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Review Article

ROLE OF *JALAUKAVACHARANA* IN THE MANAGEMENT OF INFLAMMATORY AND VASCULAR DISORDERS: A REVIEW OF CLASSICAL AND CONTEMPORARY EVIDENCE

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ABSTRACT

Jalaukavacharana (therapeutic leech application) is a classical method of *Raktamokshana* described in Ayurveda and is traditionally employed in selected disorders involving vitiated *Rakta* and *Pitta Dosha*. Contemporary medicinal leech therapy has gained scientific interest because leech saliva contains biologically active substances with anti-coagulant, anti-inflammatory, analgesic and vasomodulatory properties. **Aim:** To critically review the role of *Jalaukavacharana* in inflammatory and vascular disorders by integrating classical Ayurvedic concepts with contemporary scientific evidence. **Materials and Methods:** Classical Ayurvedic texts and contemporary biomedical literature were reviewed using electronic databases including PubMed, Scopus and Web of Science. Relevant search terms included *Jalaukavacharana*, *Jalauka*, *Raktamokshana*, medicinal leech therapy, inflammation, vascular disorders and venous congestion. Clinical trials, systematic reviews and relevant experimental studies were evaluated. **Results:** Classical Ayurvedic literature describes *Jalaukavacharana* as a relatively gentle method of *Raktamokshana*. Contemporary research suggests that medicinal leech therapy may influence coagulation, platelet aggregation, inflammation and local microcirculation. Clinical studies indicate potential therapeutic benefits in selected inflammatory and vascular conditions; however, variations in treatment protocols, sample sizes and outcome measures limit definitive conclusions. **Conclusion:** *Jalaukavacharana* provides an important link between classical Ayurvedic therapeutics and contemporary biomedical research. It may have a role in selected inflammatory and vascular disorders, particularly conditions associated with local venous congestion and impaired microcirculation. Further well-designed clinical trials using standardized protocols are required to establish its efficacy, safety and appropriate clinical indications.

INTRODUCTION

Ayurveda is a holistic system of medicine that emphasizes the maintenance of health and the management of disease through individualized approaches based on the equilibrium of *Dosha*, *Dhatu* and *Mala*. Among the therapeutic procedures described for the management of specific disorders, *Raktamokshana* (bloodletting) holds an important position, particularly in conditions associated with vitiation of *Rakta* and *Pitta Dosha*.

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Jalaukavacharana (therapeutic application of medicinal leeches) is a specialized method of *Raktamokshana* that provides controlled impure blood removal without the use of a sharp surgical instrument.

The classical Ayurvedic texts, particularly *Sushruta Samhita*, describe *Jalauka* (leech) as a suitable method of bloodletting for individuals in whom a relatively gentle approach is preferred. The procedure has traditionally been associated with disorders involving *Rakta Dushti* and localized manifestations of inflammation and congestion. Its therapeutic rationale in Ayurveda extends beyond removal of blood and is described in relation to the reduction of vitiated *Dosha* and restoration of local physiological balance.

Interest in medicinal leech therapy has re-emerged in contemporary medicine because leech saliva contains numerous pharmacologically active substances. These substances include anticoagulant and antiplatelet components, vasodilatory mediators and compounds with potential anti-inflammatory and analgesic effects. These biological activities may contribute to improved local blood flow, reduction of venous congestion and modulation of inflammatory responses.[5,7]

Contemporary clinical applications of medicinal leeches have been reported in conditions involving impaired venous drainage, postoperative venous congestion and selected inflammatory musculoskeletal disorders. However, the strength of available evidence varies substantially between indications. Differences in leech species, application protocols, treatment duration, outcome measures and study methodology make direct comparison between studies difficult.

Although previous Ayurvedic literature has discussed *Jalaukavacharana*, there is a need for an updated critical review that brings together classical indications and contemporary scientific evidence. Therefore, the present review examines the potential role of *Jalaukavacharana* in inflammatory and vascular disorders, with particular emphasis on its proposed mechanisms, clinical evidence, safety considerations and areas requiring further research.

AIM AND OBJECTIVES

Aim

To critically evaluate the therapeutic role of *Jalaukavacharana* in inflammatory and vascular disorders by integrating classical Ayurvedic concepts with contemporary scientific evidence.

Objectives

1. To review the classical Ayurvedic concept, indications and therapeutic rationale of *Jalaukavacharana*.
2. To examine the proposed pharmacological and physiological mechanisms of medicinal leech therapy from contemporary scientific literature.
3. To evaluate the available clinical evidence regarding the use of *Jalaukavacharana* in selected inflammatory disorders.
4. To assess contemporary evidence regarding its role in vascular and venous disorders.
5. To review the safety profile, contraindications, adverse effects and practical limitations associated with medicinal leech therapy.
6. To identify existing evidence gaps and suggest priorities for future clinical research on *Jalaukavacharana*.

Literature Search Methodology

A narrative literature review was conducted to integrate classical Ayurvedic literature with contemporary biomedical evidence on *Jalaukavacharana*. Classical sources including *Sushruta Samhita*, *Charaka Samhita* and *Ashtanga Hridaya* were consulted for *Raktamokshana*, *Rakta Dushti*, *Jalaukavacharana*, indications and procedural principles [1-4]. Contemporary literature was searched through PubMed/MEDLINE, Scopus and Web of Science, with additional screening of reference lists of relevant reviews and clinical studies.

The 2024 systematic review by Hosseini et al. was also used as a contemporary evidence anchor because it searched PubMed, Scopus and Web of Science through April 2023 and identified 12 eligible clinical trials [6].

Clinical trials, systematic reviews, observational studies, relevant experimental studies and safety-related publications were considered. Studies unrelated to medicinal leech therapy, duplicate publications and publications lacking sufficient relevant information were excluded. Priority was given to systematic reviews, randomized controlled trials and clinically relevant safety studies.

The available evidence was reviewed under four major themes: (1) classical Ayurvedic concepts, (2) mechanisms of action, (3) inflammatory disorders, and (4) vascular disorders. Greater emphasis was given to systematic reviews and clinical studies when evaluating therapeutic effectiveness. The findings were narratively synthesized because the available studies differed considerably in study design, patient population, treatment protocols and outcome measures.

The review also considered safety aspects, including bleeding, infection, allergy and other reported adverse effects. The purpose of this review was to integrate classical Ayurvedic knowledge with contemporary scientific evidence and to identify areas requiring further clinical research.

Classical Concept of *Jalaukavacharana*[20,21]

Jalaukavacharana is a therapeutic procedure in which a medicinal leech (*Jalauka*) is applied to a selected site of the body for controlled removal of blood. It is described as one of the methods of *Raktamokshana* (bloodletting) in classical Ayurvedic literature. *Sushruta Samhita* provides a detailed description of *Raktamokshana* and considers it an important therapeutic measure in selected disorders associated with vitiation of *Rakta*.[1-3]

According to Sushruta, *Jalauka* is particularly suitable for individuals who are considered less suitable for more invasive forms of bloodletting. The use of leeches provides a relatively gentle method of

removing vitiated blood and is therefore described as an *Ashastra Raktamokshana* procedure. The classical approach emphasizes appropriate selection of the patient, leech and site of application, followed by careful observation during and after the procedure.[1-3]

Ayurvedic texts describe *Jalauka* broadly into two categories, namely *Savisha* (poisonous) and *Nirvisha* (non-poisonous). The *Nirvisha Jalauka* are considered suitable for therapeutic application, whereas *Savisha Jalauka* are regarded as unsuitable because of their potential to produce adverse effects. Classical descriptions also provide identifying features for selecting healthy and appropriate leeches.[1-3]

The therapeutic application of *Jalaukavacharana* is traditionally associated with disorders involving vitiation of *Rakta* and *Pitta Dosha*. Conditions characterized by localized pain, inflammation, discoloration, burning sensation, swelling and congestion have been described among the clinical contexts in which bloodletting may be considered. The classical rationale is based on removal of vitiated *Rakta* and restoration of physiological balance at the affected site. [1,2]

The procedure involves selecting an appropriate site, preparing the area, applying the leech and allowing it to attach and suck blood until adequate bloodletting is achieved. After completion, the leech is carefully removed and appropriate local measures are undertaken to control bleeding and maintain cleanliness. Classical texts emphasize proper identification of the leech, appropriate duration of application and post-procedure care to minimize complications. [1-3]

From an Ayurvedic perspective, the therapeutic action of *Jalaukavacharana* can therefore be understood primarily through the principles of *Raktamokshana*, *Rakta Dushti* and localized *Dosha* involvement. Contemporary research has subsequently provided possible biological explanations for some effects observed with medicinal leech therapy, including effects on coagulation, local blood flow and inflammatory pathways. These similarities provide a basis for examining *Jalaukavacharana* from both classical and contemporary perspectives. [1-3]

Classical Indications of *Jalaukavacharana*[20,24]

In *Sushruta Samhita*, *Raktamokshana* is described as a therapeutic measure for selected disorders associated with vitiation of *Rakta*. Among the different methods of bloodletting, *Jalaukavacharana* is considered a relatively gentle approach and is particularly useful when a less invasive method is preferred. The classical indications can be understood in relation to disorders involving localized inflammation, pain, discoloration, swelling and other manifestations of *Rakta* and *Pitta* vitiation. [1,2]

Table 1: Classical therapeutic indications relevant to *Jalaukavacharana*

Classical clinical presentation/ condition	**Ayurvedic rationale**
Rakta Dushti	Removal of vitiated *Rakta*
Pitta-Rakta predominant disorders	Reduction of localized *Pitta* and *Rakta* vitiation
Localized inflammatory swelling	Reduction of local congestion and inflammatory manifestations.
Pain associated with *Rakta* vitiation	Therapeutic bloodletting for localized symptoms.
Burning sensation (*Daha*)	Particularly relevant where *Pitta* and *Rakta* involvement is prominent.
Redness/discoloration (*Raga*)	Associated with vitiated *Rakta*
Selected skin disorders	Traditionally associated with *Rakta Dushti.*
Localized vascular/congestive manifestations.	Classical rationale of removing vitiated blood from the affected region.

The classical rationale should not be interpreted as a direct one-to-one equivalence between Ayurvedic diagnostic categories and modern diseases. Rather, the clinical features described in Ayurvedic texts provide a conceptual framework for understanding why bloodletting was selected in particular presentations.

Among the different methods of *Raktamokshana*, *Jalaukavacharana* has practical relevance because it allows localized blood removal without the use of a sharp surgical instrument. This characteristic has contributed to its traditional use in individuals for whom a relatively gentle form of bloodletting is considered appropriate.

Contemporary medicinal leech therapy differs from classical *Jalaukavacharana* in several respects, including standardization of leech species, clinical indications, application protocols and infection-control practices. Therefore, classical indications should be interpreted as the historical therapeutic foundation rather than as direct evidence of efficacy for modern diseases. [1,3]

The classical description provides the basis for investigating whether some therapeutic effects attributed to *Jalaukavacharana* may be related to measurable changes in local blood flow, coagulation, inflammation and tissue perfusion. These aspects are discussed in the subsequent sections.

Contemporary Understanding and Mechanism of Action of Medicinal Leech Therapy

Modern medicinal leech therapy, commonly referred to as hirudotherapy, involves the controlled application of medicinal leeches to selected anatomical sites. Although the procedure has historical origins in traditional systems of medicine, contemporary research has demonstrated that the therapeutic effects of leech application may involve several biological mechanisms beyond blood removal.

Anticoagulant and Antiplatelet Effects

Leech saliva contains several bioactive molecules that influence the coagulation process. Hirudin, one of the best-characterized salivary components, is a potent and specific inhibitor of thrombin. By inhibiting thrombin activity, hirudin interferes with conversion of fibrinogen to fibrin and thereby prolongs local anticoagulation. Other salivary components, including calin, can inhibit platelet aggregation by interfering with platelet adhesion. These actions may facilitate continued blood flow from the bite site after the leech has detached.[5,7]

Vasodilatory and Microcirculatory Effects

Medicinal leech saliva contains substances with vasodilatory activity that may contribute to increased local blood flow. The combination of anticoagulant activity, vasodilation and prolonged local bleeding can reduce venous congestion and improve tissue perfusion. This mechanism has particular relevance in conditions characterized by impaired venous drainage, where medicinal leeches have been used clinically, including selected reconstructive and plastic-surgical situations.

Anti-inflammatory Effects

Several biologically active components of leech saliva have been investigated for their potential anti-inflammatory effects. Experimental research suggests modulation of inflammatory mediators and pathways involved in tissue inflammation. These effects may contribute to reduction in local inflammatory symptoms such as pain and swelling. However, the clinical significance of individual salivary components and their contribution to therapeutic outcomes remains incompletely established.

Analgesic Effects

Medicinal leech therapy has been investigated for its potential analgesic effects, particularly in musculoskeletal disorders. Reduction in local congestion, alteration of inflammatory activity and the presence of bioactive salivary compounds may collectively contribute to symptomatic improvement. Clinical studies in osteoarthritis have reported reductions in pain and improvement in functional outcomes following leech therapy, although differences in methodology and treatment protocols limit direct comparison between studies.

Antimicrobial and Other Biological Effects

Leech saliva contains a range of biologically active substances with reported antimicrobial and tissue-modulating properties. Hyaluronidase, for example, increases tissue permeability and may facilitate diffusion of other salivary components. Other peptides and proteins have demonstrated biological activity in experimental models. Nevertheless, these laboratory findings should not automatically be interpreted as proof of clinical efficacy in specific diseases.

Therapeutic Effects: Integrative Interpretation

From a contemporary biomedical perspective, the effects of medicinal leech therapy may therefore result from the combined influence of blood removal, anticoagulation, inhibition of platelet aggregation, vasodilation, modulation of inflammation and improvement of local microcirculation. These mechanisms provide plausible biological explanations for some traditional therapeutic observations associated with *Jalaukavacharana*.

However, modern medicinal leech therapy should not be considered identical to classical *Jalaukavacharana*. Contemporary practice generally uses standardized medicinal leeches under controlled conditions, whereas classical Ayurvedic practice incorporates specific concepts of *Jalauka* selection, *Rakta* and *Dosha* involvement, and individualized therapeutic assessment. The two frameworks can therefore be compared conceptually while maintaining their distinct clinical contexts.

Role of *Jalaukavacharana* in Inflammatory Disorders

Inflammation is characterized by a complex interaction of vascular, cellular and biochemical responses that may result in pain, swelling, altered tissue perfusion and functional impairment. From an Ayurvedic perspective, selected inflammatory manifestations may be interpreted in relation to the involvement of *Rakta*, *Pitta* and other *Dosha* according to the clinical presentation. *Jalaukavacharana* has traditionally been considered in localized conditions associated with pain, swelling, redness and other manifestations attributed to *Rakta Dushti*.

Contemporary research has particularly investigated medicinal leech therapy in musculoskeletal inflammatory and painful conditions,

with the greatest body of clinical evidence available for knee osteoarthritis.

Knee Osteoarthritis

Several clinical trials have evaluated the effects of medicinal leech therapy in patients with symptomatic knee osteoarthritis. In an early randomized controlled trial involving 51 patients, a single application of four to six medicinal leeches produced greater short-term reduction in pain compared with topical diclofenac, with improvements in function and stiffness also reported during follow-up.

Another randomized controlled trial included 52 patients with active knee osteoarthritis and compared a single medicinal-leech treatment with transcutaneous electrical nerve stimulation (TENS). Significant improvements in Lequesne's index and visual analogue scale scores were observed following leech treatment during the initial study period. The authors concluded that the findings supported further investigation, particularly regarding mechanisms and optimal treatment dose.[10]

A larger randomized study involving 113 patients compared single and repeated leech applications with a simulated-leech control. Improvements in pain, function and stiffness were reported in the treatment groups, with greater improvement observed following repeated treatment. However, the authors noted that the contribution of specific biological effects versus placebo or treatment expectations could not be completely determined.[9,11]

A subsequent randomized controlled study involving 90 patients compared medicinal leech therapy with TENS. Five leeches were applied weekly for three weeks. Both groups demonstrated significant improvements in pain and WOMAC outcomes, with leech therapy showing comparable symptomatic improvement to TENS during the study period.[10]

A meta-analysis of randomized controlled trials identified four trials involving 264 patients and reported significant improvements in pain and functional outcomes at several follow-up points. However, the analysis also found a higher incidence of adverse events in the leech-therapy groups and rated the overall certainty of evidence as moderate. Therefore, the findings support potential symptomatic benefit but do not establish medicinal leech therapy as a definitive treatment for knee osteoarthritis.[11]

Possible Mechanisms in Inflammatory Conditions

The therapeutic effects observed in musculoskeletal conditions may involve multiple mechanisms rather than simple blood removal. Anticoagulant and antiplatelet activity may maintain local bleeding after application, while vasodilatory and microcirculatory effects may influence local tissue perfusion. Bioactive substances present in leech saliva may additionally influence inflammatory pathways and pain perception.

However, these mechanisms should be interpreted cautiously. Evidence demonstrating that individual salivary constituents produce clinically meaningful anti-inflammatory effects in humans remains less established than the evidence for local anticoagulant activity and venous decompression.

Critical Appraisal of Evidence

The available clinical evidence suggests that medicinal leech therapy may provide symptomatic improvement in selected inflammatory or painful musculoskeletal conditions, particularly knee osteoarthritis. Nevertheless, several limitations remain, including relatively small sample sizes in individual trials, difficulty with blinding, variation in the number and duration of leech applications, differences in comparator interventions and variation in follow-up duration.

Therefore, *Jalaukavacharana* may be considered a potentially useful complementary intervention in appropriately selected patients, but current evidence is insufficient to recommend it as a replacement for established standard management of inflammatory disorders.

Role of *Jalaukavacharana* in Vascular Disorders

Vascular disorders may involve impaired venous drainage, local blood stasis, altered tissue perfusion and microcirculatory disturbances. From an Ayurvedic perspective, localized vascular and congestive manifestations may be considered in relation to vitiation of *Rakta*, *Pitta* and involvement of the local *Srotas*, depending upon the clinical presentation. *Jalaukavacharana* provides a localized method of blood removal and may therefore have relevance in selected conditions associated with venous congestion.

Acute Venous Congestion

The best-established contemporary clinical application of medicinal leech therapy is the management of acute venous congestion, particularly following reconstructive and plastic surgery. Venous congestion occurs when venous outflow is inadequate in relation to arterial inflow, resulting in accumulation of blood within the affected tissue and progressive impairment of tissue oxygenation. Medicinal leeches can provide temporary local venous decompression while vascular drainage is restored.

A systematic review by Whitaker et al. evaluated 67 publications involving 277 reported clinical cases of medicinal leech use in plastic and reconstructive surgery. The overall reported success rate was 77.98%. However, the review also reported substantial requirements for blood transfusion and

antibiotics, with an overall complication rate of 21.8%. The authors emphasized the lack of robust randomized controlled trials and therefore recommended cautious interpretation of the available evidence.[8]

The therapeutic effect in venous congestion is thought to result from a combination of direct blood removal, prolonged bleeding from the bite site and pharmacological effects of leech saliva. Anticoagulant and antiplatelet substances help maintain local blood flow after detachment, while vasodilatory and other salivary components may contribute to improvement in local microcirculation.

Venous Congestion and Tissue Perfusion

Medicinal leech therapy has also been investigated in conditions involving impaired local circulation and tissue congestion. Reviews of the literature describe potential effects on venous decongestion, blood and lymphatic flow, inflammation and pain. However, the available evidence outside postoperative venous congestion is considerably less robust and frequently consists of case reports, case series and small clinical studies.

The ability of leech therapy to temporarily reduce venous congestion may be particularly relevant when tissue survival depends upon restoration of adequate venous drainage. This has led to its incorporation as an adjunctive measure in selected reconstructive procedures rather than as a replacement for definitive vascular correction.

Chronic Venous Disorders and Ulcerative Conditions

Medicinal leech therapy has also been reported in various ulcerative and chronic wound conditions. A review examining venous congestion and different forms of ulcers described potential effects involving venous decongestion, enhancement of local blood and lymph flow, anticoagulation and reduction of inflammation and pain. However, the evidence in chronic ulcers is predominantly based on reviews, case reports and case series rather than high-quality randomized controlled trials.

Therefore, although the biological rationale is plausible, medicinal leech therapy should not currently be considered an established primary treatment for chronic vascular ulcers. Its potential role should be evaluated according to the underlying vascular pathology and alongside appropriate conventional wound and vascular management.

Critical Appraisal

Contemporary evidence supports the most clearly defined role of medicinal leech therapy in acute venous congestion, particularly following reconstructive surgery. Evidence for other vascular conditions remains less conclusive. The major limitations include the predominance of observational evidence, heterogeneous treatment protocols, variable numbers and duration of leech applications, risk of bleeding and infection, and the difficulty of conducting blinded studies.

Thus, *Jalaukavacharana* may have a clinically relevant role as an adjunctive therapy in selected vascular and venous-congestive conditions, but further prospective controlled studies are required before broader therapeutic recommendations can be made.

Clinical Evidence Summary

Available clinical studies indicate that medicinal leech therapy has been investigated in a range of inflammatory, painful and vascular conditions. However, the quality and quantity of evidence vary considerably between indications. Selected clinically relevant studies are summarized below.

Table 2: Summary of selected clinical evidence on medicinal leech therapy

Condition	Study design / participants	Intervention	Major findings	Evidence interpretation
Knee osteoarthritis	Randomized controlled trials; multiple studies [10,11,14]	Local application of medicinal leeches.	Reduction in pain, stiffness and improvement in functional outcomes were reported.	Moderate evidence for short-term symptomatic benefit
Knee osteoarthritis	Meta-analysis of 4 RCTs, 264 patients [12]	Medicinal leech therapy versus control interventions.	Significant improvement in VAS and WOMAC outcomes; adverse events were more frequent with leech therapy.	Potential benefit, but evidence should be interpreted cautiously
Acute venous congestion following reconstructive surgery	Systematic review of 67 publications; 277 reported cases [9]	Medicinal leech application to congested tissue.	Reported tissue-salvage success of approximately 78%; bleeding and infection were important complications.	Most established contemporary application, but evidence is predominantly observational.
Thrombosed	Clinical study;	*Jalaukavacharana*	Reduction in pain, edema,	Preliminary evidence;

hemorrhoids	12 patients [15]	at thrombosed pile mass.	discoloration and tenderness was reported.	small uncontrolled study
Musculoskeletal pain	Open-label clinical study [19]	Ayurvedic parasurgical procedures including *Jalaukavacharana.*	Reduction in localized and regional pain was reported.	Suggestive evidence; interpretation limited by open-label design and combined interventions.

Source note: Patient/participant numbers and study-level findings in Table 2 are derived from the cited original studies [9-12,14,15,19].

The evidence for knee osteoarthritis is comparatively stronger than that for most other indications. A meta-analysis of four randomized controlled trials involving 264 patients reported significant improvements in pain and WOMAC outcomes, although adverse events were more common in the medicinal-leech groups and the overall certainty of evidence was considered moderate.[11]

In reconstructive surgery, medicinal leech therapy has a more clearly defined clinical role in selected cases of acute venous congestion. A systematic review of 277 reported cases found a tissue-salvage success rate of approximately 78%, but also identified clinically important bleeding and infection-related complications. Therefore, its use in this setting requires appropriate patient selection, monitoring and infection-control measures.

Evidence from Ayurvedic clinical studies is also available. A small clinical study involving 12 patients with thrombosed piles reported improvement in pain, edema, discoloration and tenderness following *Jalaukavacharana*; however, two patients experienced uncontrolled bleeding. The small sample size and absence of a control group limit the strength of these findings.

Overall, the available evidence suggests that *Jalaukavacharana* may provide therapeutic benefit in selected inflammatory and vascular conditions. Nevertheless, differences in treatment protocols, number of leeches, duration of application, comparator interventions and outcome measures make direct comparison between studies difficult. Larger, well-designed controlled trials using standardized protocols are required to establish condition-specific efficacy and safety.

Safety, Contraindications and Adverse Effects of *Jalaukavacharana*

Although *Jalaukavacharana* is considered a relatively gentle method of *Raktamokshana*, medicinal leech therapy is associated with potential adverse effects. Appropriate patient selection, hygienic precautions and clinical monitoring are therefore essential. Reported complications include prolonged bleeding, local reactions, allergic reactions, infection, anemia and, rarely, severe systemic complications.

Prolonged Bleeding and Blood Loss

The anticoagulant and antiplatelet components of leech saliva can cause bleeding to continue after detachment of the leech. Although prolonged bleeding contributes to the therapeutic effect, excessive blood loss may result in anemia and, in some cases, may require blood transfusion. Particular caution is required in patients with pre-existing anemia, coagulation abnormalities or those receiving anticoagulant or antiplatelet medication.[5,7,15]

Infection

Infection is one of the most important complications associated with medicinal leech therapy. Aeromonas species, which are part of the natural intestinal microbiota of medicinal leeches, are frequently implicated in leech-associated infections. Reported infections may range from localized wound infection to severe tissue infection and sepsis. Appropriate infection-control measures and clinically appropriate antimicrobial prophylaxis are therefore important, particularly in postoperative and reconstructive applications.[15,16]

Local and Allergic Reactions

Local itching, erythema, swelling and discomfort may occur at the site of leech application. Allergic reactions to components of leech saliva have also been reported. Patients should therefore be observed for both local and systemic hypersensitivity reactions during and after treatment.

Other Complications

Other reported complications include hypotension, anemia, migration of the leech and, rarely, unusual systemic complications. Although uncommon, these reports emphasize the importance of appropriate patient selection and clinical supervision.

Contraindications and Precautions

Particular caution or avoidance is warranted in patients with significant anemia, bleeding or coagulation disorders, active systemic infection, severe hypotension, clinically significant arterial insufficiency or known hypersensitivity to medicinal leeches. Patients receiving anticoagulant or antiplatelet therapy require careful individual assessment because of the possibility of excessive bleeding.

Before treatment, relevant medical history, bleeding risk, medication use and the patient's ability

to tolerate blood loss should be assessed. In contemporary clinical practice, medicinal leech therapy should be performed using appropriately sourced medicinal leeches under controlled infection-prevention conditions.

Thus, the potential therapeutic benefits of *Jalaukavacharana* should always be considered alongside its risks. Standardized protocols, appropriate monitoring and adequate infection-control measures are essential for safe clinical application.

DISCUSSION

Jalaukavacharana represents an important therapeutic procedure described under *Raktamokshana* in Ayurveda. Its classical application is primarily based on the assessment of *Rakta Dushti*, *Pitta Dosha* involvement and the clinical presentation of the patient. The contemporary resurgence of medicinal leech therapy provides an opportunity to examine some of these traditional therapeutic principles using modern physiological and pharmacological evidence.

One important area of convergence is the effect of medicinal leech therapy on local circulation. Contemporary studies demonstrate that leech saliva contains biologically active substances with anticoagulant, antiplatelet and vasomodulatory properties. These effects can prolong local bleeding and may temporarily improve venous drainage and tissue perfusion. This provides a plausible biological explanation for the established contemporary application of medicinal leeches in selected cases of venous congestion.

Clinical evidence in inflammatory disorders is most developed for knee osteoarthritis. Randomized clinical studies and meta-analyses have reported improvements in pain and functional outcomes following medicinal leech therapy. However, differences in treatment protocols, number of leeches, duration of application and comparator treatments limit direct comparison between studies. Therefore, the available evidence supports a potential symptomatic benefit rather than definitive superiority over established treatment modalities.

The evidence in vascular disorders is comparatively stronger for acute venous congestion, particularly in reconstructive surgery. In this setting, medicinal leeches can provide temporary venous decompression while normal venous drainage is restored. Nevertheless, this application should be considered an adjunctive measure rather than a substitute for correction of an underlying vascular problem. The evidence base outside postoperative venous congestion remains considerably more heterogeneous.

From an Ayurvedic perspective, the effects of *Jalaukavacharana* should not be reduced solely to the concept of blood removal. The classical approach considers the patient's *Dosha*, *Dushya*, disease stage, site and suitability for *Raktamokshana*. Contemporary biomedical findings may help explain selected physiological effects of the procedure, but direct equivalence between Ayurvedic diagnostic concepts and modern pathological diagnoses should be avoided.

An important limitation of the current evidence is the relatively small number of high-quality clinical trials. A systematic review published in 2024 identified only 12 clinical trials meeting its predefined eligibility criteria despite searching PubMed, Scopus and Web of Science. The authors also noted variation in the conditions studied and the need for further rigorous research.

Safety is another important consideration. Prolonged bleeding and infection, particularly infection associated with Aeromonas species, remain clinically relevant concerns. Therefore, appropriate patient selection, standardized application procedures, infection-control measures and monitoring are essential. The therapeutic potential of *Jalaukavacharana* should consequently be considered together with its safety profile rather than assessed only on symptomatic outcomes.

Overall, the available evidence suggests that *Jalaukavacharana* has a scientifically plausible therapeutic basis and may have a role as an adjunctive intervention in selected inflammatory and vascular conditions. However, evidence is not equally strong for all proposed indications. Future research should focus on standardized treatment protocols, adequately powered randomized controlled trials, validated outcome measures, long-term follow-up and systematic evaluation of adverse events.

Research Gaps and Future Perspectives

Although *Jalaukavacharana* has a long history of therapeutic use in Ayurveda and medicinal leech therapy has demonstrated potential in selected contemporary clinical applications, several evidence gaps remain. The current literature is characterized by considerable variation in patient selection, number of leeches used, application sites, treatment duration, frequency of sessions and outcome assessment. Such heterogeneity makes comparison between studies difficult and limits the development of standardized treatment protocols.

There is also a need for adequately powered randomized controlled trials evaluating *Jalaukavacharana* in specific inflammatory and vascular disorders. Future studies should include clearly defined diagnostic criteria, appropriate control groups, standardized intervention protocols and validated clinical outcome measures. Wherever appropriate, objective parameters such as inflammatory biomarkers, vascular-flow

measurements and imaging findings may complement subjective measures such as pain and functional scores.

Another important research area is the systematic evaluation of the relationship between classical Ayurvedic principles and contemporary biomedical mechanisms. Concepts such as *Rakta Dushti*, *Pitta Dosha* involvement and localized therapeutic bloodletting should be investigated through interdisciplinary research without assuming direct equivalence with modern pathological entities.

Safety research also requires greater attention. Future clinical studies should systematically report bleeding duration, blood-loss estimates, hemoglobin changes, infection rates, allergic reactions and other adverse events. Standardized protocols for leech sourcing, storage, application, disposal and infection prevention should also be developed.

Modern analytical techniques may provide opportunities to characterize the bioactive components of medicinal leech saliva and investigate their individual and combined biological effects. Further translational research may help determine which components contribute most significantly to anticoagulant, anti-inflammatory, analgesic and vasomodulatory effects.

Future research should therefore move from isolated case reports and small clinical studies toward standardized, reproducible and adequately powered clinical trials. Such evidence would help determine the appropriate indications, treatment protocols, comparative effectiveness and safety of *Jalaukavacharana* and strengthen its evidence-based integration into contemporary clinical practice.

CONCLUSION

Jalaukavacharana is an important classical *Ayurvedic* method of *Raktamokshana* with potential relevance to selected inflammatory and vascular disorders. Contemporary research provides plausible biological explanations for some of its therapeutic effects through anticoagulant, antiplatelet, vasomodulatory and anti-inflammatory actions of medicinal leech saliva.

The available clinical evidence suggests potential benefits particularly in selected painful inflammatory conditions such as knee osteoarthritis and in situations involving acute venous congestion. However, the strength of evidence varies considerably between clinical indications, and the available studies demonstrate substantial methodological and protocol-related heterogeneity.

Therefore, *Jalaukavacharana* should presently be considered a potentially useful complementary therapeutic intervention in appropriately selected patients rather than a replacement for established conventional management. Proper patient selection, standardized procedures, infection-control measures and monitoring for bleeding and other adverse effects are essential for safe application.

Future research involving well-designed randomized controlled trials, standardized treatment protocols, objective outcome measures and systematic safety assessment is required to establish condition-specific efficacy and define the appropriate role of *Jalaukavacharana* in evidence-based clinical practice.

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