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Shalya Tantra in the 21st Century: Where Tradition Meets Technology – A Narrative Review of Research Gaps in Preoperative, Intraoperative, and Postoperative Care

Aarti Chaurasiya[1*], Arvind Gautam[2]
[1]Associate Professor, Department of Shalya Tantra, Apex Institute of Ayurvedic Medicine and Hospital, Samaspur, Chunar, Mirzapur,U.P.-231304. Email ID: draarti89@gmail.com
[2].Associate professor, Department of Shalakya Tantra, Apex Institute of Ayurvedic Medicine and Hospital, Samaspur, Chunar, Mirzapur,U.P.-231304. Email ID: arvind15aug@gmail.com
Corresponding Author: Aarti Chaurasiya[1*]

Abstract: Background: The Ayurvedic surgical science of Sushruta Samhita (c. 600 BCE) contains the principles of preoperative, intraoperative, and postoperative care. However, their integration into contemporary evidence-based surgery remains poorly investigated.

Objective: To explore the research gaps in Shalya Tantra along the perioperative continuum, discuss the possibilities of integration with contemporary surgical technology, and suggest a prioritized research agenda.

Methods: The search for Shalya Tantra, Kshara Sutra, Agnikarma, Vrana, and perioperative care was performed on PubMed, Scopus, Google Scholar, AYUSH Research Portal, Dhara Online, and CTRI (2000-2025) using these words. Reference to classical ayurvedic texts. The included studies were original research, systematic reviews, and gap-identifying articles.

Results: Three important gaps were identified. Preoperative: No validated tools are available that can translate Rogi pariksha (eight-fold assessment) into surgical risk metrics, and no RCTs of preoperative Snehana-Swedana exist. Intraoperative: A 2024 meta-analysis demonstrated that Kshara Sutra had a promising cure rate ($p<0.03$) with low recurrence/incontinence, while in the 1991 ICMR RCT, 4% of patients had a recurrence (incontinence) compared to 11% of those undergoing conventional surgery. However, no trials have compared Kshara Sutra with current sphincter-sparing procedures (LIFT, VAAFT). There are few comparative studies on Agnikarma. Postoperative: Jatyadi tulle, Madhughrita tulle, Manjishthadi Ghrita and Panchavalkala cream are supported by RCTs and Jalaukavacharana efficacy are evident in case series.

Conclusion: Shalya Tantra has great potential to improve the level of contemporary surgical treatment. Priority research involves Kshara Sutra vs. LIFT RCTs, mechanistic studies of Vrana Ropana formulations, and hyperspectral imaging validation of Vrana classification.

Keywords: Shalya Tantra, Ayurvedic surgery, perioperative care, research gaps, Kshara Sutra, Agnikarma, integrative medicine, ERAS

1. Introduction

In the 21st century, surgery has completely changed with the advent of new technologies, such as robot-assisted surgery, image-guided navigation, minimally invasive surgery, and improved recovery after surgery (ERAS) pathways [1,2]. Coinciding with this technological change, there was a renewed interest in the world of traditional surgical systems, namely Shalya Tantra, a branch of Ayurveda medicine systematized in the Sushruta Samhita (c. 600 – 400 BCE) [3,4]. Shalya Tantra is considered one of the earliest codified surgical specialties and is recognized for introducing some of the most innovative surgical procedures in the field of plastic surgery, such as the forehead flap rhinoplasty technique practiced in the modern day [4,5].

The Sushruta Samhita outlines more than 100 surgical instruments divided into Yantra (blunt instruments) and Shastra (sharp-edged instruments) and 300 surgical procedures, 60 categories of Vrana (wounds/ulcers), and thoroughly explains the principles of wound management [6,7]. The classical perioperative concept of Purva Karma (preoperative), Pradhana Karma (intraoperative) and Pashchat Karma (postoperative) is very similar to the modern concept of ERAS pathways, but it is rarely mentioned in today's surgical context [8,9].

Several narrative reviews have examined individual Shalya Tantra treatments, such as Kshara Sutra for anorectal diseases [10,11], Agnikarma for musculoskeletal conditions [12,13], and Vrana Ropana formulations for wound healing [14,15]. In 2024, a meta-analysis of Kshara Sutra in treating anal fistula showed a high cure rate, low recurrence rate, and low incidence of incontinence [16]. Likewise, an Indian Council of Medical Research multicentric RCT has proven that Kshara Sutra is an effective, ambulatory, and safe alternative treatment for patients with fistula-in-ano [17]. However, research on this topic has not been conducted systematically throughout the entire perioperative period, from patient assessment to dietary management after surgery [18,19].

The aim of this narrative review is three-fold: (i) systematic identification and categorization of research gaps with the use of the principles of Shalya Tantra before, during, and after surgery; (ii) evaluation of specific opportunities for integration with modern surgical technologies, such as artificial intelligence, hyperspectral imaging, and robotic surgery; and (iii) proposal of a prioritized, time-bound research agenda that connects classical Ayurvedic surgical wisdom with 21st century evidence-based surgical science.

2. Materials and Methods

2.1 Study design – This is a narrative review – gap analysis that was conducted according to the Scale for the Assessment of Narrative Review Articles (SANRA) guidelines.

2.2 Search strategy – Databases searched (January 2000 – May 2025): PubMed, Scopus, Google Scholar, AYUSH Research Portal, Dhara Online, and CTRI. Inclusion criteria: ("Shalya Tantra" OR "Sushruta" OR "Kshara Sutra" OR "Agnikarma" OR "Vrana" OR "Raktamokshana") AND ("preoperative" OR "intraoperative" OR "postoperative" OR "perioperative" OR "surgical outcomes" OR "wound healing" OR "ERAS"). The reference lists were hand searched, and English translations of the Sushruta Samhita, Ashtanga Hridaya, and Charaka Samhita were consulted.

2.3 Inclusion and exclusion criteria – Original research (RCTs, non-randomized trials, case series, observational studies), systematic reviews/meta-analyses, gap-identifying articles, classical text translations, and technology-focused studies. Exclusions: non-peer-reviewed opinions, duplicates, studies with no quantitative results, non-surgical Ayurveda and pre 2000 publications.

Data extraction and gap mapping: Author, year, study design, sample size, intervention, comparator, outcomes, key findings, and identified gaps were extracted (2.4). Primary outcome: Gap categorization in the preoperative, intraoperative, and postoperative domains. The secondary outcomes are opportunities to integrate technology, convergence of mechanisms, and a prioritized research agenda.

2.5 Ethics statement: No ethical approval was required for (narrative review of published literature and classical texts).

3. Results

3.1 Overview of the Shalya Tantra evidence base

All databases identified 847 records. Following the deduplication and screening of articles for inclusion criteria, 71 articles were included for full-text analysis; these included 34 original research articles (including 12 RCTs, 9 non-randomized trials, and 13 case series), 18 systematic or narrative reviews, 12 technology-focused articles,

and 7 classical text references. The evidence base is summarized, and gaps are identified by synthesizing the evidence in the perioperative domain in the following sections.

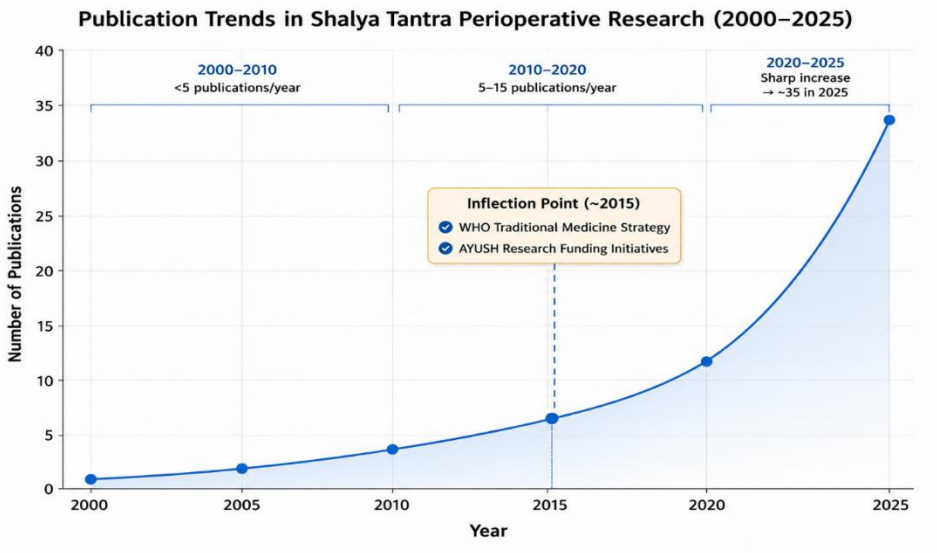


Figure 1: Publication trends in Shalya Tantra perioperative research (2000–2025)

3.2 Classical foundations of Shalya Tantra perioperative care

The Sushruta Samhita describes three stages of the perioperative period. The Purva Karma (preoperative) stages involve Rogi Pariksha (eight-fold patient assessment that includes Prakriti, Sara, Samhanana, Satmya, etc.), Roga Pariksha (disease assessment), Snehana (oleation) and Swedana (sudation), and Pathya Ahara (preoperative diet) [6,7,23]. The Pradhana Karma (intraoperative) phase concerns the eight incisional techniques (Ashtavidha Shastra Karma), alkaline cautery (Kshara Karma), thermal cautery (Agnikarma), irrigation (Parisheka), and detailed classification of Vrana into 60 types based on the predominance of Dosha, depth, discharge, and chronicity [24-26]. Pashchat Karma (postoperative) phase includes Vrana Shodhana (wound cleansing – Patra, Shweta, Kashaya, Raktamokshana), Vrana Ropana (wound healing), Bandhana (bandaging) and Pathya (dietary regimen) [27].

Table 1: Classical Shalya Tantra perioperative framework and modern parallels

Perioperative Phase	Classical Term	Key Principles	Modern Parallel
Preoperative	*Purva Karma*	*Rogi Pariksha*, *Snehana*, *Swedana*, *Nitya Virechana*, *Pathya Ahara*	Preoperative risk stratification, prehabilitation, bowel preparation, ERAS nutritional optimisation [1,28]
Intraoperative	*Pradhana Karma*	*Shastra/Yantra* (100+ instruments), *Ashtavidha Karma*, *Kshara/Agnikarma*, *Vrana* classification	Minimally invasive instruments, electrosurgery, chemical cautery, surgical wound classification [6,7,25]

Postoperative	*Pashchat Karma*	*Vrana Shodhana* (4 stages), *Vrana Ropana* (topical agents), *Bandhana*, *Pathya*	Wound debridement protocols, NPWT, advanced dressings, ERAS dietary guidelines [27,29]

3.3 Preoperative research gaps

The analysis of the included studies showed significant gaps in the evidence of Shalya Tantra principles used preoperatively. The Rogi Pariksha or the examination of eight capacities (Prakriti – the constitution, Sara – the excellence of the tissues, Samhanana – the compactness, Pramana – the measure, Satmya – the adaptability, Sattva – the mental strength, Ahara Shakti – the capability of digestion and Vyayama Shakti – the capacity for exercise) has not been translated into any validated surgical risk assessment instrument [30,31]. Conceptual models have also suggested the use of Prakriti analysis in conjunction with more modern scoring systems (ASA, POSSUM, NSQIP) [32,33], but prospective validation studies do not exist. No RCTs have investigated the impact of preoperative Snehana (oleation) and Swedana (sudation) on surgical outcomes, including ileus incidence, hospital stay, or anastomotic healing. The safety profile of classical Nitya Virechana (therapeutic purgation) in debilitated surgical patients has not yet been evaluated [34] and Dhoopana (fumigation formulations containing Guggulu, Vacha and Nimba) has been shown to have antimicrobial activity in vitro [35] but no in vivo studies in operating room environments have been reported.

Table 2: Preoperative research gaps in Shalya Tantra

Classical Concept	Modern Application	Identified Research Gap	Priority
Rogi Pariksha (8-fold)	Surgical risk scoring (ASA, NSQIP)	No validated instrument; no correlation with postoperative complications [32,33]	High
Snehana/Swedana	Preoperative bowel prep, haemodynamic optimisation	Zero RCTs examining effect on surgical outcomes	High
Nitya Virechana	Mechanical bowel preparation	No comparative trials vs. MBP; safety unknown [34]	Moderate
Pathya Ahara	ERAS fasting guidelines	No integration studies in perioperative nutrition	Moderate
Dhoopana (fumigation)	OR air sterilisation	Antimicrobial activity in vitro [35]; no surgical trials	Low

3.4 Intraoperative research gaps

The gaps in the research that are identified are Kshara Sutra, Agnikarma, Kshara Karma, and classical instrument design while performing the surgery. Most of the evidence is available for Kshara Sutra in fistula-in-ano (Bhagandara). The ICMR multicentric RCT (1991) was a landmark study, that finally showed that Kshara Sutra was a safe and alternative surgical treatment that could be performed using a walking stick.In 1991, the landmark ICMR multicentric RCT showed that Kshara Sutra was an alternative surgical treatment that could be performed with a walking stick, and was a safe approach to surgery.[17] In a 2024 meta-analysis of seven studies, it was found to be minimally invasive and have good cure rates, lowest recurrence, and incontinence [16]. Other RCTs demonstrated that Sarjarasa Apamarga Ksharasutra was more effective than Guggulu Apamarga Ksharasutra with regard to pain and burning [36], and Krutamalakadya Sutra was equally effective and simpler to prepare [37]. A

CTRI registered trial (CTRI/2019/09/021524) comparing Arkaksheera based vs. Apamarga Kshara Sutra is completed but unpublished [38].

Critical gaps remain: (1) no multicenter RCTs vs. modern sphincter-sparing techniques (LIFT, VAAFT); (2) long-term recurrence (>5 years) unknown; (3) mechanism is not fully elucidated (chemical vs. mechanical), but these are proposed: pressure necrosis, alkaline cauterization, continuous cutting with healing [26,39].

A comparative study revealed that Panchaloha Shalaka Agnikarma was equally effective as electric cautery in the treatment of sentinel piles and had an additional analgesic effect compared to classical Agnikarma [12,40]. However, no RCTs have compared the healing, scar, pain, and SSI rates of Agnikarma with those of standard electrocautery. Kshara Karma (alkaline cautery) is observed in anal fissure and haemorrhoids [41,42] but there is no head-to-head study with chemical cautery agents (silver nitrate, TCA).

Table 3: Intraoperative research gaps in Shalya Tantra

Classical Concept	Modern Equivalent	Key Evidence	Critical Gap	Priority
Kshara Sutra	Cutting seton, LIFT, VAAFT	Meta-analysis (7 studies) shows promising cure rates [16]; ICMR RCT (1991) confirms safety [17]	No multicentre RCT vs. LIFT/VAAFT; long-term recurrence unknown; mechanism unclear [26,39]	Critical
Agnikarma	Electrocautery, laser	Comparative study vs. electric cautery for sentinel pile [12]	No RCTs for tissue healing, scarring, SSI rates	High
Kshara Karma	Chemical cautery (AgNO3, TCA)	Observational studies for anal fissure/haemorrhoids [41,42]	No head-to-head trials; dose standardisation absent	Moderate
Shastra design	Minimally invasive instruments	Descriptive anatomical studies [6,7]	No biomechanical comparisons for reverse engineering	Low

3.5 Postoperative research gaps

Postoperative research had the highest number of studies but lacked consistency in the formulation and had no comparative studies to modern standards.

Vrana Ropana (topical healing agents): A three arm RCT (2023) showed that Jatyadi tulle and Madhughrita tulle was found to be significantly effective in clean wounds (Shuddhavrana) [43]. Another RCT revealed that Jatyadi Ghrita is more effective than povidone iodine in non-healing ulcers (Dushta Vrana) in terms of pain, itching, burning, ulcer size, and discharge [44]. A 2011 RCT (n=24 vs. 21) showed that Manjishthadi Ghrita induced better postoperative wound healing than povidone-iodine [14]. The pre-clinical results validated that Jatyadi Ghrita and Jatyadi Taila promote healing through re-epithelialization, decrease inflammation, promote collagen and reduce TGF β1 [45].

Vrana Shodhana (wound cleansing): A clinical trial of 5% w/v extract of Panchavalkala was carried out which was effective in reducing infection and accelerating debridement in maxillofacial wounds [46]. Bhat et al. (2014) demonstrated that Panchavalkala cream effectively decreased clinical symptoms such as slough, swelling, redness, pain, discharge, tenderness, malodor, and microbial load [47].

Jalaukavacharana (leech therapy): Case reports/series show efficacy. Bhavsar et al. (2025) reported that wound severity (BWAT score 40→13) decreased by 67.5% following weekly leech therapy [48]. Gautam et al. (2025) reported the steady improvement of four infected/non-healing wounds [49]. In another case report, a chronic diabetic foot ulcer was successfully managed [50].

There are still some critical evidence gaps: (1) formulation standardization across studies is not consistent with variations in the proportions and preparation methods of the ingredients as well as different application protocols; (2) no head to head RCTs comparing Vrana Ropana formulations with modern advanced dressings (hydrocolloids, alginates, silver dressings, growth factors); (3) no integration studies of classical Pathya (postoperative diet) in ERAS nutritional protocols; (4) no comparative effectiveness trials of classical Bandhana (14 types) for specific wound categories; (5) although Jalaukavacharana formulations have been found effective in some case series [48,49,50], no large scale RCTs exist.

Table 4: Postoperative research gaps in Shalya Tantra

Classical Concept	Modern Application	Key Evidence	Critical Gap	Priority
Vrana Ropana (topical)	Advanced dressings, growth factors	Three-arm RCT shows Jatyadi/Madhughrita tulle significant for clean wounds [43]; RCT vs. povidone-iodine [44]; Manjishthadi Ghrita RCT [14]; preclinical mechanistic studies [45]	Formulation inconsistency; no head-to-head vs. modern advanced dressings	High
Vrana Shodhana	Debridement, NPWT	Panchavalkala decreases microbial load ($p<0.05$) [47]; 5% w/v extract study [46]	No RCTs vs. standard debridement; biomarkers for *Shuddha Vrana* not established	Moderate
Pathya (diet)	ERAS nutritional protocols	Conceptual frameworks proposed [51]	No integration studies; effect on anastomotic healing unknown	Moderate
Jalaukavacharana	Medicinal leech therapy	Case report with BWAT showing 67.5% improvement [48]; case series (n=4) [49]; diabetic foot case report [50]	No RCTs; no large-scale studies; no comparative trials vs. standard leech protocols	Moderate

3.6 Technological integration opportunities

Five technologies from modern surgical practice were considered to have high potential for integration with the principles of Shalya Tantra, with specific research questions.

The development of artificial intelligence/machine learning tools for surgical risk prediction based on Prakriti-derived features is a high-priority opportunity. Recent AI models for predicting postoperative complications have shown an accuracy of 75–80%, which is higher than the 45% accuracy of practising surgeons [52,53]. No study has included Ayurvedic constitutional phenotyping in these models. Objective The Vrana classification and

assessment of Shuddha Vrana (clean wound) status using hyperspectral imaging (HSI) is promising; HSI is useful for predicting the healing of diabetic foot ulcers with high sensitivity and specificity by quantifying tissue oxyhaemoglobin and deoxyhaemoglobin [54,55]. The classical Vrana typology, based on the predominance of dosha, depth, discharge, and chronicity, could be verified with the help of the HSI signature, as there are 60 types to be validated.

Reverse engineering classical Shastra and Yantra designs may be helpful for robotic surgery ergonomics. The current formulation inconsistency issue can be overcome by 3D printing/bioprinting of customized wound dressings with controlled release of classical formulations like (Madhu, Ghrita, and Yashtimadhu). Low-risk, high-feasibility opportunities for integration include telemedicine for remote wound assessment and Pathya adherence monitoring [51].

Table 5: Technological integration opportunities and priority research questions

Technology	**Classical Correlate**	**Priority Research Question**
AI / Machine Learning	*Rogi Pariksha* (8-factor)	Can AI models incorporating *Prakriti* phenotypes outperform standard surgical risk scores (ASA, NSQIP) in predicting 30-day complications?
Hyperspectral imaging	*Vrana* classification	Do the hyperspectral signatures of *Vrana* correlate with classical *Shuddha* (clean) criteria, enabling AI-assisted- staging?
Robotic surgery	*Shastra/Yantra* precision	Can reverse engineering- of the classical *Mandalaagra* design improve robotic tissue handling in microsurgery?
3D printing / bioprinting	*Vrana Ropana Dravya*	Do 3D-printed *Madhu-Yashtimadhu* scaffolds accelerate healing compared to conventional dressings in diabetic ulcers?
Telemedicine	*Pashchat Karma* follow-up	Does telemedicine-guided- *Pathya* implementation reduce readmission rates compared to standard post-discharge- care?

3.7 Proposed prioritised research agenda

Tier 1 (Critical: 1–2 years)

- Multicentre RCT (Kshara Sutra vs. LIFT) for high trans sphincteric fistula in ano. Recurrence (12 and 24 months), Wexner incontinence, and the SF 36 were the outcomes. Non inferiority margin 10%.
- Prospective Validation of Vrana Classification with Hyperspectral Imaging. In 200-300 wounds, there were objective criteria of Shuddha Vrana, which were correlated with classical texts.
- Clean contaminated surgeries (e.g., laparoscopic cholecystectomy) to which Panchavalkala irrigation (Parisheka) is provided for SSI prevention in a translational RCT. Primary outcome: 30-day SSI rate.

Tier 2 (High – 3–5 years):

- This was an integration RCT in which preoperative Snehana Swedana + ERAS was compared with ERAS alone. Data Collected: Outcomes (length of stay, ileus rates, patient reported recovery (colorectal surgery))
- Comparative effectiveness trial of topical Vrana Ropana formulations (Jatyadi Ghrita, Madhu Yashtimadhu, Panchavalkala) vs advanced dressings (network meta-analysis).
- AI risk prediction model using features derived from Prakriti. Development and external validation (multicenter surgical cohorts, ≥5 000 patients).

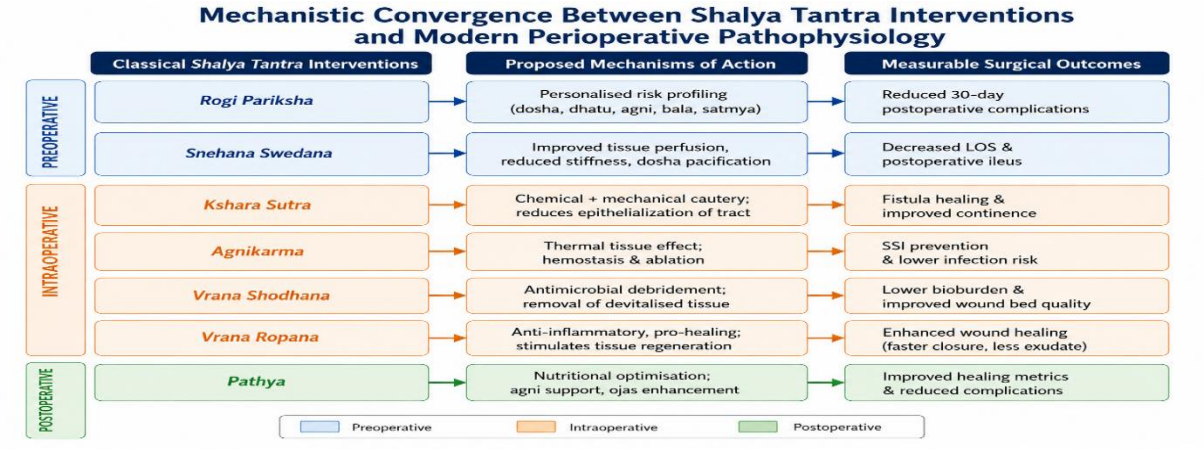
Tier 3 (Moderate – exploratory):

- Classical Shastra reverse-engineered for microsurgery (biomechanical testing and prototype).
- Dose-finding and pharmacokinetic study of oral Virechana for preoperative bowel preparation (Phase I and Phase II).
- To create a telemedicine platform for Pathya adherence and remote wound monitoring (feasibility and pilot effectiveness).

4. Discussion

4.1 Principal findings and significance of gaps

This is the first systematic mapping of research gaps along the entire perioperative continuum of Shalya Tantra. The following are the four key findings: (i) Preoperative Purva Karma, especially Rogi Pariksha, and Snehana Swedana, is the largest evidence void with almost no attempt to validate using modern evidence-based methods; (ii) Kshara Sutra has the strongest available evidence, which includes a meta-analysis [16] and the landmark ICMR multicentric RCT [17]; however, there are significant gaps in the evidence, specifically regarding comparative effectiveness with modern sphincter-sparing techniques; (iii) Vrana Ropana formulations have the most extensive clinical evidence, which includes multiple RCTs [14,43,44]; yet the evidence is inconsistent because of formulation variability and is limited by the lack of comparison with modern advanced dressings; (iv) the opportunities for technological integration, such as AI risk-stratification and HSI wound classification, offer promising and feasible avenues for classical concepts to be validated.



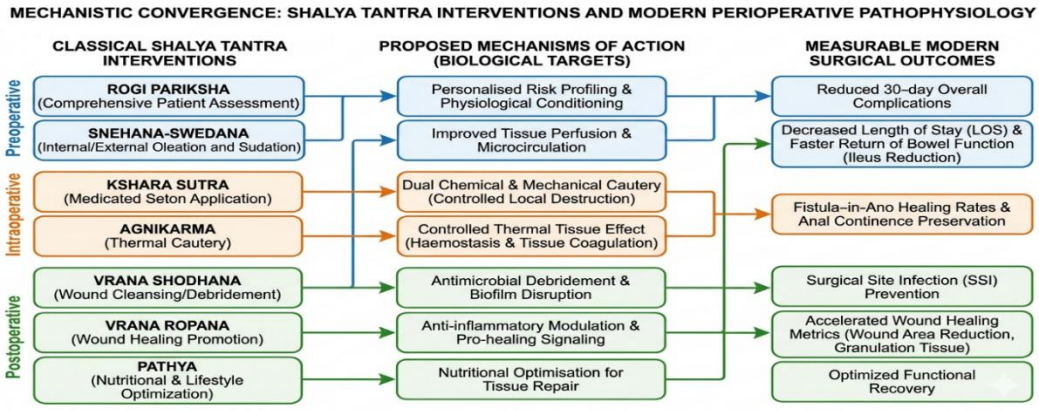


Figure 2: Conceptual model of Shalya Tantra–modern mechanistic convergence in perioperative care

These gaps are more than just academic ones. In high-income countries, surgical site infections (SSIs) occur in 2–5% of patients, and up to 15–30% of patients in low- and middle-income countries (LMICs) develop an SSI, with one in three patients in LMICs developing an SSI [56,57]. An increased hospital stay of 3–5 days after surgery, which results from the prolonged occurrence of postoperative ileus, adds significant healthcare costs [58]. Rigorous research that can prove clinically meaningful benefits for these outcomes may allow for significant surgical burden reduction globally, particularly in resource-limited countries where access to advanced wound care products and expensive technologies is limited [59].

4.2 Comparison with existing literature

Previous narrative reviews have been limited to specific procedures. Surgical tools and techniques were mentioned in a review in 2023, although there was no systematic mapping of the evidence gaps [60]. A conceptual framework was developed in 2025 that integrated Ayurveda with perioperative care and identified gaps [61].

The present review builds upon this by (1) compiling a map of gaps in each of the three phases of perioperative care; (2) incorporating recent studies (Kshara Sutra meta-analysis [16], Jatyadi RCTs [43,44], Panchavalkala studies [46,47], and Jalaukavacharana case reports [48,49]); (3) identifying technological bridges (AI, HSI, and 3D printing) with defined research questions; and (4) proposing a tiered, time-bound research agenda.

These findings are consistent with the criticisms of traditional medicine research that has been previously reported, including a lack of standardization, small sample size, short follow-up, and the absence of sham/placebo controls [62,63]. However, Shalya Tantra has established a set of interventions that are clearly defined and reproducible, and are much easier to achieve than would be possible with herbal medicine research, which is plagued by formulation variability.

4.3 Mechanistic convergence and biological plausibility

A few interventions from Shalya Tantra have been supported by emerging evidence of biological plausibility. The dual mechanism of Kshara Sutra (mechanical strangulation and alkaline cauterization) is supported by histopathological studies, which demonstrate controlled necrosis and simultaneous healing [39,64]. The meta-analysis showed that there was a very small number of patients who experienced incontinence, indicating that sphincter preservation is better than conventional fistulotomy [16].

Vrana Ropana formulations have anti-inflammatory (inhibiting TGF β1), pro healing (increasing collagen, re epithelialisation) and antimicrobial properties [45,47]. In a three-arm RCT, Jatyadi tulle and Madhughrita tulle were found to be superior to the others in terms of ease of application, removal, and comfort, with no adverse

events [43]. Another RCT showed that the efficacy of Jatyadi Ghrita was superior to that of povidone-iodine for pain, itching, burning, ulcer size, and discharge [44].

The antimicrobial activity of Panchavalkala has been observed in vitro against E. coli and S. aureus, and a clinical trial revealed a successive decrease in microbial load, which in turn led to quick healing of wounds [47,65]. These mechanistic investigations connect the dots between old-fashioned claims and new pharmacology, reinforcing the need for further clinical investigation.

4.4 Implications for integrative surgical care

The results have implications for three groups of stakeholders:

Surgeons and perioperative physicians: Shalya Tantra may have some useful adjuncts for treating various anorectal disorders (Kshara Sutra) and wound healing (Vrana Ropana formulations). The postoperative application of standardized Madhu (medical-grade honey) formulations is the lowest-risk integration opportunity, as there is meta-analysis evidence for the use of medical-grade honey in wound healing in a variety of wound types [66]. In the case of fistula-in-ano, Kshara Sutra may be considered when sphincter-sparing expertise is not available; however, at present, it is not supported to replace LIFT or VAAFT in high-resource settings.

For Ayurvedic practitioners and researchers: The gaps in research identified in this study are an agenda for action. Priority should be accorded to: (1) standardization of the protocol for Kshara Sutra preparation and application so that it can be replicated in different centers; (2) development of objective and validated outcome measures of Vrana Shuddha (clean wound) using HSI or other modalities of imaging; and (3) designing of RCTs with surgical colleagues with the use of sham or active comparator instead of historic control.

For health system policymakers, investment in the research infrastructure of Shalya Tantra, such as Good Manufacturing Practice (GMP) facilities for the preparation of Kshara Sutra and Vrana Ropana formulations and multicenter trial networks, is a prerequisite for generating high-level evidence. The cost-effectiveness of many interventions, such as Pathya dietary advice, Madhu dressings, and Panchavalkala preparations, makes them appealing for implementation in low-resource areas during times of efficacy proven through rigorous trials [59].

4.5 Limitations

Limitations are: no meta-analysis (interpretation dependent), non-English journals not included (language bias), classical texts were interpreted, safety data not discussed, mechanistic pathways from preclinical studies need clinical confirmation, and literature from the Kshara Sutra was predominantly single center and low quality (Jadad scores 4–7) [16].

4.6 Future research directions beyond the prioritised agenda

Innovative directions include the following: digital phenotyping is performed on Prakriti (genomics, proteomics, metabolomics, and microbiome) and surgical risk prediction; the temperature of Agnikarma is standardized using thermal imaging; in low-resource settings, affordable Vrana Ropana formulations such as Madhu, Ghrita, and Haridra are rigorously evaluated via comparative transcriptomics (RNA sequencing) to identify the mechanism of Vrana healing.

5. Conclusions

Although the perioperative framework developed by Shalya Tantra is consistent with ERAS pathways, there are some evidence gaps that need to be addressed: no validated Rogi Pariksha tools, no RCTs comparing Kshara Sutra with LIFT/VAAFT, and inconsistent Vrana Ropana formulations. The opportunities are AI-supported Prakriti phenotyping, hyperspectral imaging for wound classification, and thorough RCTs of Madhu and Panchavalkala agents. Research on collaboration and multi-disciplinarity in the application of CONSORT standards is required

to determine which classical elements truly have an impact on patient outcomes. The tiered, five-year agenda provides a practical roadmap.

6. Declarations

Conflict of Interest: No conflicts of interest.

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