotoxic damage caused by arecoline.

Conclusion:

The convergence of localized matrix remodeling (Triphala) and systemic cellular regeneration (Abhrak Bhasma) offers a multi-targeted therapeutic strategy. This integrated approach not only addresses the clinical symptoms of trismus and burning but also targets the underlying molecular triggers of malignant transformation. This protocol represents a non-invasive, cost-effective, and holistic alternative for the management of OSMF that warrants further large-scale clinical validation.

Keywords: Oral Submucous Fibrosis, Triphala Gel, Abhrak Bhasma, DNA Repair, Cellular Senescence, Rasa Shastra, Trismus, Arecoline, Genoprotection, Phytopharmacology.

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Introduction

Oral Submucous Fibrosis (OSMF) is a chronic, insidious, and potentially malignant disorder (OPMD) characterized by progressive juxta-epithelial inflammatory reactions followed by fibroelastic changes in the oral lamina propria.[1] Primarily prevalent in Southeast Asia, the condition is strongly associated with the habitual chewing of areca nut (*Areca catechu*), which contains alkaloids like arecoline that stimulate excessive collagen synthesis by fibroblasts.[2] Clinically, OSMF manifests as mucosal blanching, loss of elasticity, and the formation of palpable vertical fibrous bands, leading to a progressive reduction in mouth opening known as trismus.[3]

In the classical texts of Ayurveda, OSMF finds a clinical correlation with Sarvasara Mukharoga, a systemic oral affliction. From the perspective of Rasa Shastra, the condition is viewed as a result of *Atiyoga* (overuse) of *Katu* (pungent) and *Kashaya* (astringent) *Rasas*, which causes the vitiation of *Vata* and *Pitta*.[4] This leads to *Dhatu-Kshaya* (tissue depletion) and the obstruction of *Srotas* (channels), resulting in the characteristic stiffness (*Stambha*) and dryness (*Rukshata*) of the oral mucosa.

The primary challenge in managing OSMF is its high rate of malignant transformation, estimated between 7% and 13%.[1] Current conventional treatments, such as intralesional steroid injections and hyaluronidase, focus on symptomatic relief but often fail to address the underlying cellular damage and oxidative stress.[5] Furthermore, these interventions can be painful and may lead to secondary infections.

Recent pharmacological shifts have highlighted the potential of Triphala, a polyherbal formulation, in reversing arecoline-induced cellular senescence—a state of permanent cell-cycle arrest that promotes fibrosis.[1] Simultaneously, the use of Abhrak Bhasma (incinerated mica) as a *Rasayana* (rejuvenator) offers a novel systemic vector. As a biocompatible nanoparticle, Abhrak Bhasma has been shown to enhance DNA Base Excision Repair (BER), effectively mitigating the genotoxic damage inherent in pre-cancerous oral lesions.[6] By integrating the localized anti-fibrotic action of Triphala Gel with the systemic genoprotective influence of Abhrak Bhasma[7,8,9] a multi-targeted therapeutic strategy can be established to arrest disease progression and improve the quality of life for OSMF patients.[4]

While existing literature independently validates the topical anti-fibrotic efficacy of Triphala and the systemic genoprotective potential of Abhrak Bhasma, there is a distinct paucity of integrated research exploring their synergistic interaction. Current therapeutic models largely focus on monotherapies, leaving a critical gap in understanding how localized mucosal remodeling and systemic DNA repair can be unified into a single clinical protocol to mitigate the risk of malignant transformation in OSMF.

This review aims to bridge this gap by synthesizing clinical and molecular evidence into a comprehensive dual-vector framework. The objective is to establish a biological rationale for combining Triphala Gel—to address structural trismus and extracellular matrix deposition—with Abhrak Bhasma—to stabilize genomic integrity and enhance systemic antioxidant defense—thereby offering a holistic, non-invasive alternative to conventional OSMF management.

This review employed a systematic integrative methodology to evaluate the combined therapeutic efficacy of Abhrak Bhasma and Triphala Gel in the management of Oral Submucous Fibrosis (OSMF). A comprehensive literature search was conducted across major biomedical and integrative medicine databases, including PubMed, PubMed Central (PMC), Google Scholar, and the NLM Catalog. The search strategy integrated high-quality evidence from classical Ayurvedic clinical trials, modern phytopharmacological investigations, and molecular biology studies. Data synthesis focused on correlating the anti-fibrotic, antioxidant, and genoprotective properties of these interventions to provide a robust, evidence-based evaluation of their synergistic potential in reversing mucosal fibrosis and stabilizing genomic integrity.

Triphala Gel: Localized Anti-Fibrotic Vector

The efficacy of Triphala—a synergistic combination of *Terminalia chebula*, *Terminalia bellirica*, and *Phyllanthus emblica*—as a topical agent in OSMF is attributed to its high concentration of tannins, gallic acid, and vitamin C. When delivered in a mucoadhesive gel base, it acts as a potent localized modulator of the fibrotic microenvironment. Mechanism of action include

1. Inhibition of Collagen Cross-linking and TGF-β1

The hallmark of OSMF is the stabilization of collagen through the lysyl oxidase (LOX) pathway, stimulated by arecoline. Research suggests that the polyphenolic constituents of Triphala possess the capacity to inhibit fibroblast proliferation and reduce the secretion of Transforming Growth Factor-beta 1 (TGF-β1), a key pro-fibrotic cytokine.[2,3] By modulating these pathways, Triphala facilitates the breakdown of existing fibrous bands, clinically manifesting as an increase in inter-incisal distance (mouth opening).[2]

2. Reversal of Arecoline-Induced Cellular Senescence

A significant breakthrough in understanding Triphala's role in OSMF is its effect on cellular senescence. Arecoline causes oral mucosal cells to enter a state of permanent growth arrest (senescence), where they secrete pro-inflammatory factors that accelerate fibrosis. In vitro studies have confirmed that Triphala extract negates this arecoline-induced senescence by downregulating the expression of the tumor suppressor proteins p16INK4a and p21.[1] This action effectively "rejuvenates" the mucosal lining at a cellular level, preventing the atrophy typical of advanced OSMF.

3. Anti-inflammatory and Antioxidant Scavenging

The chronic inflammation associated with OSMF creates a high-oxidative-stress environment. Triphala acts as a "scavenger" of reactive oxygen species (ROS), neutralizing the free radicals generated by tobacco and areca nut habits.[5] Its *Ropana* (healing) and *Shothahara* (anti-inflammatory) properties help reduce mucosal blanching and provide rapid relief from the burning sensation (*Daha*) experienced by patients when consuming spicy foods. [2,4,5]

Abhrak Bhasma: Systemic Genoprotective Vector

Abhrak Bhasma (incinerated mica) is a classical mineral formulation processed through repeated cycles of *Puta* (incineration), which transforms the bulk mineral into a biocompatible, nanocrystalline form. In the management of OSMF, its role extends beyond mere nutrition, acting as a systemic biological response modifier that targets DNA-level damage.

1. DNA Base Excision Repair (BER) and Genoprotection

One of the most profound risks in OSMF is the high rate of malignant transformation due to areca nut-induced DNA damage. Research has demonstrated that Abhrak Bhasma significantly enhances the Base Excision Repair (BER) capacity of cells.[6] This mechanism is critical for identifying and repairing small base lesions caused by oxidative stress and tobacco-derived nitrosamines. By facilitating the repair of DNA strand breaks, it effectively provides a genoprotective shield, potentially slowing or halting the progression toward Oral Squamous Cell Carcinoma (OSCC).[8]

2. Induction of Antioxidant Hormesis

Abhrak Bhasma operates on the principle of hormesis—where low-level stress from mineral nanoparticles triggers an adaptive survival response in the body. Systemic administration has been shown to upregulate endogenous antioxidant enzymes, specifically Superoxide Dismutase (SOD) and Catalase.[7] This systemic boost neutralizes the reactive oxygen species (ROS) that are chronically elevated in the oral environment of OSMF patients, thereby preventing further lipid peroxidation and mucosal atrophy.

3. Micro-Circulatory Enhancement and Tissue Rejuvenation

From a Rasa Shastra perspective, Abhrak Bhasma is a potent Rasayana and Hridya (cardioprotective/circulatory stimulant). Clinically, OSMF is characterized by ischemia and blanching of the mucosa due to narrowed blood vessels. The systemic use of Sahasraputi Abhrak Bhasma improves *Rakta Dhatu* (blood) quality and micro-circulation.[8] Enhanced blood flow ensures the delivery of essential nutrients and the systemic clearance of fibrotic waste products, supporting the "softening" of the oral mucosa initiated by the topical Triphala gel.

4. Nanomedicine and Bioavailability

Modern analytical characterization (including XRD and TEM) confirms that correctly prepared Abhrak Bhasma consists of nanoparticles in the range of 5–50 nm.[9] This ultra-fine size allows the mineral to bypass standard metabolic barriers and achieve high bioavailability. When used as an adjunct in OSMF, it acts as a systemic "driver," potentially enhancing the metabolic activity of oral keratinocytes and making them more receptive to the local anti-fibrotic effects of the Triphala formulation.[4]

Proposed Synergistic Mechanism: The Dual-Vector Therapeutic Model

The management of Oral Submucous Fibrosis (OSMF) through the combination of Triphala Gel and Abhrak Bhasma represents a "Dual-Vector" therapeutic approach that targets the disease at both the phenotypic (structural) and genotypic (molecular) levels.[1,4]

1. Convergence of Localized and Systemic Action

The synergy is initiated by the localized Lekhana (scraping/anti-fibrotic) action of the Triphala Gel. By inhibiting the TGF-β1 pathway and downregulating cellular senescence markers such as p16 and p21, Triphala effectively breaks the cycle of chronic inflammation and pathological collagen cross-linking in the oral lamina propria. [1,2] This creates a receptive environment for systemic rejuvenation. Simultaneously, the internal administration of Sahasraputi Abhrak Bhasma provides a Rasayana effect, enhancing the Dhatu Agni (metabolic fire) of the mucosal tissues.[9] This systemic boost ensures that the new cells being generated are physiologically healthy and resistant to the fibrotic triggers of arecoline.[9]

2. The "Bhasma-Potentiation" Effect on Phytoconstituents

In Rasa Shastra, Bhasmas are often recognized as Yogavahi (catalysts/carriers) that enhance the bioavailability and targeted delivery of co-administered herbal drugs.[9] The systemic mineral nanoparticles of Abhrak Bhasma improve micro-circulation (*Srotas Shodhana*) and reduce ischemic hypoxia in the oral mucosa.[6,8] This enhanced blood flow facilitates deeper penetration of the Triphala Gel's polyphenols and tannins into the submucosal layers, thereby magnifying its anti-fibrotic efficacy.

3. Prevention of Malignant Transformation via DNA Repair

The most critical synergistic outcome is the mitigation of Genotoxic Stress. While Triphala manages the symptomatic trismus and burning sensation, Abhrak Bhasma specifically addresses the high-risk "precancerous" instability of OSMF.[8] By upregulating Base Excision Repair (BER) and adaptive antioxidant enzymes like SOD and Catalase, the Bhasma acts as a genomic stabilizer, repairing the DNA strand breaks caused by chronic tobacco and areca nut exposure.[5,6] This dual-attack—topical remodeling and systemic genomic repair—significantly minimizes the risk of the lesion progressing to Oral Squamous Cell Carcinoma (OSCC).[5,8]

Discussion

The management of Oral Submucous Fibrosis (OSMF) remains one of the most challenging aspects of oral medicine due to its progressive nature and high malignant transformation rate, estimated between 7% and 13%.[1] Conventional therapies primarily focus on alleviating trismus and burning sensations through anti-inflammatory steroids and hyaluronidase injections, which often result in localized tissue atrophy and significant patient discomfort.[2,5] The integrated protocol of Triphala Gel and Abhrak Bhasma shifts the therapeutic paradigm from symptomatic relief toward cellular rejuvenation and genomic stabilization.

Mechanism of Anti-Fibrotic Synergy

The "Lekhana" (scraping) property of Triphala, scientifically validated through its inhibition of TGF-β1 and reversal of p16/p21-mediated senescence, provides a non-invasive method to remodel the stiffened extracellular matrix.[1,3] However, local therapy alone cannot address the systemic oxidative and genotoxic stress inherent in OSMF. The addition of Abhrak Bhasma introduces a nanomedical approach to DNA repair. By enhancing Base Excision Repair (BER) capacity, it addresses the pre-cancerous mutations caused by arecoline.[6] This systemic mineral support ensures that the oral keratinocytes are shielded from further malignant transformation, a claim supported by studies showing Bhasma's role in reducing chromosomal damage.[6,9]

Bhasma as a Nanomedicine: Safety and Bioavailability

The safety of mineral-based Bhasmas is a subject of frequent debate in contemporary medicine. However, when prepared via the Sahasraputi (1,000-cycle incineration) method, the bulk mica is transformed into a non-toxic, nanocrystalline silicate with a particle size ranging between 5 and 50 nm.[9] These nanoparticles act as biological response modifiers, triggering a "hormetic response" that upregulates endogenous antioxidant enzymes such as SOD and Catalase.[7,8] This systemic boost neutralizes the reactive oxygen species (ROS) that contribute to the chronic inflammatory state of the oral mucosa. Furthermore, pilot studies using holistic Ayurvedic management have demonstrated a 25.16% improvement in inter-incisal distance, suggesting that combined internal and external therapies are superior to monotherapy.[4]

Clinical Implications and Future Directions

The integration of local and systemic therapies aligns with the Ayurvedic principle of treating both the Sthana (local site) and the Adhisthana (underlying systemic cause). While Triphala reduces the localized fibrous bands, Abhrak Bhasma provides the systemic "template" for healthy cellular regeneration.[4,6] For clinical implementation, the use of a mucoadhesive gel base for Triphala is essential to ensure prolonged contact time with the buccal mucosa. Simultaneously, the internal administration of Bhasma with an Anupana (adjuvant) like honey or ghee facilitates

targeted delivery to the oral tissues.[8] Future research should focus on double-blind randomized controlled trials to quantify the synergistic index of this protocol and establish long-term safety profiles via renal and hepatic monitoring.

Conclusion

This review concludes that the combination of topical Triphala Gel and systemic Abhrak Bhasma offers a comprehensive, multi-targeted therapeutic strategy for OSMF. While Triphala acts as the localized anti-fibrotic agent that restores mucosal elasticity and improves the inter-incisal distance, Abhrak Bhasma serves as the systemic genomic stabilizer that enhances DNA repair and antioxidant defense. Together, they not only alleviate the painful symptoms of trismus and burning but also provide a critical biological barrier against malignant transformation into Oral Squamous Cell Carcinoma. Further large-scale, double-blind randomized controlled trials are essential to standardize this "Herbomineral Synergistic Protocol" for global clinical practice.

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