SYSTEMATIC REVIEW

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Incisional hernia after specimen extraction in minimally invasive gynaecologic surgery: a systematic review

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ABSTRACT

Background: The location and size of abdominal incisions to enable tissue extraction might increase the risk of incisional hernia (IH).

Objectives: To determine the reported incidence of IH after specimen extraction in gynaecological minimally invasive surgery.

Methods: On January 9th 2025 we performed a systematic literature review of PubMed, Embase, and Clarivate Analytics/ Web of Science Core Collection from inception to 25 May 2023. Minimally invasive surgery, IH, specimen extraction, morcellation and gynaecology were used as search terms. All cohort studies and randomised controlled trials reporting IHs after minimally invasive gynaecological surgery with either morcellation or abdominal specimen extraction through an enlarged trocar site or mini-laparotomy were included.

Main Outcomes Measures: The primary outcome was the incidence of IH. Secondary outcomes included incision length and location, time to diagnosis and risk factors for developing IH.

Results: Thirty one studies were identified, of which three retrospective cohort studies met the inclusion criteria. The reported incidence of IH was between 0.02% and 8.3%, with a time to diagnosis spanning two days to two and a half years. Data were lacking or insufficient on the size and location of the incision and on the technique used for specimen extraction.

Conclusions: There is a lack of evidence on the risk of developing IH in minimally invasive gynaecological surgery. Given the increasing use of minimally invasive surgical techniques, there is a pressing need for high-quality research on the prevalence and risk factors of IH, as well as on interventions aimed at mitigating this risk.

What is New? This review reveals a lack of high-quality evidence and consistent reporting on factors influencing IH after specimen extraction in minimally invasive gynaecological surgery.

Keywords: Minimally invasive surgery, morcellation, incisional hernia

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#Equal contribution and therefore qualify for joint first authorship

Introduction

Incisional hernias (IHs) are one of the most common complications after abdominal wall incisions. IH is defined as any abdominal wall gap with or without a bulge in the area of a postoperative scar, perceptible or palpable by clinical examination or imaging.[1] A meta-analysis of Bosanquet et al.,[2] including over 14,000 patients between 1980 and 2011, reported the incidence of IH to be 12.8% two years after midline laparotomy. Kossler et al.[3] performed a systematic review (SR) and meta-analyses including 24 trials and showed a significantly reduced incidence after laparoscopy (4.3%) compared to open abdominal surgery (10.1%). However, when a tissue extraction site was used, the incidence was comparable (5.5 vs. 7.8%)[3] IH can cause pain, small bowel obstructions, strangulation and incarceration.[4] The consensus European Hernia Society (EHS) and the American Hernia Society (AHS) guidelines recently recommended avoiding a midline incision for tissue extraction sites to reduce the risk of IH.[5]

In minimally invasive gynaecologic surgery (MIGS), specimen extraction can be performed through an incision in the abdominal wall or through a vaginal incision. Morcellation is a technique used to divide large masses of tissue that allows removal through a small incision and is an integral part of making MIGS possible.[6,7] A vaginal incision such as a colpotomy theoretically leads to a 0% chance of IH. Still, it can result in other complications such as vaginal cuff dehiscence, bladder injury, conversion to an abdominal incision for extraction and vaginal wall laceration.[8] When using an abdominal wall incision for specimen extraction, the options are either in-bag power morcellation, involving a trocar incision of 15 mm,[9] or cold knife morcellation, performed with a mini-laparotomy of 20-60 mm by either enlarging the incision of a trocar site or by creating a separate abdominal incision.[10]

Gynaecology is not represented in either of the Hernia Societies, nor in the presented guideline by the EHS and AHS. There are no guidelines or recommendations from the most common gynaecologic authorities on the incision other than "to perform a small incision" on the abdominal wall.[11,12] As specimen extraction is a common procedure in MIGS it may contribute to the overall incidence of IH. Specific characteristics of gynaecologic procedures involve the extraction of large specimens, including large uteri or fibroids, and often require morcellation techniques. This may result in longer or differently located incisions compared to other minimally invasive surgeries,[13] and may create a different force on the abdominal wall, which may all contribute to an additional risk for developing IH. Understanding the risk of IH in gynaecologic surgeries is important to continue MIGS procedures when specimen extraction is needed. There is a need for a targeted review to supplement the existing guidelines of the EHS and AHS. This study aims to determine the reported incidence and location of IH after specimen extraction in MIGS in the current literature, in addition to the current IH literature of other surgical specialties.

Methods

We systematically reviewed the literature on the incidence of IH in MIGS, an area in which focused data remains limited. In contrast, over the past six years, several SRs have addressed IH incidence in other surgical subspecialties, including urology, bariatric surgery, general surgery, and colorectal surgery.[14-17] Part of these studies have contributed to the development of international consensus guidelines of the EHS and AHS.[5] These previous studies have extensively covered the prevalence of IH within these other disciplines; therefore, our search strategy was deliberately tailored to gynaecology. Where relevant, the findings of this review will be compared with the data from SRs from other surgical specialties to identify broader trends and formulate recommendations for surgical practice.

Systematic Search

On January 9th 2025, we searched the electronic databases of PubMed, Embase, and Clarivate Analytics/Web of Science Core Collection from inception to January 9, 2025. We used all terms for minimally invasive surgery, IH, specimen extraction, morcellation, and gynaecology as search terms (Figure 1, Supplemental Figure 1a-c). No limitations on date or language were applied in the search. The protocol of this SR was prospectively registered in the PROSPERO registry under the identification number CRD42023486103.

Inclusion and Exclusion Criteria

Cohort studies and randomised controlled trials on MIGS, including abdominal specimen extraction reporting on IH, were included. Minimally invasive surgery was defined as either straight stick laparoscopy or robotic surgery. Studies that included patients who received chemotherapy or radiotherapy before surgery were excluded. Studies were excluded if they did not clearly state details on technical aspects of the incision of the

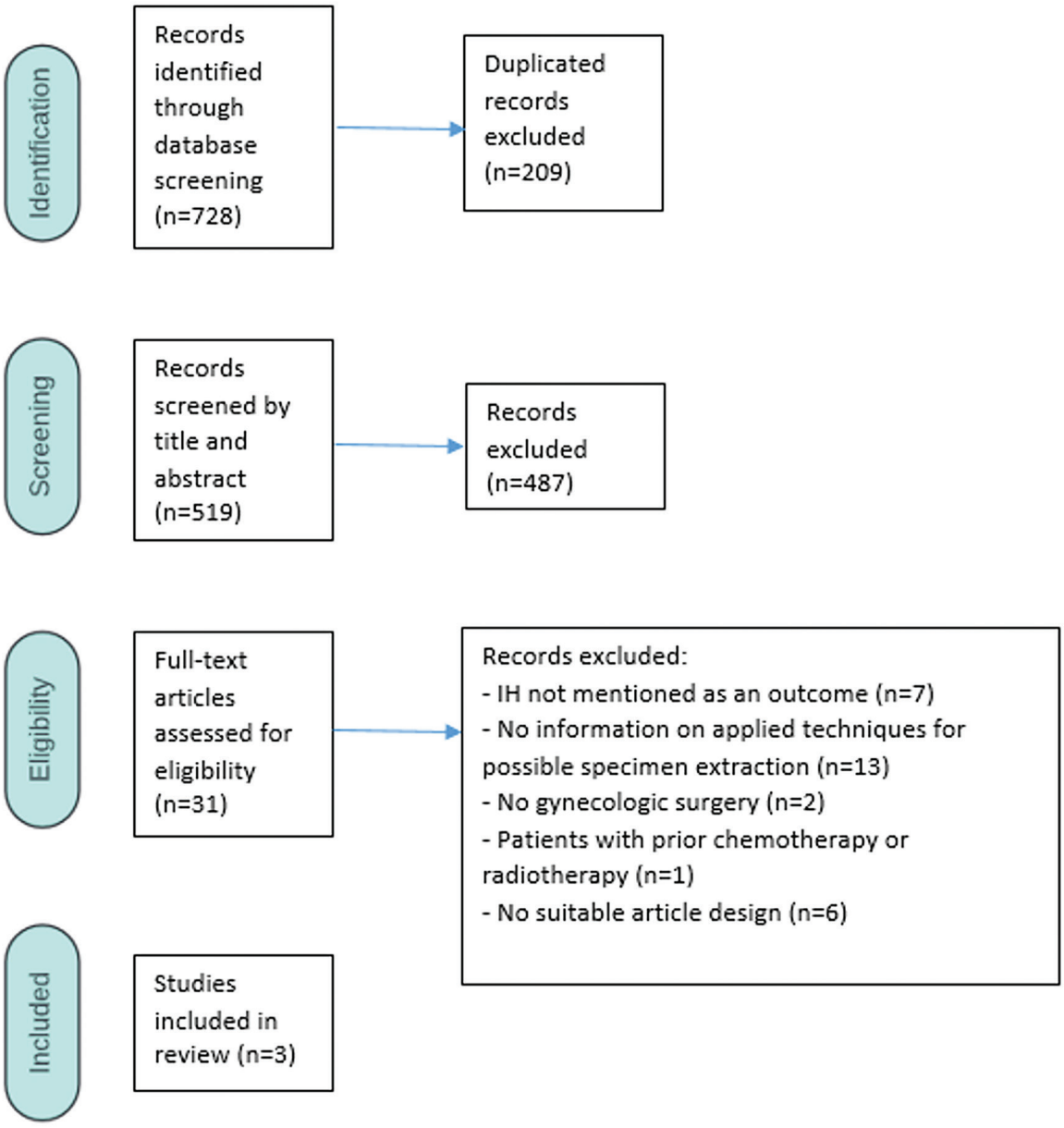

Figure 1. Prisma flowchart.

IH: Incisional hernia.

specimen extraction site (such as length or location), the extraction technique used, or when IH was inadequately reported.

Study Selection

Two independent reviewers (JvK and RV) reviewed all studies. The search results were screened for titles and abstracts. Screening the remaining articles for full text determined which studies could be included. The references of the included studies were reviewed for other suitable studies. Disagreements were resolved between the independent reviewers. A third reviewer (RdL) was available when consensus could not be reached.

Data Extraction

Data from the selected studies were extracted by two independent reviewers (Jvk and RV) using a pre-determined form, which included year of publication, study design, number of participants, and duration of follow-up. Several baseline characteristics were extracted from the included studies. Patient characteristics included age and body mass index. Surgical characteristics included the type of operation, location of the specimen extraction, length of the extraction incision, fascial closure techniques and the method used to diagnose IH. The primary outcome of this study was the incidence of IH.

Secondary outcomes include incision length and location, time to diagnosis of IH and risk factors for developing IH. Due to the limited number of studies and heterogeneity in study design, sample size, and outcome reporting, statistical pooling was not considered appropriate. Consequently, results were synthesised descriptively.

Risk of Bias Assessment

Two independent reviewers (JvK and RV) assessed the quality of selected papers using the Cochrane Risk of Bias[18] for randomised controlled trials and The Newcastle-Ottawa Scale[19] for non-randomised studies. If a study received a score of ≥6, it was considered a high-quality publication with a low risk of bias.

Results

The final search resulted in 782 articles, of which 519 remained after duplication. After reviewing the title and abstract, 31 studies were selected. After full-text screening, three studies met our inclusion criteria (Figure 1). No randomised controlled trials were performed on this subject. The selected studies included three retrospective single-centre studies, which included 374, 300, and 55,244 patients (Table 1).

Outcomes

Griffith et al.[20] conducted a retrospective cohort study with a follow-up period from 1 month to 3 years. They reported 374 patients who underwent laparoscopic myomectomy (43%), or hysterectomy (57%) followed by a mini-laparotomy for specimen extraction. A mini-laparotomy was defined as an enlarged or a new incision of 3 to 6 cm at either the umbilical or suprapubic site. Specimen extraction was performed using a contained hand morcellation technique with a scalpel. In total, 289 women (77.3%) underwent an umbilical mini-laparotomy and 85 women (22.7%) underwent a suprapubic mini-laparotomy. Incision size was significantly smaller in the umbilical group (3.3±0.8 cm vs. 4.2±0.6 cm; $P<0.001$). All mini-laparotomies were closed using a running or interrupted closure technique with slowly absorbable polydioxanone (PDS II, Ethicon) or polyglactin (Vicryl, Ethicon). Time to diagnosis was reported at 4 to 14 months, and the diagnosis of IH was either patient-reported or clinically diagnosed. The overall incidence of IH was reported to be 2.7% (n=10). There was no significant difference in IH incidence between the umbilical group (n=9, 3.1%) and the suprapubic group (n=1, 1.2%) ($P=0.833$).

Table 1. Study characteristics and patient characteristics.

Study	Study design	Number of patients	Follow-up time	Age (years)	BMI (kg/m²)
Griffith et al.[20]	Retrospective cohort study	374	1-3 years	Umbilical: Mean 43.4 (±8.9) Suprapubic: Mean 43.7 (±7.0) (*P*=0.782)	Umbilical: Mean 27.9 (±7.3) Suprapubic: Mean 27.7 (±6.2) (*P*=0.828)
Ustunyurt et al.[21]	Retrospective study	300	1 year	IH group: Mean 42.12 (±10.2) No-IH group: Mean 40.64 (±11.1) (*P*=0.520)	IH group: Mean 28.44 (±4.26) No-IH group: Mean 27.05 (±) (*P*=0.520)
Zhu et al.[22]	Retrospective single-center study	55244	1-21 years	IH group: Mean 53.4 (±19) No-IH group: No information	IH group: Mean 25.1 (range 17.6-34) No-IH group: No information

BMI: Body mass index, IH: Incisional hernia.

Ustunyurt et al.[21] performed a retrospective study, reporting the incidence of IH in 300 patients who underwent laparoscopic surgery for benign gynaecologic indications. No information on specimen extraction techniques was reported. There was a minimum follow-up of one year, with no maximum follow-up mentioned. The incidence of IH was 8.3% (n=25). Twenty three patients had IH at the umbilical site and two at the extra-umbilical site. Diagnosis of IH was made by physical examination combined with ultrasound examination, and time to diagnosis was reported as 12-29 months. No significant difference was found based on whether the trocar incision was enlarged, nor was information given on which incisions were enlarged. Parity ≥3 (P=0.018) and not closing the fascia (P<0.001) were identified as risk factors for developing IH.

Zhu et al.[22] performed a retrospective single-center study to assess the incidence of IH following conventional or single-port laparoscopic surgery (SILS) for benign gynaecologic indications. The study included 55,244 patients with a 1 to 21-year follow-up period. Details on surgical characteristics such as the location of specimen extraction, length of the extraction incision, or fascia closure techniques was not reported. The time to diagnosis of IH varied from 2 to 730 days, with diagnosis methods including physical examination, CT-scan, or ultrasound. Of the 55,244 patients, 0.016% (n=9) developed IH. Among those who developed IH, 5 cases were associated with the right lateral port, 4 involving specimen extraction. 4 developed IH at the umbilical port, of which 2 were associated with specimen extraction using SILS. Despite reporting the incidence of IH across different incision locations, the sample size was too small to determine any significance. The reported lengths of incisions varied among IH cases, including 2 cases with 5 mm ports, 5 cases with 10 mm ports, 1 SILS with a 40 mm incision, and 1 SILS with a 25 mm incision (Tables 2 and 3). An overview of which key surgical variable was reported and which variable was missing per included study is reported in Table 4.

Risk of Bias Assessment

The quality of each study was scored. The studies of Griffith et al.[20] and Zhu et al.[22] were considered fair quality, corresponding with 3-5 points on the Newcastle-Ottawa Scale for cohort and case-control studies. Ustunyurt et al.[21] was considered high quality, corresponding with a score of 6 (Table 5).

Discussion

Main Findings

This review aimed to provide an overview of the available literature on the risk of IH after specimen extraction in MIGS. Two cohort studies of fair quality and one of high quality were included in this review and reported an incidence of IH between 0.016% and 8.3%, with a time to diagnosis spanning two days to 2.5 years. Ustunyurt et al.[21] had an average time of follow-up of 16 months post-surgery. Griffith et al.[20] had a follow-up up to 3 years. Zhu et al.[22] had a minimum of 1-year follow-up, but no further distribution of follow-up time is known. Only one of the included studies reported on the size and location of the incision used for specimen extraction; the same study that reported routine fascia closure. None of the studies specified the use of morcellation techniques for specimen extraction. Ustunyurt et al.[21] diagnosed IH consistently with ultrasound; the other studies used self-reported questionnaires or medical records.

Strengths and Limitations

This SR addresses a timely and clinically relevant topic in MIGS. It was conducted according to a predefined protocol and used standard methodological tools for literature search, study selection, data extraction, and quality assessment, ensuring transparency and methodological rigor. Despite an extensive search, only three studies were identified that specifically reported on IH following specimen extraction in gynaecologic surgery. All included studies were retrospective in nature and exhibited substantial heterogeneity in study design, sample size, follow-up duration, and outcome reporting, including poor reporting on key surgical variables. Due to heterogeneity no pooled analysis could be performed and results were presented descriptively and should be interpreted with caution.

Strengths and Limitations Compared to Other Studies

Given the limited number of gynaecologic studies identified in our review, findings from other surgical specialties may provide indirect contextual insight. Several SRs have evaluated the incidence of IH following minimally invasive surgery in colorectal, urologic, general, and bariatric procedures.[15-17,23] In colorectal surgery, den Hartog et al.[24] included 36 studies assessing IH after specimen extraction, predominantly following segmental colon and rectal resections. Their analysis demonstrated a significantly higher incidence of IH after

Table 2. Surgical characteristics.

Study	Operation type and techniques	Location specimen extraction	Length incision	Time to diagnosis	Fascia closure	Diagnosis IH
Griffith et al.[20]	Laparoscopic or robotic-assisted hysterectomy (n=213) or myomectomy (n=161) combined with a mini-laparotomy made at the umbilical or suprapubic site Using contained hand morcellation with a scalpel	Umbilical mini-laparotomy: n=289, 77.3% Suprapubic mini-laparotomy: n=85, 22.7%	Umbilical mini-laparotomy: Mean 3.3 cm (±0.8) Suprapubic mini-laparotomy: Mean 4.2 cm (±0.6) (*P*<0.001)	4-14 months	Slowly absorbable Polydioxanone or Vicryl suture using a running or interrupted closing technique (100%)	Reported by patient Clinical diagnosis (specific method is not mentioned)
Ustunyurt et al.[21]	Cystectomy (33%) Hysterectomy (25.3%) Tubal ligation (19.3%) Myomectomy (7.6%) Salpingectomy (6.3%) Salpingo-oophorectomy (4.6%) Other (3.7%) No information on morcellation techniques	Per patient, 3 trocars: Umbilical, n=1 Lateral (6-7 cm from midline and 4-5 cm above symphysis), n=2	Per patient, 3 trocars: Umbilical 10/12 mm, n=1 Lateral 5 mm, n=2	12-29 months	Techniques not mentioned IH group: 40% fascia closure No-IH group: 82.2% fascia closure	Physical examination AND ultrasound
Zhu et al.[22]	Hysterectomy (18.6%) Adnexectomy (57.5%) Myomectomy (19.6%) Other (4.3%)	No information	No information	2-730 days	Not mentioned	Physical examination OR CT OR ultrasound

IH: Incisional hernia, CT: Computed tomography.

midline extraction compared with Pfannenstiel extraction [odds ratio (OR): 9.7, 95% confidence interval (CI): 5.0–18.8; *P*<0.001). This finding suggests that extraction site location may be an important determinant of hernia risk, a factor that may also be relevant in gynaecologic surgery.

In urology, Calcerrada Alises et al.[15] reviewed 84 studies involving multiport laparoscopic procedures with specimen extraction of kidneys, ureters, and bladder, reporting an overall IH incidence of 1.9%. However, information regarding incision length and the use of morcellation was not provided. Similarly, Jensen et al.,[16] in a review of 56 studies on laparoscopic cholecystectomy, reported a low overall IH incidence of 0.2%, without detailed data on incision length, extraction site location, or morcellation techniques. In bariatric surgery, Karampinis et al.[17] included 68 studies—primarily sleeve gastrectomy and gastric bypass procedures—and reported an overall IH incidence of 3.22%. The largest incision reported was 15 mm, with no specification of extraction site location, and morcellation was not performed in any of the included studies.

Across these reviews, follow-up duration was inconsistently reported; only den Hartog et al.[24] specified a follow-up period of five years. Hernias were generally diagnosed through clinical examination and/or imaging [ultrasound or computed tomography (CT)], yet differences in detection rates by modality were not reported.

A related observation comes from SILS, which involves a larger (2-4 cm) umbilical incision without necessarily including specimen extraction. A recent SR including 2471 patients demonstrated higher odds of IH after SILS compared with conventional laparoscopy (OR: 2.37, 95% CI: 1.25–4.50, *P*=0.008).[14] Since enlarged umbilical incisions are also common for specimen extraction in

Table 3. Study outcomes.

Study	Incidence of IH	Location of IH	Length incision in IH group	Weight of extracted specimen	Enlarged incision (yes)	Risk factors
Griffith et al.[20]	10/374 patients (2.7%)	Umbilical: n=9 (90%) Suprapubic: n=1 (10%) (*P*=0.833)	Not mentioned	Umbilical: 472.6 gr (±357.1) Suprapubic: 683 gr (±475.7) (*P*<0.001)	Mini-laparotomy is defined as a new or enlarged incision to 3-to-6 centimeters long	Age, surgeon, mini-laparotomy size, specimen weight, operative time and BMI = all not significant
Ustunyurt et al.[21]	25/300 patients (8.3%)	Umbilical: n=23 Lateral: n=2 *P=not mentioned*	Not mentioned	Not mentioned	IH group: n=1 (4%) No IH group: n=37 (12.7%) (*P*=0.223) Size is not mentioned	Parity ≥3 (*P*=0.018) Not closing the fascia (*P*<0.001)
Zhu et al.[22]	9/55.244 patients (0.016%) Operation type has no significant effect on IH incidence (*P*=0.626)	Umbilical: n=4 (with specimen extraction: n=2) Lateral: n=5 (with specimen extraction: n=4) *P=not mentioned*	5 mm: n=2 10 mm: n=5 SILSs 40 mm: n=1 SILSs 25 mm: n=1	Not mentioned	Not mentioned	Age >60 years (*P*=0.008) SILS (*P*=0.003)

IH: Incisional hernia, SILS: Single-port laparoscopic surgery, BMI: Body mass index.

MIGS, the risk of IH may be comparable. While different surgical forces may explain SILS-related risk, specimen extraction in conventional laparoscopy–especially with cold knife morcellation–can similarly stress the fascia.

However, these data from colorectal, urologic, bariatric surgery and SILS represent indirect evidence. Differences in patient population, specimen characteristics, operative technique, and wound closure limit direct extrapolation to gynaecology. These findings should therefore be considered hypothesis-generating rather than practice-changing, reinforcing the need for gynaecology-specific prospective studies.

In MIGS, the umbilicus is often chosen for specimen extraction since the incision can be concealed and avoids an additional incision. If IH occurs, it often presents beyond routine gynaecologic follow-up and is managed by general surgeons, reducing specialty-specific awareness. Given that mean time-to-diagnosis has been reported at 11.1 months,[25] with only 31.5% occurring within six months and approximately 50% after one year,[26] short follow-up likely leads to under-ascertainment. Moreover, imaging modalities, particularly CT and ultrasonography, substantially increase the detection of IH compared with clinical examination alone.[27] Variable follow-up duration and inconsistent diagnostic reporting across studies therefore likely underestimate true IH incidence and limit cross-specialty comparability. Although direct comparison with other surgical fields and techniques is limited, there is some overlap, specifically with colorectal surgery that allows insight from a broader surgical field which highlight the potential relevance of extraction site characteristics and surgical technique in development of IH.

Clinical and Policy Implications

Even though the recent recommendation of EHS and AHS to avoid a midline incision for specimen extraction,

Table 4. Availability of key variables in included studies.

Study	Specimen size	Extraction site	Incision length	Fascial closure technique	Use of morcellation	Surgeon experience
Griffith et al.[20]	✓	✓	✓	✓	✗	✗
Ustunyurt et al.[21]	✗	✓	✓	✓	✗	✗
Zhu et al.[22]	✗	✗	✗	✗	✗	✗

Table 5. Newcastle-Ottawa Scale assessment.

Cohort studies									
	Selection				Comparability	Outcome			
Study, year (ref)	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study	Comparability of cohorts based on the design or analysis	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow-up of cohorts	Total
Griffith et al.,[20] 2018	1	0	1	1	1	0	0	0	4
Ustunyurt et al.,[21] 2020	1	0	1	1	1	1	1	0	6
Zhu et al.,[22] 2019	0	0	0	1	0	1	1	0	3

and the presented increased risk of IH in colorectal surgery and SILS that endorses avoiding an umbilical incision for specimen extraction, there remains a notable lack of evidence specifically addressing the risk of IH in MIGS. Given the increasing use of minimally invasive surgical techniques, there is a pressing need for high-quality research on the prevalence and risk factors of IH, and to evaluate strategies for its prevention.

Unanswered Questions and Future Research

There is a need for more robust, standardised reporting within this field, including the size and location of the extraction incision and the technique of morcellation used. In addition, a long-term follow-up is needed to better understand the potential impact of specimen extraction in MIGS procedures on the risk of IH. For future research, we suggest an international prospective cohort study with a follow-up time of at least five years, using a standardized, accurate method such as ultrasound or CT for diagnosing IH. A prospective design allows for the collection of appropriate surgical details and close monitoring of the incidence and risk factors of IH.

Conclusion

Even though the recent recommendation of EHS and AHS to avoid a midline incision for specimen extraction, and the presented increased risk of IH in colorectal surgery and SILS that endorses avoiding an umbilical incision for specimen extraction, there remains a notable lack of evidence specifically addressing the risk of IH in MIGS. Given the increasing use of minimally invasive surgical techniques, there is a pressing need for high-quality research on the prevalence and risk factors of IH, as well as on interventions aimed at mitigating this risk.

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Supplementary Figure: https://d2v96fxpocvxx.cloudfront.net/37eae217-e8b5-4f55-976f-35df98003e83/content-images/d009762d-d577-4863-bbfc-cf1c500f6dc6.pdf

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