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Recent Advances in the Minimally Invasive Management of Anorectal Disorders: A Narrative Review

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Abstract
Hemorrhoidal disease, fistula-in-ano, anal fissures, pilonidal sinus disease, and rectal prolapse are examples of anorectal maladies that account for a significant share of surgical caseloads worldwide. Even while traditional surgical procedures are often effective, they are sometimes hampered by considerable postoperative morbidity, slowed wound healing, and possible sphincter function compromise. Coloproctology has recently undergone a paradigm change towards minimally invasive surgery (MIS), with a focus on functional preservation and targeted tissue ablation. This narrative review assesses the current therapeutic arsenal, which includes advanced Ksharasutra-based interventions (IFTAK, MIKST, and MIKKT), video-assisted anal fistula treatment (VAAFT), laser hemorrhoidoplasty (LHP), ligation of the intersphincteric fistula tract (LIFT), and Doppler-guided hemorrhoidal artery ligation (DG-HAL). This study summarizes the most recent research on operative principles, clinical reasons, and functional results to demonstrate how contemporary methods reduce tissue damage while optimising patient recovery.

1. Introduction

One common problem in colorectal practice is anorectal diseases. Patients' quality of life is significantly impacted by pathologies such as haemorrhoids, anal fistulas, fissures, and pilonidal sinuses, which can cause crippling pain, persistent discharge, haemorrhage, and related psychological distress [1,5]. Excisional hemorrhoidectomy, conventional fistulotomy, and extensive local excision are examples of the gold-standard therapeutic techniques that have historically had high success rates. Nevertheless, these traditional methods are inherently associated with significant postoperative morbidity, prolonged recovery, and a significant risk of postoperative faecal incontinence [1,5].

Sphincter-sparing, functionally restorative operations are becoming more common in proctology as a result of the introduction of minimally invasive surgery (MIS). This contemporary method's fundamental principles include minimising collateral tissue damage, maintaining the anal sphincter complex strictly, reducing postoperative pain, and facilitating an expedited return to normal activities. Colorectal surgeons now have a much wider range of therapeutic options thanks to recent advancements utilizing laser energy, endoscopic imaging, radiofrequency ablation, mechanical stapling, and modified Ksharasutra applications [2, 3].

2. Minimally Invasive Modalities by Pathology

Hemorrhoidal Disease-Excisional paradigms for the surgical treatment of severe hemorrhoidal illness have given way to tissue-preserving methods intended to restore normal anatomical relationships and decrease vascular influx..

Doppler-Guided Hemorrhoidal Artery Ligation (DG-HAL): This method precisely isolates and ligates the superior rectal artery's terminal branches using transanal Doppler ultrasound. DG-HAL causes ischemic hemorrhoidal cushion shrinking while maintaining the anoderm by reducing artery input. Significant decreases in surgical discomfort, quick patient mobilisation, and a positive complication profile are reported in studies by Faucheron et al. and Giordano et al. [2, 19, 20].

Stapled Hemorrhoidopexy (PPH). This surgery involves resecting a circumferential ring of excess rectal mucosa close to the dentate line using a circular stapling device. As a result, the prolapsed tissue is anatomically suspended and the vascular supply is disrupted. The literature indicates a slightly greater recurrence probability in cases with grade IV prolapse, despite the fact that it offers shorter operating durations and less pain than standard excision [1].].

Laser Hemorrhoidoplasty (LHP): A radial-emitting diode laser fiber inserted centrally into the hemorrhoidal nodule is used in LHP. Without mucosal excision, the photothermal radiation causes coagulative necrosis and eventual fibrosis of the vascular plexus. It has minimal bleeding and quick recovery, making it ideal for day-case surgery [7].

Radiofrequency Ablation (RFA): RFA causes quick coagulation and ultimately cicatrization by applying regulated heat energy to the targeted tissue. Clinical observations show less need for analgesics and less perianal edema following surgery.

Fistula-in-Ano, or Anal Fistula

Eliminating the septic tract without sacrificing faecal continence is the main goal of treating complicated anal fistulas.

Video-Assisted Anal Fistula Treatment (VAAFT): Meinero and Mori invented VAAFT, which uses a customised fistuloscope to enable direct endoluminal tract imaging. The process includes targeted fulguration of the tract, secure closure of the internal orifice, identification of the internal aperture, and diagnostic fistuloscopy. Promising healing rates with little chance of sphincter damage are shown by meta-analyses [3, 6].

Fistula Laser Closure (FiLaC): A radial-emitting laser probe is advanced through the fistulous tract using this method. Circumferential photothermal energy destroys the tract as the probe is methodically removed, encouraging structural collapse and recovery with little scarring [4].

Ligation of Intersphincteric Fistula Tract (LIFT): The fistulous tract is located, ligated, and separated inside the intersphincteric groove using a historic sphincter-sparing approach. Because the internal and external anal sphincters are not divided using this anatomical method, recovery rates in properly chosen cohorts often surpass 70% [5].

Advanced Ksharasutra Techniques (IFTAK & MIKST):

IFTAK- (Interception of Fistulous Tract with Application of Ksharasutra) is designed to treat recurrent and complicated fistulas. In order to eliminate diseased crypts and cause controlled fibrosis, a medicated Ksharasutra is applied locally after the tract near the anal canal is surgically intercepted [10, 11].

MIKST For low and trans-sphincteric fistulas, the Minimal Invasive Kshara Sutra Technique is modified. MIKST minimizes the systemic inflammatory response and lowers the frequency of seton exchanges by combining focused chemical seton administration with restricted surgical incision [12, 13].

Anal Fissure-Internal anal sphincter spasm relief without permanent surgical division is the main goal of contemporary treatments for refractory chronic anal fissures.

Botulinum Toxin Injection: While avoiding the irreversible hazards of lateral internal sphincterotomy, chemodenervation through targeted injection of botulinum toxin type A causes the internal anal sphincter to temporarily relax, promoting strong mucosal repair [18].].

Laser & Radiofrequency Sphincterotomy: Utilizing advanced energy devices allows for highly precise, measured division or ablation of fibrotic tissue with enhanced hemostasis and limited lateral thermal spread.

Pilonidal Sinus Disease-Traditional wide excision of pilonidal cysts frequently results in protracted secondary healing.

Endoscopic Pilonidal Sinus Treatment (EPSiT): By modifying the VAAFT principles, EPSiT offers an endoscopic view of the pilonidal cavity, allowing for careful follicular extraction and debridement through a small access port. Superior cosmesis and quick walking are correlated with this [8].

Laser Ablation and MIKKT**:** Excellent cosmetic results are possible when laser fibres are used to completely destroy the sinus cavity. Furthermore, even in complicated, recurrent cases linked to concurrent anal fistulas, the Minimal Invasive Kshara Karma Technique (MIKKT), which uses controlled chemical cauterisation through a small incision, has proven effective [14].

Rectal Prolapse

Laparoscopic and Robotic Ventral Mesh Rectopexy: Open pelvic floor surgery has mostly been replaced by endoscopic methods. Laparoscopic ventral rectopexy shows long-lasting structural repair by minimising autonomic nerve damage and reducing postoperative constipation [9]. This method is further improved by incorporating robotic platforms, which offer greater dexterity and three-dimensional pelvic imaging.

Emerging technology: By incorporating cutting-edge biomedical and computational technology, the field of anorectal surgery is rapidly advancing**.**

Artificial Intelligence (AI): 3D fistula mapping and predictive surgical planning are being optimised using machine learning algorithms applied t preoperative MRI and endoanal ultrasonography.

Regenerative medicine: Mesenchymal stem cell injections locally show promise, especially for refractory fistulizing Crohn's disease.

Advanced Energy Devices: Devices that provide unmatched accuracy in hemostasis and tissue dissection, like the LigaSureTM, harmonic scalpels, and plasma kinetic devices, are constantly evolving.

3. Discussion

Proctology's current paradigm shift toward minimally invasive methods is a major improvement in surgical therapy with notable clinical advantages. These contemporary methods provide better functional and cosmetic results, coupled with faster tissue recovery by less anatomical disruption. The emphasis on anal sphincter maintenance, which is essential for preserving patient continence and overall postoperative quality of life, is a major benefit of this progression. Additionally, a significant decrease in postoperative pain is closely correlated with a reduction in surgical trauma, which promotes a quicker recovery and return to regular activities for patients. Despite these revolutionary benefits, there are a number of significant clinical and systemic obstacles to the broad adoption and standardisation of these cutting-edge technologies. The high financial cost of the initial capital investment is one of the main obstacles to widespread adoption. Many healthcare organisations may find it prohibitively expensive to purchase

specialised, cutting-edge technology, such as complex robotic consoles, high-definition endoscopic visualisation towers, and sophisticated laser generators. Surgeons must undergo extensive, specialised training in order to attain and sustain procedural proficiency due to the steep, quantifiable learning curve associated with the clinical application of these technologies. Additionally, even though the short-term perioperative results consistently show very promising safety and efficacy profiles, the clinical durability of these therapies is still being assessed. Variations in disease recurrence rates that have been documented underscore the need for standardised surgical procedures and optimal patient selection. Ultimately, the surgical community has to give priority to thorough, multicenter, randomised controlled trials (RCTs) in order to definitively establish the long-term therapeutic efficacy and cost-effectiveness of these developing methods. The genuine durability and overall benefit of minimally invasive proctology can only be conclusively determined with reliable, long-term data.

Conclusion:

The surgical strategy for anorectal problems has definitely changed as a result of minimally invasive procedures. Advanced targeted therapies (IFTAK, MIKST), FiLaC, LIFT, and VAAFT are examples of modalities that optimize the fine balance between rigorous functional preservation and definite therapeutic efficacy. The standard of care in proctology will continue to change toward more accurate, patient-centred procedures as surgical technologies combine with robots, orthobiologics, and artificial intelligence.

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