https://doi.org/10.22416/1382-4376-2025-35-4-39-47
UDC 616.147.17-007.64-085

Innovations in Hemorrhoid Treatment: A Bibliometric Review of Laser, Stapled, and Doppler-Guided Techniques

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Background. Over the past decade, innovations in haemorrhoid surgery particularly laser haemorrhoidoplasty, stapled haemorrhoidopexy, and Doppler-guided haemorrhoidal artery ligation (DG-HAL) have gained increasing attention due to their potential to reduce postoperative pain, recurrence, and improve patient quality of life. Despite this progress, a comprehensive bibliometric analysis of the global research trends in these techniques has not yet been conducted.

Aim: to analyse the global scientific literature on innovative haemorrhoid treatments from 2015 to 2025 using bibliometric methods, and to identify key trends in authorship, institutional and geographic contributions, citation impact, and thematic evolution.

Methods. A bibliometric search was conducted using the Scopus database for publications between 2015 and 2025. The search included terms related to “laser haemorrhoidoplasty”, “stapled haemorrhoidopexy”, and “Doppler-guided haemorrhoidal artery ligation”. Data were exported, cleaned, and analysed using Microsoft Excel and VOSviewer (v. 1.6.19). Co-authorship networks, country collaborations, keyword co-occurrence, citation density, and institutional productivity were visualised and interpreted.

Results. A total of 273 articles were identified. Publication output increased steadily, peaking in 2021. Italy emerged as the leading contributor in terms of publications and international collaborations. Most cited articles focused on clinical guidelines and randomised trials comparing innovative with conventional techniques. Keyword analysis revealed a shift from traditional surgery towards minimally invasive procedures, with increasing focus on patient-centered outcomes such as pain and quality of life.

Conclusion. There has been significant global academic interest in innovative haemorrhoid treatments over the past decade, with laser and Doppler-guided methods gaining prominence. Research is concentrated in high-income countries, particularly Italy, with limited representation from low- and middle-income countries. Future studies should address global equity, long-term outcomes, and cost-effectiveness through broader collaborations and implementation science.

Keywords: haemorrhoids, laser haemorrhoidoplasty, stapled haemorrhoidopexy, Doppler-guided haemorrhoidal ligation, bibliometric analysis, minimally invasive surgery

Conflict of interest: the authors declare no conflict of interest.

For citation: Putra J.A., Handaya A.Y., Setyanto H., Prawira M. Innovations in Hemorrhoid Treatment: A Bibliometric Review of Laser, Stapled, and Doppler-Guided Techniques. Russian Journal of Gastroenterology, Hepatology, Coloproctology. 2025;35(4):39–47. https://doi.org/10.22416/1382-4376-2025-35-4-39-47

Инновации в лечении геморроя: библиометрический обзор лазерных, степлерных и доплеровских методов

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Введение. За последнее десятилетие инновации в хирургии геморроя, в частности лазерная геморроидопластика, степлерная геморроидопексия и доплеровское лигирование геморроидальных артерий (Doppler-guided haemorrhoidal artery ligation, DG-HAL), привлекают все большее внимание благодаря их потенциалу для уменьшения послеоперационной боли, риска рецидивов и улучшения качества жизни пациентов. Несмотря на этот прогресс, комплексный библиометрический анализ мировых тенденций исследований в области этих методов до сих пор не проводился.

Цель: проанализировать мировую научную литературу по инновационным методам лечения геморроя за период с 2015 по 2025 г., используя библиометрические методы, и выявить ключевые тенденции в области авторства, институционального и географического вклада, а также оценить влияние цитирования и проследить эволюцию тем.

Методы. Был проведен библиометрический анализ публикаций за период с 2015 по 2025 г., собранных в базе данных Scopus. Поиск включал термины, связанные с «лазерной геморроидопластикой», «степлерной геморроидопексией» и «перевязкой геморроидальных артерий под доплеровским контролем». Данные были экспортированы и обработаны с помощью Microsoft Excel и VOSviewer (v. 1.6.19). В ходе анализа были визуализированы и интерпретированы сведения о сотрудничестве между авторами, между странами, о совместной встречаемости ключевых слов, плотности цитирования и продуктивности организаций.

Результаты. Всего было выявлено 273 статьи. Количество публикаций неуклонно росло, достигнув пика в 2021 г. Италия стала лидером по количеству публикаций и международному сотрудничеству. Большинство цитируемых статей были посвящены клиническим рекомендациям и рандомизированным исследованиям, сравнивающим инновационные и традиционные методы. Анализ ключевых слов выявил переход от традиционной хирургии к малоинвазивным процедурам с растущим акцентом на результатах, ориентированных на пациента, таких как боль и качество жизни.

Выводы. В последнее десятилетие во всем мире наблюдается значительный академический интерес к инновационным методам лечения геморроя, при этом все большую популярность приобретают лазерные и доплеровские методы. Исследования сосредоточены в странах с высоким уровнем дохода, особенно в Италии, при этом страны с низким и средним уровнем дохода представлены ограниченно. В будущих исследованиях необходимо сосредоточиться на глобальном охвате, долгосрочных результатах и экономической эффективности. Это может быть достигнуто через более тесное сотрудничество и активное внедрение научных разработок.

Ключевые слова: геморрой, лазерная геморроидопластика, степлерная геморроидопексия, доплеровское лигирование геморроидальных узлов, библиометрический анализ, малоинвазивная хирургия

Конфликт интересов: авторы заявляют об отсутствии конфликта интересов.

Для цитирования: Путра Дж.А., Хандайя А.Ю., Сетьянто Х., Правира М. Инновации в лечении геморроя: библиометрический обзор лазерных, степлерных и доплеровских методов. Российский журнал гастроэнтерологии, гепатологии, колопроктологии. 2025;35(4):39–47. https://doi.org/10.22416/1382-4376-2025-35-4-39-47

Introduction

Haemorrhoidal disease remains one of the most prevalent benign anorectal conditions, affecting an estimated 4–5 % of the global adult population, with a higher incidence in individuals aged 45 to 65 years [1, 2]. While conservative therapies such as dietary fiber, topical agents, and flavonoids are effective in early stages, advanced or symptomatic haemorrhoids often require procedural intervention [3]. Over the past two decades, significant innovation has occurred in the surgical management of haemorrhoids, aiming to optimise patient outcomes, reduce postoperative pain, and minimise complications. Among the notable advancements are stapled haemorrhoidopexy, introduced as a less painful alternative to conventional excisional surgery, and Doppler-guided haemorrhoidal artery ligation (DG-HAL), which targets arterial flow to reduce haemorrhoidal congestion [4]. Recently, laser haemorrhoidoplasty has gained attention for its minimally invasive approach, utilising radial fiber laser probes to ablate haemorrhoidal tissue with minimal disruption to surrounding structures [5, 6]. These techniques have been associated with reduced postoperative pain, faster recovery, and preservation of anorectal function, although recurrence and complication rates remain subjects of ongoing evaluation [7]. Despite these advancements, there has been no comprehensive mapping of global research trends in these innovative modalities. Bibliometric analysis enables an objective assessment of the evolution of academic interest, collaboration patterns, citation impact, and thematic shifts within a specific field [8]. This study therefore aims to offer insights into the current research landscape and future directions of minimally invasive haemorrhoid surgery.

Methods

Study design

Bibliometric analysis was conducted to assess global research trends in innovative haemorrhoid treatments, specifically focusing on laser haemorrhoidoplasty, stapled haemorrhoidopexy, and Doppler-guided haemorrhoidal artery ligation (DG-HAL) over a 10-year period (2015–2025).

Data source and search strategy

A comprehensive search was performed on the Scopus database in April 2025. The search query targeted keywords related to haemorrhoids and the specified techniques, using Boolean operators. The exact search string used was: TITLE-ABS-KEY (hemorrhoid* OR haemorrhoid*) AND TITLE-ABS-KEY (“laser hemorrhoidoplasty” OR “stapled hemorrhoidopexy” OR “Doppler-guided hemorrhoidal artery ligation” OR “DG-HAL” OR “THD” OR “transanal hemorrhoidal dearterialization” OR

Table 1. Top ten journals in hemorrhoid innovation research
Таблица 1. Десять ведущих журналов по исследованию инноваций в области лечения геморроя

	Journal	Publications
1.	Techniques in Coloproctology	23
2.	International Journal of Colorectal Disease	16
3.	Annals of Coloproctology	13
4.	Journal of Coloproctology	8
5.	Colorectal disease	8
6.	Disease of Colon and Rectum	7
7.	BMC Surgery	6
8.	Laser in Medical Science	6
9.	ANZ Journal of Surgery	5
10.	Indian Journal of Surgery	5

"LigaSure hemorrhoidectomy" OR "energy-based device") AND PUBYEAR > 2014 AND PUBYEAR < 2026. Articles were limited to original research (articles) and review papers, written in English. Grey literature, conference abstracts, editorials, and letters were excluded.

Data extraction and preparation

Metadata including titles, authors, author affiliations, abstracts, source titles, publication years, citations, and keywords were exported in .csv format from Scopus. Duplicates were removed manually. For visualisation and network mapping, VOSviewer (v. 1.6.20) was used. Co-authorship, co-occurrence, and citation analyses were performed with thresholds set at a minimum of five occurrences per keyword/author/institution to ensure clarity of visualisation. Time-overlay maps were generated to explore the evolution of research themes.

Results

A total of 273 articles were identified between 2015 and 2025, focusing on innovations in haemorrhoid management, particularly laser haemorrhoidoplasty, stapled haemorrhoidopexy, and Doppler-guided techniques. Annual publication output showed a fluctuating but overall increasing pattern, suggesting sustained and growing academic interest in advanced haemorrhoid treatment modalities. Beginning with 25 publications in 2015, the trend dipped slightly through 2018, followed by a notable surge from 2019 onwards. The peak year was 2021, with 34 publications, indicating heightened research activity possibly driven by the emergence and refinement of energy-based devices. The most productive journals in this domain include both general surgical and specialist colorectal outlets. Top ten journals reflect a multidisciplinary contribution, spanning proctology, minimally invasive surgery, and gastroenterology.

The co-authorship analysis reveals three prominent clusters of researchers, predominantly concentrated in Italy, which appears to be a major contributor in this niche domain.

Cluster 1 (Blue Cluster) include key authors: Domenico Mascagni, Pietro Mascagni, Gaetano Gallo. This group is characterised by close intra-cluster collaboration. Their work focuses on surgical refinements and comparative outcomes, especially in traditional vs. newer modalities such as LigaSure and energy-based devices. The density map shows strong productivity and co-publication frequency.

Cluster 2 (Green Cluster) include key authors: Gabriele Naldini, Alessandro Sturiale, Jacopo Martellucci, Claudia Menconi, Bernardina Fabiani. This is the largest and most central cluster, reflecting a high degree of connectivity and interdisciplinary collaboration. Their contributions appear to span both clinical trials and long-term outcome evaluations of laser and THD procedures.

Cluster 3 (Red Cluster) include key authors: Luigi Brusciano, Gianmattia del Genio, Salvatore Tolone, Ludovico Docimo. This cluster shows tightly interlinked collaboration, with multiple co-authored studies on the efficacy of newer haemorrhoid treatments and patient-reported outcomes.

The country network and overlay maps offer insights into the global distribution of research productivity and international collaborations in the field of innovative haemorrhoid treatment methods, including laser, stapled, and Doppler-guided techniques. Italy stands out as the central hub of research collaboration, with the largest node and strongest interlinkages to countries across Europe, North America, and Asia. It serves as the primary collaborative nucleus, especially with Spain, Switzerland, Bulgaria, and the UK. United Kingdom and United States also play a significant role, though more diversified in their collaboration networks. UK has prominent links to Germany, Romania, and Denmark and US connects actively with Egypt, Germany, and the UK.

Italy, United Kingdom, and the United States have been consistently active since at least 2019, indicating sustained research output. Newer contributors, such as Ireland and Egypt, appear more recently (closer to 2021–2022 on the gradient), suggesting emerging research activity or recent collaborations in

Table 2. Top ten most cited articles
Таблица 2. Десять самых цитируемых статей

Title	Author(s)	Source title	Year	Cited by
Treatment of hemorrhoids: A coloproctologist's view	Lohsiriwat V.	World Journal of Gastroenterology	2015	197
Systematic review and network meta-analysis comparing clinical outcomes and effectiveness of surgical treatments for haemorrhoids	Simillis C., Thoukididou S.N., Slesser A.A., Rasheed S., Tan E., Tekkis P.P.	The British Journal of Surgery	2015	158
Comparison of stapled haemorrhoidopexy with traditional excisional surgery for haemorrhoidal disease (eTHoS): A pragmatic, multicentre, randomised controlled trial	Watson A.J.M., Hudson J., Wood J., Kilonzo M., Brown S.R., McDonald A., Norrie J., Bruhn H., Cook J.A.; eTHoS study group	The Lancet	2016	120
European Society of ColoProctology: Guideline for haemorrhoidal disease	van Tol R.R., Kleijnen J., Watson A.J.M., Jongen J., Altomare D.F., Qvist N., Higuero T., Muris J.W.M., Breukink S.O.	Colorectal Disease	2020	118
Hemorrhoids: Diagnosis and treatment options	Mott T., Latimer K., Edwards C.	American family physician	2018	111
Postoperative discomfort and pain in the management of hemorrhoidal disease: Laser hemorrhoidoplasty, a minimal invasive treatment of symptomatic hemorrhoids	Brusciano L., Gambardella C., Terracciano G., Gualtieri G., Schiano di Visconte M., Tolone S., del Genio G., Docimo L.	Updates in Surgery	2020	56
Emborrhoid: A new concept for the treatment of hemorrhoids with arterial embolization: The first 14 cases	Vidal V., Sapoval M., Sielezneff Y., De Parades V., Tradi F., Louis G., Bartoli J.M., Pellerin O.	Cardiovascular and Interventional Radiology	2015	56
Transanal hemorrhoidal dearterialization (THD) for hemorrhoidal disease: A single-center study on 1000 consecutive cases and a review of the literature	Ratto C.; Campennì P., Papeo F., Donisi L., Litta F., Parello A.	Techniques in Coloproctology	2017	54
Documented complications of staple hemorrhoidopexy: A systematic review	Porrett L.J., Porrett J.K., Ho Y.-H.	International Surgery	2015	50
Evaluation and management of hemorrhoids: Italian society of colorectal surgery (SICCR) consensus statement	Trompetto M., Clerico G., Cocorullo G.F., Giordano P., Marino F., Martellucci J., Milito G., Mistrangelo M., Ratto C.	Techniques in Coloproctology	2015	50

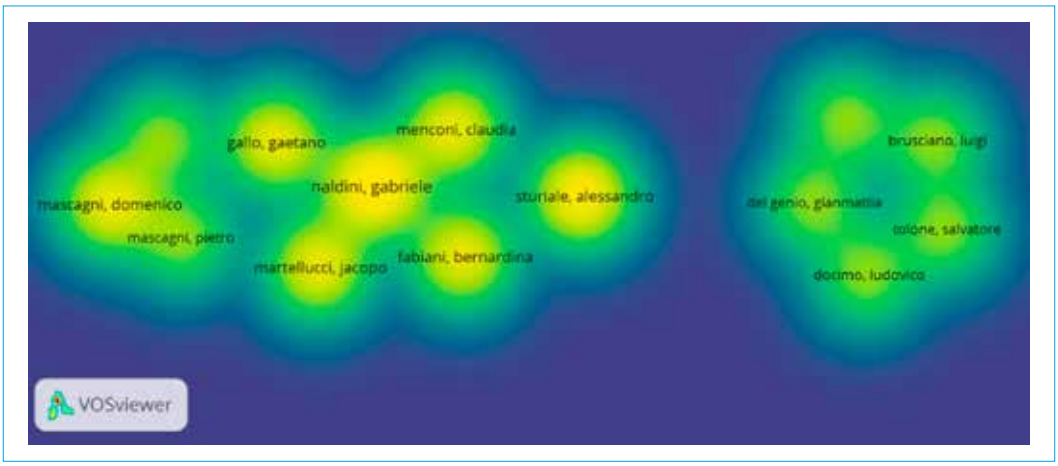

Figure 1. Author Co-Citation Density Map filtered by minimum citation count (≥5) journal of publication
Рисунок 1. Карта плотности совместного цитирования авторов, отфильтрованная по минимальному количеству цитирований (≥5) в журнале публикаций

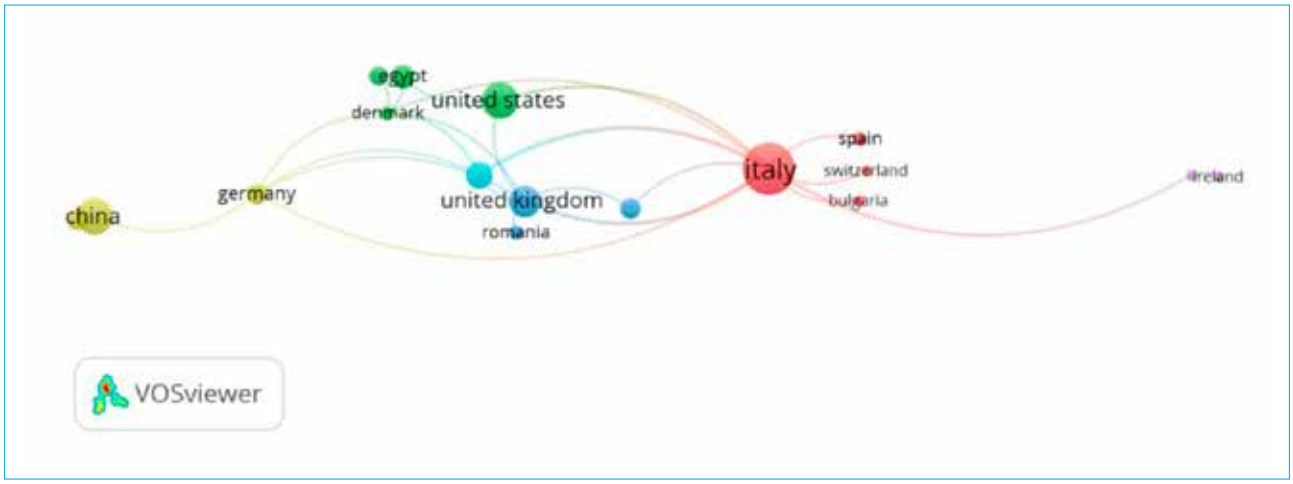

Figure 2. Country Collaboration Network for publications on innovative haemorrhoid treatment
Рисунок 2. Сеть сотрудничества стран при публикациях об инновационных методах лечения геморроя

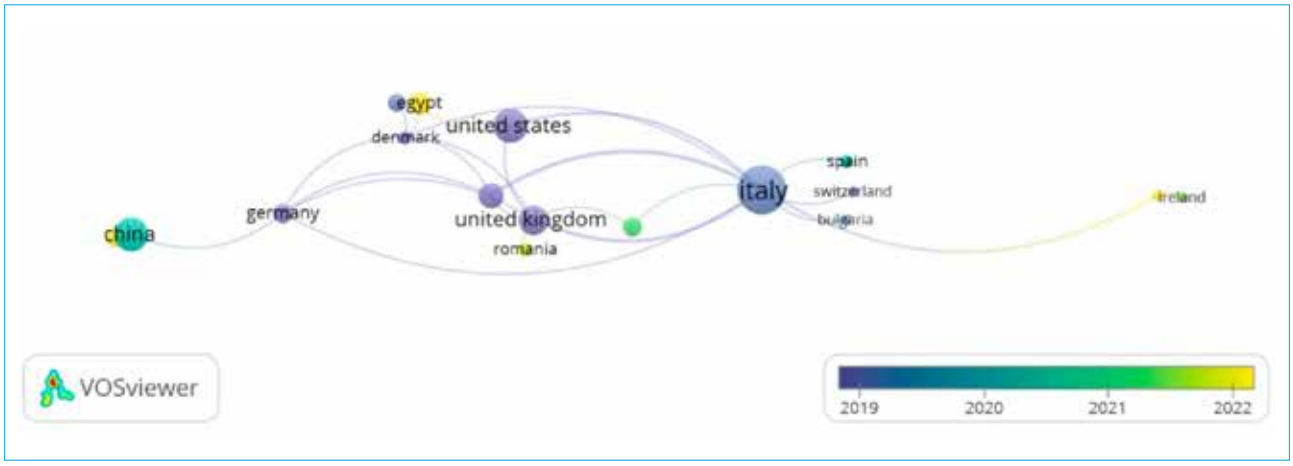

Figure 3. Overlay visualisation of international co-authorship by country in the field of innovative haemorrhoid treatment
Рисунок 3. Наложение визуализации международного соавторства по странам в области инновационного лечения геморроя

the domain. This trend supports the hypothesis that minimally invasive haemorrhoid treatment is gaining global momentum, even in previously underrepresented regions.

Keywords analysis and research interest

From the density visualisation, the most frequently co-occurring keywords include: "Hemorrhoids" and "hemorrhoidectomy", indicating central focus on disease and surgical treatment. "Stapled hemorrhoidopexy", "laser hemorrhoidoplasty", and "Doppler-guided hemorrhoidal artery ligation" (DG-HAL) highlight specific innovations in procedural technique. Other key terms: "recurrence", "complications", "pain", "quality of life", and "postoperative complications", reflecting outcome-oriented evaluations.

In the network visualisation, terms are grouped into interconnected clusters, representing thematic proximity and co-authorship frequency:

a. *Yellow cluster* (central): Represents general clinical management including hemorrhoidectomy, hemorrhoids, complications, recurrence.

b. *Green cluster*: Procedural innovations like laser hemorrhoidoplasty, Doppler-guided, proctology, linked to minimally invasive techniques.

c. *Red cluster:* Focuses on ligation, THD, mucopexy, and anatomical aspects.

d. *Blue cluster*: Quality of life indicators, postoperative outcomes, surgical staplers, and rectovaginal fistula.

e. *Purple cluster*: Concentrated on stapled techniques and variations including stapled hemorrhoidopexy, conventional hemorrhoidectomy, ligasure.

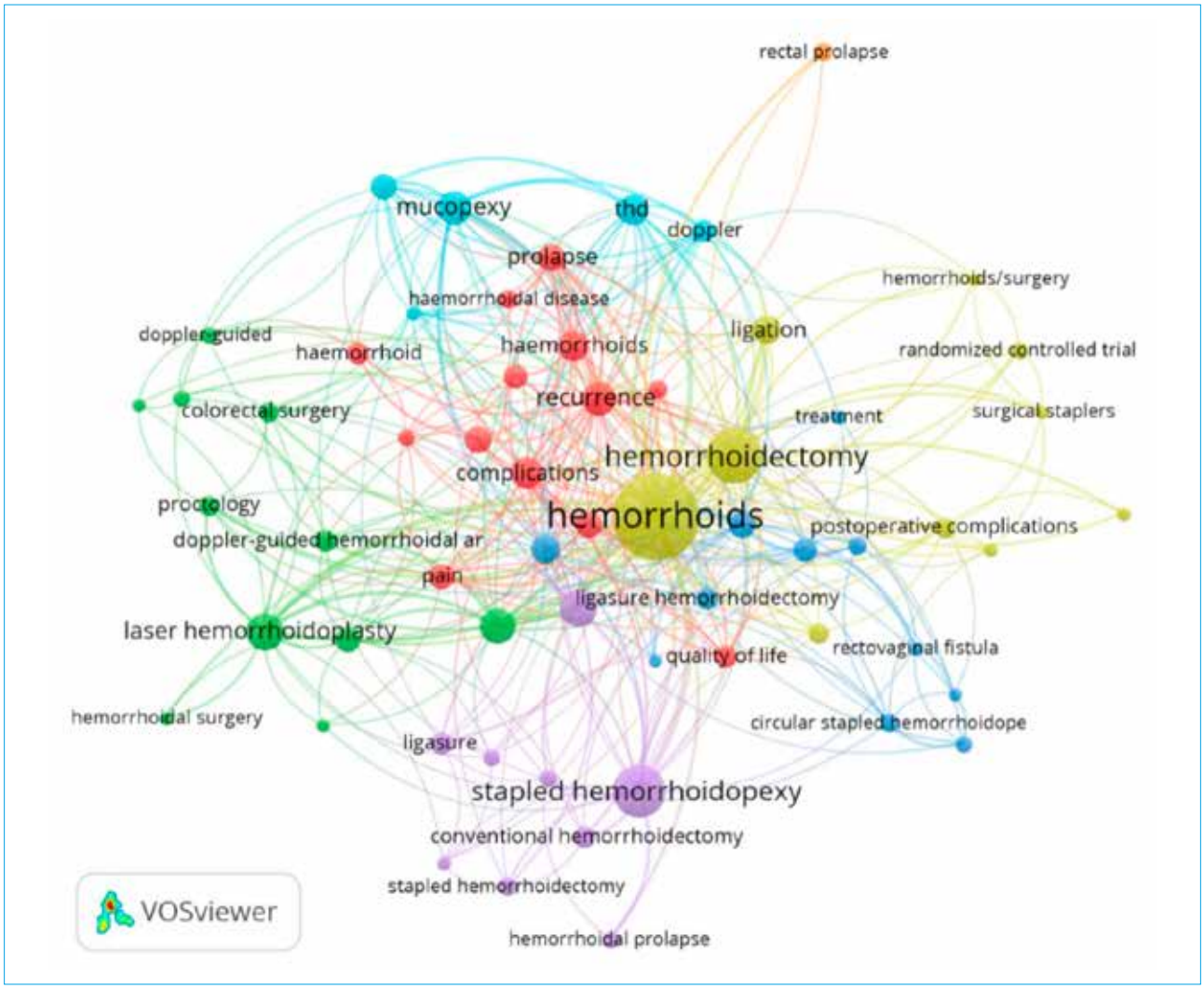

Figure 4. Keyword Co-occurrence Network Visualisation of innovative haemorrhoid treatment
Рисунок 4. Визуализация сети совпадений ключевых слов в публикациях по инновационному лечению геморроя

These clusters suggest an evolving and multidisciplinary approach that balances innovation with outcome monitoring. The overlay map (2018–2022) indicates the chronological evolution of key research topics. Earlier focus (dark blue/purple) was on stapled hemorrhoidopexy, ligation, and conventional hemorrhoidectomy. More recent keywords (bright green/yellow), such as laser hemorrhoidoplasty, quality of life, and doppler-guided techniques, suggest a shift towards patient-centred and minimally invasive care.

Discussion

This bibliometric analysis offers a comprehensive overview of global research trends in innovative haemorrhoid treatment modalities, namely laser haemorrhoidoplasty, stapled haemorrhoidopexy, and Doppler-guided haemorrhoidal artery ligation (DG-HAL) over the last decade. The results reveal several important patterns in scholarly output, authorship, collaboration, and thematic development. There has been a steady increase in the number of publications between 2015 and 2025, peaking in 2021. This aligns with the broader trend of minimally invasive techniques gaining popularity due to their reported benefits in postoperative recovery, pain reduction, and functional outcomes [9, 10]. The surge in interest may also reflect the rising demand for patient-centered care and outpatient-friendly procedures, particularly after the COVID-19 pandemic, which emphasised efficiency and short hospital stays in surgical planning [11]. The analysis highlights Italy as the dominant contributor, both in terms of publication volume and international collaboration. Italian institutions such as the University of Naples, Sapienza University of Rome, and the Catholic University of the Sacred Heart feature prominently. This reflects Italy's long-standing expertise in coloproctology and its role in refining and disseminating newer surgical

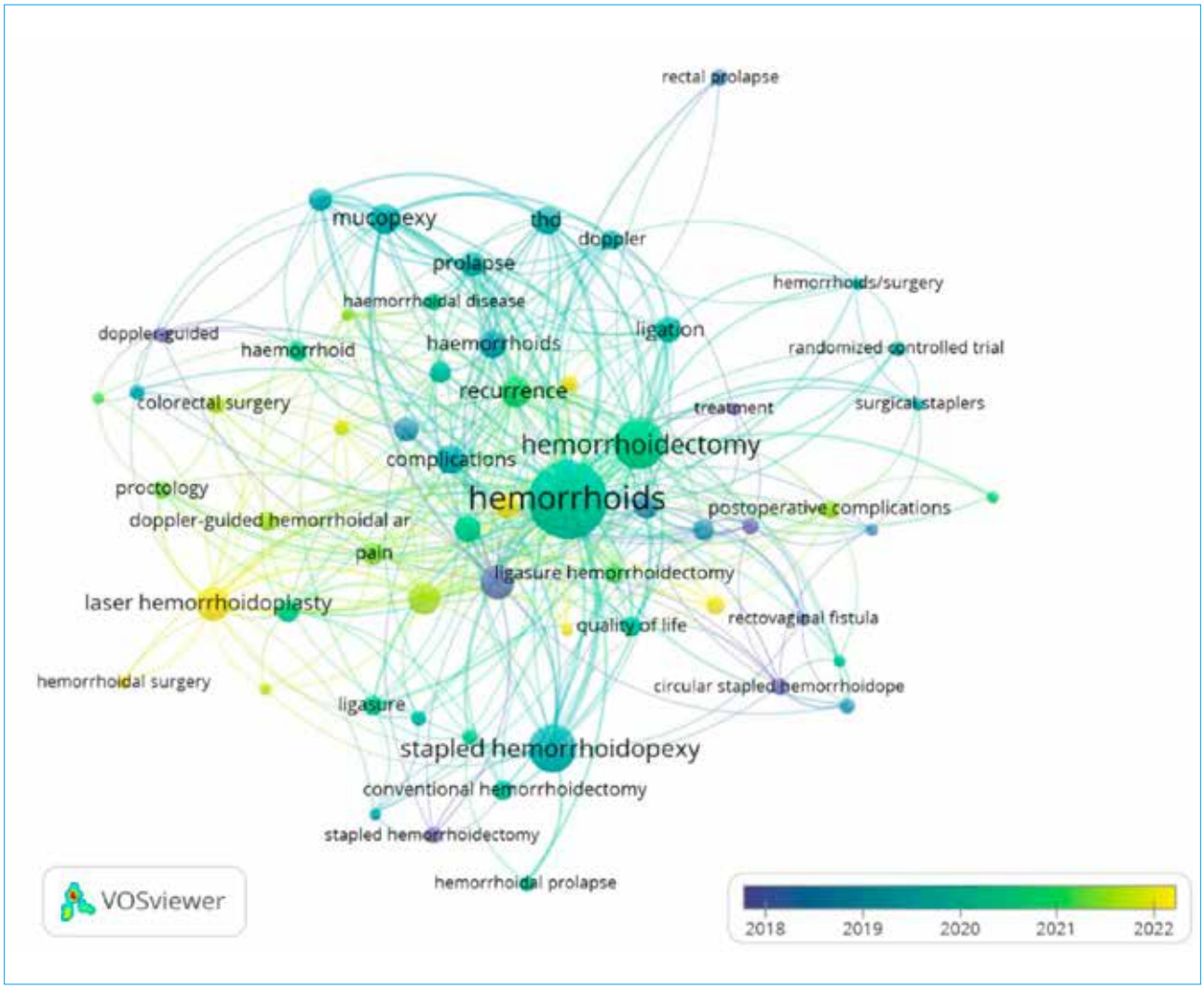

Figure 5. Keyword Overlay Visualisation by average publication year
Рисунок 5. Визуализация наложения ключевых слов по году публикации

techniques [12]. Other active countries include the United Kingdom, United States, and Germany, with recent emerging contributions from Egypt, Ireland, and Romania. However, there remains a notable disparity in research output from low- and middle-income countries (LMICs), despite the global prevalence of haemorrhoidal disease. This indicates potential barriers in technology access, funding, or academic infrastructure [13]. Authorship analysis revealed three major collaboration clusters centred around prolific Italian researchers such as Naldini, Sturiale, and Brusciano. These networks indicate tight intra-institutional collaboration but limited inter-cluster interaction. This siloed structure suggests an opportunity for increased multicentre and cross-border trials, which would enhance the generalisability of clinical outcomes [14]. The most cited articles included foundational clinical guidelines, systematic reviews, and landmark randomised controlled trials (RCTs) comparing stapled haemorrhoidopexy with conventional haemorrhoidectomy [15–17]. These high-impact papers shaped current surgical practice and demonstrate the continued relevance of evidence synthesis and guideline development. Laser haemorrhoidoplasty, a relatively newer technique has begun to appear in recently cited systematic reviews and meta-analyses, signifying its growing clinical acceptance and the need for long-term comparative data [18].

Keyword analysis revealed central themes such as “hemorrhoidectomy”, “recurrence”, “pain”, and “quality of life”. The overlay map confirmed a temporal shift from traditional excisional surgery to energy-based and Doppler-guided innovations, with terms like “laser hemorrhoidoplasty” becoming more prominent post-2020. This reflects a broader transition in surgical practice from purely anatomical excision to function-preserving, less traumatic interventions, as well as the integration of patient-reported outcomes into treatment evaluation [19]. Moreover, the growing use of terms such as “randomised controlled

trial" and "meta-analysis" indicates a methodological maturation in the field, shifting from observational reports toward higher levels of evidence. Despite advancements, recurrence, postoperative complications, and cost-effectiveness remain ongoing concerns [20]. Innovations like LigaSure and laser systems offer promising results, but they often require specialised equipment and training, potentially limiting their widespread adoption in resource-constrained settings [21].

Conclusion

This bibliometric analysis provides a comprehensive examination of global research trends in the field of innovative haemorrhoid treatment, specifically focusing on laser haemorrhoidoplasty, stapled haemorrhoidopexy, and Doppler-guided haemorrhoidal artery ligation over the past decade (2015–2025). The findings demonstrate a growing body of literature characterised by increasing publication volume, a shift toward minimally invasive and patient-centered techniques, and a concentration of scholarly output in high-income countries, particularly Italy. Thematic mapping revealed that research has evolved from traditional excisional approaches toward advanced technologies aimed at improving postoperative outcomes and quality of life. Co-authorship and institutional network analyses highlighted tightly clustered collaborations with opportunities for enhanced interregional and interdisciplinary research. Despite these advancements, key challenges remain, including variability in recurrence rates, accessibility in low-resource settings, and the need for robust cost-effectiveness data. To address these gaps, future research should prioritise multicentre trials, long-term outcome assessments, and broader international collaboration, especially involving low- and middle-income countries. These efforts are essential to ensuring equitable global access to effective and innovative haemorrhoid therapies.

Practical recommendations for surgeons

Based on the identified global research trends in innovative hemorrhoid treatment, several practical considerations can guide surgical practice:

1. **Adopt minimally invasive approaches where feasible:** Laser hemorrhoidoplasty and Doppler-guided hemorrhoidal artery ligation (DG-HAL) are increasingly supported by evidence for reduced postoperative pain and faster recovery, making them valuable alternatives to conventional excisional hemorrhoidectomy.

2. **Individualize technique selection:** No single technique suits all patients. Stapled hemorrhoidopexy may be advantageous in selected cases, particularly for circumferential prolapse, while laser and Doppler-guided methods are preferable for patients prioritizing rapid recovery and lower pain scores.

3. **Prioritize patient-centered outcomes:** Emerging research emphasizes quality of life, recurrence, and complication profiles. Surgeons should integrate these outcomes in preoperative counselling and shared decision-making.

4. **Consider cost-effectiveness and resource availability:** Advanced devices (laser, staplers, Doppler systems) may not be universally accessible, particularly in low- and middle-income settings. Careful assessment of institutional resources and patient affordability should guide implementation.

5. **Engage in continuous professional training:** The adoption of innovative methods requires adequate technical expertise. Surgeons should seek structured training and peer collaboration to ensure safe and effective practice.

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Проверка верстки и ее согласование с авторским коллективом: все авторы.

Submitted: 16.05.2025 Accepted: 19.07.2025 Published: 29.08.2025
Поступила: 16.05.2025 Принята: 19.07.2025 Опубликована: 29.08.2025

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