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Outcomes of Minimally Invasive versus Open Surgery for Incarcerated or Strangulated Abdominal Wall Hernia Repair

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Abstract

Emergency repair of acutely incarcerated or strangulated abdominal wall hernias requires prompt reduction, assessment of bowel viability and definitive repair, with the operative approach influenced by the patient's physiological condition, the degree of contamination and the need for bowel resection. This narrative review examines outcomes of minimally invasive surgery (MIS) compared with open repair, focusing on feasibility, postoperative outcomes, patient selection, mesh use and surgical expertise. The available literature suggests that laparoscopic repair, particularly transabdominal pre-peritoneal (TAPP) repair for groin hernias, is feasible in selected patients and may be associated with shorter hospital stays and fewer wound complications. MIS can also permit direct assessment of bowel viability and, in appropriately equipped and experienced centres, bowel resection when required. However, suspected ischaemia or the need for resection demands careful assessment, and perforation, generalised peritonitis, extensive contamination, haemodynamic instability or inadequate laparoscopic access may favour open surgery or prompt conversion. Mesh may reduce recurrence in selected emergency repairs, although infection risk becomes more relevant with bowel resection and contamination. Interpretation of comparative outcomes is limited by predominantly retrospective evidence, selection bias, variation in hernia types and operative techniques, and inconsistent long-term follow-up. Current evidence therefore supports MIS as a selective option rather than a universally superior approach. Prospective multicentre studies with standardised definitions and long-term assessment of recurrence, reoperation, chronic pain and functional recovery are needed.

Keywords: Emergency hernia repair; incarcerated hernia; strangulated hernia; minimally invasive surgery; laparoscopy; open repair; mesh; bowel resection.

Abbreviations: MIS, minimally invasive surgery; TAPP, transabdominal pre-peritoneal; TEP, totally extraperitoneal repair; WSES, World Society of Emergency Surgery; rEVHR, robotic emergency ventral hernia repair; IPOM+, intraperitoneal onlay mesh repair with defect closure; SSI, surgical site infection; LOS, length of stay; RCT, randomised controlled trial; PROMs, patient-reported outcome measures.

Introduction

Abdominal wall hernias are classified according to their location and include groin hernias, such as inguinal and femoral hernias, and ventral hernias, including umbilical and incisional hernias. Most undergo planned elective repair; however, acute incarceration or strangulation requires urgent surgical management. An incarcerated hernia cannot be reduced back into the abdominal cavity and may cause mechanical bowel obstruction. Strangulation occurs when the blood supply to the trapped contents is compromised. Prolonged obstruction or persistent hypoperfusion can progress to bowel necrosis, perforation and peritonitis. Delays in treatment have been associated with increased postoperative morbidity and mortality [6,12]. The goals of emergency surgery are therefore to reduce the herniated contents, assess tissue viability, resect non-viable bowel where necessary and achieve definitive hernia repair [2,4,6,12].

Historically, open surgery has been the standard approach for emergency hernia repair. Open techniques have evolved from Bassini, Shouldice and McVay repairs to the widely used mesh-based Lichtenstein repair [6]. Direct exposure allows reduction of the hernia contents, assessment of bowel viability and definitive repair, with access for primary fascial closure or mesh placement [4,7]. Minimally invasive surgery (MIS) has become an alternative, supported by advances in laparoscopic techniques and accumulated surgical experience [1, 4].

The choice of approach depends on more than the hernia itself. Bowel viability, the need for resection, the extent of contamination and the patient's physiological condition all influence operative planning. Incarceration without bowel injury generally constitutes a clean field, whereas bowel resection without gross enteric spillage is classified as clean-contaminated. Gross gastrointestinal spillage creates a contaminated field, while perforation with peritonitis constitutes a dirty or infected field. These distinctions affect the suitability of permanent synthetic mesh, alternative materials or delayed definitive repair. Reduction alone also does not guarantee recovery of intestinal perfusion, making reassessment essential. Diagnostic laparoscopy may be useful when a strangulated groin hernia reduces spontaneously before surgery, as the previously compromised bowel can still be inspected. Conversely, severe bowel distension, dense adhesions, perforation, extensive contamination and haemodynamic instability may limit laparoscopic access or favour open surgery [2,4,6,12].

For ventral and incisional hernias, laparoscopic repair commonly involves intraperitoneal onlay mesh placement, sometimes combined with primary fascial closure. When bowel resection is required, it may be performed intracorporeally, through a small incision or following conversion to open surgery

[6]. The principal laparoscopic techniques for groin hernias are TAPP and totally extraperitoneal repair (TEP). TAPP allows direct inspection of the abdominal cavity, reduction of incarcerated contents and assessment of bowel viability before mesh placement in the preperitoneal space. TEP avoids entering the peritoneal cavity, but this limits direct assessment of intra-abdominal bowel when ischaemia is suspected [4,6,7].

This review examines outcomes of minimally invasive versus open surgery in adults undergoing emergency or urgent repair of acutely incarcerated or strangulated abdominal wall hernias. Particular attention is given to feasibility, postoperative outcomes, bowel viability, the need for resection, contamination, hernia location, patient selection and surgical expertise.

Section I. Factors Affecting the Feasibility of MIS

1. Bowel ischaemia and the need for bowel resection

Suspected bowel ischaemia or the need for resection does not necessarily preclude MIS in emergency hernia repair. However, it changes the operative priorities: reduction must be achieved without further injury, bowel viability must be established, and contamination must be controlled. Conversion to open surgery remains necessary when these objectives cannot be achieved safely through the laparoscopic approach [2,3,4,6,10,12]. Laparoscopy can facilitate controlled reduction and direct inspection of the affected bowel, but viability assessment may be difficult immediately after release of the constricting defect [3,4,10,12].

Discolouration and absent peristalsis do not always indicate irreversible damage and should not, in isolation, determine the need for resection. Assessment should consider the overall appearance of the bowel, mesenteric pulsation and peristalsis where these can be reliably evaluated. When viability remains uncertain, reassessment after reduction and a period of reperfusion may help distinguish reversible ischaemia from irreversible injury. Correcting reversible causes of impaired perfusion, including hypotension and hypoxia, is also important [2,10]. Indocyanine-green fluorescence and Doppler assessment may provide additional information where available, although there is insufficient evidence to establish either as a routine requirement.

Bowel that recovers adequate perfusion may be preserved, whereas persistent evidence of irreversible ischaemia or established necrosis warrants resection. Resection should not be delayed in an attempt to maintain a minimally invasive approach [4]. Reduction is particularly important when the bowel is oedematous or the hernia neck is tight. Excessive traction can cause bowel injury and enteric spillage; gentle manipulation, controlled external compression and, where necessary, enlargement of the constricting defect under direct vision may facilitate reduction. The appropriate manoeuvre depends on the hernia anatomy and should not be generalised to all groin hernias. Severe bowel distension can further restrict working space, and decompression may be considered in selected cases when it can be performed without compromising contamination control [2,10,12,14].

When resection is necessary, it can be performed intracorporeally or through a small incision with laparoscopic assistance. Intracorporeal resection maintains minimally invasive access but requires appropriate expertise and careful control of enteric contents. Extracorporeal resection allows direct

handling of the bowel through an incision, although the additional incision may increase wound-related morbidity [4,7,10,12]. Both approaches have been described, but the available evidence does not establish the superiority of either technique [2,4,6,7,10]. The studies in reference [6] reported laparoscopic bowel resections performed intracorporeally or through an enlarged umbilical incision, as well as procedures involving conversion, with generally favourable outcomes. In one comparative series involving groin and ventral hernias, 13% of patients treated laparoscopically required resection of necrotic tissue, with low complication rates and no reported mesh infections [4]. Another high-volume centre performed segmental enterectomy through a small umbilical incision when bowel viability failed to recover [7].

Although these findings suggest that laparoscopic repair may be feasible when bowel resection is required, the evidence remains largely observational. The WSES guidelines favour open repair when strangulation and bowel resection are suspected [12]. Planned diagnostic laparoscopy may nevertheless be reasonable in a stable patient with suspected but unconfirmed bowel compromise when the surgeon can safely perform or facilitate resection and is prepared to convert promptly [4,6]. Extensive necrosis, difficult resection, inadequate visualisation, uncertain bowel viability or an inability to perform safe reconstruction should prompt conversion or primary open surgery [4,6,12].

The degree of contamination has a major influence on operative planning. Favourable outcomes reported in laparoscopic series largely concern selected patients without diffuse peritonitis or significant enteric contamination [6,7]. In the study reported in reference [7], patients with bowel perforation or peritonitis were excluded from the comparison of definitive hernia repairs. Contamination was managed separately through drainage, lavage and bowel resection, with definitive mesh repair postponed because the local conditions were considered unsuitable [7]. These results should not be generalised to heavily contaminated or dirty operative fields.

Bowel resection and gross contamination should be considered separately. According to the WSES guidelines, synthetic mesh may be used in a clean-contaminated field involving strangulation or bowel resection when there is no gross enteric spillage. Contaminated and dirty fields require a different approach based on the extent of contamination and infection [12]. A systematic review also reported low mesh-related complication rates after selected bowel resections, but identified haemodynamic instability and peritoneal contamination as circumstances in which open surgery may be preferable [6].

Overall, bowel ischaemia and the need for resection do not automatically rule out MIS. The more important considerations are whether bowel viability can be assessed adequately, resection can be performed safely and contamination can be controlled while achieving an appropriate hernia repair. The operative approach should remain flexible, with timely conversion when these objectives cannot be met laparoscopically [2,3,4,6,10,12].

2. Conversion to open surgery

Conversion remains an important part of emergency MIS when bowel viability cannot be established reliably or when resection and contamination control cannot be managed safely laparoscopically

[2,3,4,10,12]. Other reasons include failure of reduction, severe bowel distension, dense adhesions, distorted anatomy, haemodynamic instability and intolerance of prolonged pneumoperitoneum [10,12]. Conversion should not be regarded merely as a technical failure. During TEP repair, difficult dissection, extensive peritoneal disruption and loss of the operative space have been reported as reasons for abandoning the laparoscopic approach. A series involving a newly qualified surgeon recommended conversion when difficult dissection increased the risk of vascular or visceral injury and cautioned against switching to a different laparoscopic technique with which the surgeon was less familiar [19,21].

Conversion rates must be interpreted in relation to the population studied. Lai et al. reported a pooled conversion rate of 2.78% across five studies of emergency laparoscopic groin hernia repair, but this estimate should not be extrapolated to all emergency hernias, particularly those with confirmed strangulation or more complex operative findings [2]. Deeba et al. reported six conversions among 328 patients, with reasons including severe bowel distension, extensive adhesions, unexpected anatomy, bowel injury and the need for additional procedures [8]. Conversion may be more frequent in cohorts specifically involving strangulated hernias. Gökdere and Kesikli initially attempted TAPP in 62 patients with strangulated inguinal hernias, of whom 11 (17.7%) required conversion because safe laparoscopic reduction was not possible [10]. This difference highlights the importance of distinguishing broadly incarcerated hernias from cases involving more advanced visceral compromise.

Open access remains appropriate when reduction cannot be achieved safely, distension or adhesions prevent adequate visualisation, or perforation and extensive contamination make laparoscopic repair impractical [2,7,8,16]. The decision should also account for the surgeon's competence and the resources immediately available. In robotic emergency repair, limited experience in troubleshooting may result in conversion only after the patient has already been exposed to the additional operative time and risks of the minimally invasive approach [25]. Recognising these limitations early may allow the surgeon to choose open repair from the outset or convert before technical difficulties increase the risks. Experience therefore influences not only the ability to perform MIS but also the judgement required to decide when it should not be pursued. Evidence from elective TAPP procedures suggests that standardised technique and experienced supervision contribute to reproducible repair, although these findings cannot be directly extrapolated to emergency strangulated hernias [18].

3. Does Hernia Type Affect the Choice of Approach?

The outcomes of emergency MIS cannot be interpreted adequately without considering hernia type. Groin hernias, including inguinal and femoral hernias, differ from ventral hernias in anatomy, operative technique and the likelihood of bowel compromise. For groin hernias, laparoscopic repair commonly involves TAPP or TEP, with mesh placed in the preperitoneal plane. Emergency ventral hernia repair may instead involve IPOM+, while open repair allows mesh placement in different tissue planes depending on the defect and operative findings [1,2,6]. These differences affect the interpretation of evidence on bowel resection, contamination and mesh-related complications.

A single-centre series that included both groin and ventral hernias reported bowel resection rates of 13% and 28%, respectively, using TAPP for groin repairs and IPOM+ for ventral repairs [15]. These results cannot be generalised across all emergency hernias, but they illustrate why anatomical site and operative technique should be reported separately when comparing MIS with open repair.

Femoral hernias deserve particular attention because they are more likely than inguinal hernias to present with obstruction, strangulation and a need for bowel resection. Brown et al. reported bowel resection in 14.7% of femoral hernias compared with 3.5% of inguinal hernias [24]. This does not mean that femoral hernias should routinely be treated by open surgery, but the greater likelihood of compromised bowel should be considered when planning the operation.

Overall, findings from groin hernia repair should not automatically be extrapolated to ventral or incisional hernias. Differences in anatomy, defect size, repair technique and contamination risk make separate assessment necessary.

4. Surgeon Experience, Training and Centre Volume

Surgeon experience is an important consideration when assessing emergency minimally invasive hernia repair. Laparoscopic hernia repair has a measurable learning curve, and outcomes vary depending on the stage of training. Most evidence on the learning curve concerns elective inguinal hernia repair rather than emergency incarcerated or strangulated hernias [17 -21]. This evidence helps explain why established expertise may influence emergency MIS, but it does not directly establish the level of experience required for cases involving ischaemic bowel, contamination or resection.

Evidence from emergency robotic ventral hernia repair offers more direct, although limited, support for this argument. In a retrospective single-centre study involving three experienced surgeons, the choice between open and robotic emergency repair depended on each surgeon's expertise with the relevant technique [25]. The study was small and susceptible to selection bias, limiting the generalisability of its findings. The authors also suggested that prolonged operating times during the robotic learning curve could lead surgeons with less experience to favour open repair in emergency cases [25]. This illustrates how expertise can influence both the selection of an operative approach and its feasibility.

The available evidence does not establish a number of elective procedures after which a surgeon can be considered competent to perform MIS for a strangulated hernia. It instead suggests that emergency MIS depends partly on technical skills acquired before the surgeon encounters the additional demands of an acute presentation.

Laparoscopic inguinal hernia repair requires familiarity with posterior inguinal anatomy, precise dissection within a restricted working space, and the ability to manage peritoneal tears, loss of the operative field and mesh placement near major vessels and visceral structures [17,19,21]. Proficiency therefore cannot be defined simply by the number of operations performed. Studies have assessed the

learning curve using operative time, conversion, complications and recurrence, but the number of procedures associated with proficiency varies considerably [17,20].

A systematic review of 22 studies involving 4,011 patients reported a median learning-curve threshold of 35.7 procedures: 34.15 for TEP or single-incision TEP and 37.5 for TAPP [17]. Meta-regression suggested that approximately 32.5 procedures were required to reach an initial plateau in operative time by 2020, although thresholds varied according to technique, study period and the definition of proficiency [17]. Some individual studies reported longer learning curves. In an unsupervised single-surgeon TEP series, operating time stabilised after approximately 60 cases [19]. A high-volume centre using a structured TAPP training pathway considered approximately 100 progressively more difficult repairs necessary before independent proficiency was achieved [20]. In another series, a newly qualified surgeon's operating time improved after 18 selected unilateral primary repairs, although proficiency in avoiding major complications did not necessarily imply equivalent competence in managing minor morbidity or complex cases [21].

These differences make it difficult to establish a single learning-curve threshold. Previous laparoscopic experience, anatomical knowledge, the technique used, case complexity, supervision, standardisation and the criteria used to assess proficiency all contribute [17, 19, 20, 21].

The available literature supports supervised, staged training rather than unsupervised acquisition of laparoscopic hernia skills. In a high-volume TAPP programme, trainees were required to understand laparoscopic anatomy and procedural difficulties, assist with the camera during at least 50 TAPP operations, complete at least 20 laparoscopic cholecystectomies and demonstrate competence in individual operative steps before undertaking a complete repair [18]. Their operations were supervised by an experienced laparoscopic surgeon, and some operative recordings were subsequently reviewed by the team [18]. Trainees achieved a recurrence rate of 0.4% and morbidity of 3.2%, with no significant differences from experienced surgeons, although their operating times remained longer [18].

Another high-volume centre used a stepwise TAPP training pathway, beginning with repeated peritoneal closure, followed by mesh placement and closure, before progressing to complete repairs under expert supervision [20]. Trainees first performed at least 50 relatively simple repairs and then another 50 of increasing complexity before progressing to independent practice [20]. This approach treats proficiency as the gradual acquisition of individual technical skills rather than a single transition from observation to independent operating.

Supervision may be particularly important during early TEP experience. The unsupervised series reporting a 60-case learning curve found that experienced supervision during the initial cases could reduce operating time and help prevent complications [19]. Similarly, the series involving a newly qualified surgeon found acceptable rates of major complications, conversion and recurrence following standard surgical training, but suggested that additional supervision might reduce minor complications and operating time [21]. Workshops, courses, teaching videos and simulation can supplement this process, but the studies did not consider them substitutes for operative experience and mentorship [20,21].

These findings support structured training in laparoscopic hernia repair, but they do not establish that the same training thresholds are sufficient for emergency cases. Incarceration, ischaemic bowel, contamination and the potential need for resection introduce additional demands that are not adequately assessed by elective learning-curve outcomes.

Centre volume may influence outcomes by creating the conditions for repeated practice, supervision, standardised procedures and ongoing outcome monitoring. The TAPP training programme reported by a high-volume institution operated on approximately 1,100 -1,200 inguinal hernias annually and had more than 15,000 TAPP procedures recorded in its database [18]. Another centre had more than 30 years of experience in laparoscopic hernia surgery and had performed over 3,500 procedures [20]. These settings supported repeated exposure, expert supervision, gradual progression to more complex cases and the development of standardised techniques [18,20]. However, the available studies do not establish that volume independently improves outcomes in emergency hernia repair.

Standardisation may reduce variation during the learning phase. In the high-volume TAPP series, recurrence and complication rates decreased after the operative technique was standardised [20]. The authors identified three prerequisites for introducing TAPP into training: the procedure should already be established in routine clinical practice, the technique should be strictly standardised, and a structured educational programme should be available [20]. However, these institutional series cannot determine whether improved outcomes resulted from centre volume itself or from surgeon experience, case selection, specialist staffing, standardisation or other institutional resources.

Overall, the available evidence suggests that surgeon experience, supervised training, procedural standardisation and institutional readiness are closely related factors affecting the feasibility of emergency MIS. It does not establish a minimum number of elective procedures that guarantees competence in strangulated hernia repair, nor does it demonstrate that high centre volume alone improves emergency outcomes. Rather, emergency MIS should be undertaken where the relevant technique is established, appropriate supervision and trained personnel are available, and the team is prepared to convert promptly when safe progression is not possible [17 -21,25].

Section II. Mesh Use in Emergency Hernia Repair

Mesh use in emergency hernia repair requires balancing the recurrence benefit of reinforcement against the risks of surgical site infection (SSI), mesh infection and possible mesh removal. The decision depends on the hernia type, bowel viability and degree of contamination, particularly whether bowel resection, perforation or significant intestinal spillage has occurred. The evidence differs between groin and ventral hernias and becomes less certain as the operative field progresses from clean to clean-contaminated or contaminated/dirty [12,26].

The WSES guidance distinguishes bowel resection without gross enteric spillage from cases involving gross contamination or established infection [12,14]. In a clean field, synthetic mesh is generally

supported. In clean-contaminated cases involving strangulation or bowel resection without gross spillage, mesh may still be appropriate in selected patients. In contaminated, dirty or infected fields, source control takes priority, and primary repair or an alternative or staged approach may be more appropriate, depending on the defect and degree of contamination [2,3,12,14]. Synthetic mesh should therefore not be regarded as categorically contraindicated whenever bowel resection is performed. Equally, the absence of a resection does not, by itself, establish that mesh implantation is safe. The operative field and the patient's condition must guide the choice of repair [12,14].

Groin hernias

For acutely incarcerated or strangulated groin hernias, available evidence generally favours mesh over primary tissue repair because of lower recurrence, although the certainty of evidence is limited. The 2025 EAST systematic review and meta-analysis favoured mesh over tissue repair, finding lower recurrence with mesh (OR 0.34, 95% CI 0.13 -0.87; p=0.02), while acknowledging that the underlying evidence was retrospective and of very low quality [3]. Another meta-analysis involving 12,402 patients also found significantly lower recurrence with mesh (OR 0.36, 95% CI 0.19 -0.67; p=0.001; I^2=35%), without an overall increase in SSI or other significant complications [9]. In clean emergency groin repairs, incarceration or strangulation alone should therefore not exclude mesh use, particularly when the bowel remains viable [3,9].

The infection risk becomes more relevant when bowel resection is required. Although the same meta-analysis found no overall increase in SSI, mesh was associated with increased SSI in the bowel-resection subgroup (OR 1.74, 95% CI 1.04 -2.91; p=0.04; I^2=9%) [9]. This supports distinguishing uncomplicated incarceration from cases involving bowel necrosis or resection. Findings from individual studies are less consistent: some reported similar or lower wound infection rates with mesh, whereas others identified bowel resection as an important risk factor for infection [14,23]. In a study of 166 emergency incarcerated hernia repairs, bowel resection was identified as a risk factor for SSI. The overall SSI rate was 4.8%, although the authors reported that mesh could still be used when bowel resection was required [14].

Reported outcomes from individual mesh series have generally shown low recurrence and acceptable wound infection rates, with recurrence ranging from 0 -4% and wound infection from 0 -10% [23]. In a study of incarcerated paraumbilical hernias, recurrence was not observed after mesh repair, compared with 19% after tissue repair; wound infection rates were 9.5% and 14.3%, respectively [23]. Similarly, among patients undergoing repair of strangulated inguinal hernias, wound infection occurred in 6% after mesh repair compared with 10% after Bassini repair, while recurrence rates were 3% and 5%, respectively [23]. These findings should be interpreted in the context of the individual study populations and the selection of patients considered suitable for mesh repair.

Mesh infection should be distinguished from superficial SSI because infection involving the prosthetic material may necessitate mesh removal. Although this appears to be uncommon, mesh removal has been reported in patients undergoing bowel resection [9]. Other series have reported no mesh removals

despite infections in patients who required bowel resection, suggesting that infection does not invariably lead to explantation when appropriately managed [23]. Nevertheless, full-thickness bowel necrosis, perforation, gross spillage and established peritonitis raise greater concerns about implanting permanent prosthetic material. In these circumstances, primary tissue repair or delayed reconstruction may be preferable where technically feasible [3,9].

Ventral and emergency abdominal-wall hernias

The evidence for emergency ventral hernias is less consistent, partly because of differences in patient selection and contamination severity. Surgeons may be more likely to choose tissue repair in patients with extensive contamination or physiological instability, making direct comparisons between mesh and suture repair difficult [12,26]. Despite these limitations, available ventral-specific evidence suggests a recurrence benefit with mesh.

In a study of 122 patients undergoing emergency ventral hernia repair, 66 received synthetic mesh and 56 underwent suture repair. Although 21 patients required bowel resection, only two of them received mesh, illustrating how the choice of repair was influenced by contamination [26]. Recurrence occurred in 7 of 56 patients (12.5%) after suture repair, compared with none of the 66 patients after mesh repair ($p=0.003$), at a median follow-up of 24 months [26]. SSI rates did not differ significantly between the groups, at 7.5% with mesh and 5.3% with suture repair ($p=0.72$). However, surgical-site occurrences were more frequent after mesh repair (36.3% versus 17.8%), mainly because of seroma formation (22.7% versus 7.1%) [26]. Thus, in appropriately selected patients with incarcerated or strangulated ventral hernias, synthetic mesh may reduce recurrence without a demonstrated significant increase in SSI, although wound morbidity may be greater.

The degree of contamination remains central to the decision. In this study, incarcerated hernias were classified as CDC class I (clean), strangulated hernias without bowel resection as CDC class II (clean-contaminated), and strangulated hernias requiring bowel resection as CDC class III (contaminated) [26]. The WSES recommendations cited by the authors strongly supported synthetic mesh for clean incarcerated ventral hernias, recommended more cautious use in strangulated hernias with or without bowel resection, and favoured biological rather than synthetic mesh when acute strangulation was accompanied by bowel perforation [26].

Bowel resection should therefore be considered a marker of increased risk rather than an absolute contraindication to synthetic mesh. In the ventral hernia cohort, intestinal resection with CDC class III contamination was an independent predictor of SSI (OR 5.7, $p=0.02$), alongside diabetes (OR 11.2) and previous recurrence (OR 6.2). Of the 21 patients who underwent bowel resection, four developed SSI, with two infections occurring after mesh repair and two after suture repair [26]. However, the wider literature remains conflicting. Xourafas et al. reported SSI rates of 22% with prosthetic mesh versus 5% without mesh during simultaneous bowel resection, whereas other studies found no significant difference in wound morbidity between mesh and non-mesh repair in clean-contaminated emergency ventral hernias [12,26]. Bowel resection alone should not automatically exclude synthetic

mesh, but perforation, gross contamination and peritonitis substantially weaken the case for permanent synthetic reinforcement [12,26].

Influence of technique and mesh position

Mesh position may influence postoperative pain, wound morbidity and the durability of repair. In groin hernia surgery, TAPP and TEP allow mesh placement in the preperitoneal plane, avoiding the anterior tissue dissection required for open anterior repair. This may partly explain the lower chronic pain and discomfort reported after laparoscopic repair in some studies [4,7,22]. However, these findings should not be attributed to mesh position alone, as differences in operative access, tissue handling and patient selection may also contribute.

For emergency ventral hernias, IPOM+ combines closure of the defect with intraperitoneal mesh placement. The outcomes depend on the defect, the condition of the bowel and the degree of contamination. When bowel resection is required, an approach that separates the mesh from the contaminated operative field may be considered where technically feasible. Preperitoneal or retroperitoneal placement, including approaches involving extracorporeal bowel resection, may help limit direct contact between the prosthesis and potential contamination [9,22]. Nevertheless, such strategies do not eliminate infection risk, and the evidence does not establish that they make permanent mesh appropriate in every contaminated emergency.

The choice of technique should therefore be guided by the clinical circumstances rather than an assumption that one mesh position is universally superior. In particular, the advantages of preperitoneal placement in groin hernia repair should not be directly extrapolated to emergency ventral hernias, where the anatomy, defect characteristics and contamination risks differ.

Does MIS change the mesh decision?

MIS primarily changes surgical access rather than the underlying indications for mesh. The EAST meta-analysis associated laparoscopic emergency groin hernia repair with lower recurrence (OR 0.75, 95% CI 0.58 -0.99) and shorter hospital stay, although the evidence was of very low quality and predominantly observational [3]. Another analysis reported a 25% reduction in recurrence with laparoscopic repair (OR 0.75, 95% CI 0.62 -0.92; p=0.02), without significant heterogeneity [3]. However, most laparoscopic repairs also involved mesh, making it difficult to separate the benefits of laparoscopic access from those of prosthetic reinforcement. Patients requiring bowel resection were also more likely to undergo open repair, introducing further selection bias [3].

MIS may facilitate hernia reduction and assessment of bowel viability and offer recovery advantages in selected patients. It does not, however, eliminate the infection risks associated with placing mesh in a

contaminated field [3,7]. The decision to use mesh should therefore remain separate from the decision to undertake laparoscopic or open repair, with both guided by the patient's physiological condition, the operative findings, the degree of contamination and the feasibility of achieving safe, definitive closure.

Section IV. Feasibility and Outcomes of MIS in Emergency Hernia Repair

The feasibility of MIS in acutely incarcerated or strangulated hernias depends on whether reduction, assessment of bowel viability, adhesiolysis, bowel resection when required, and definitive hernia repair can be performed safely without routine open access. Available evidence demonstrates that these steps can be completed laparoscopically in selected patients, particularly those with groin hernias, although conversion remains necessary when adequate exposure or safe reduction cannot be achieved [2,4,6,8,10].

For acute groin hernias, most published experience involves TAPP, with a smaller body of evidence supporting TEP. In a systematic review by Sartori et al., 433 patients underwent emergency laparoscopic repair of incarcerated groin hernias. TAPP was the most frequently used technique, followed by TEP, and laparoscopic reduction was achieved in 343 patients. Only 10 conversions to open repair were reported across the included studies [6]. Earlier studies reviewed by Deeba et al. similarly demonstrated that both approaches could be used to reduce incarcerated contents and proceed to definitive repair [8].

The transabdominal approach is particularly useful when strangulation is suspected because it allows direct inspection of the bowel following reduction and reassessment of its viability during the operation [4,7,10]. In the 2026 series by Gökdere and Kesikli, bowel viability was assessed laparoscopically following reduction, and resection was performed when irreversible ischaemia was identified [10]. Reduction may involve gentle intra-abdominal traction, external compression or controlled enlargement of the hernia ring, depending on the operative findings.

The need for bowel resection does not necessarily preclude MIS. Deeba et al. reported 17 bowel resections among 328 laparoscopically managed incarcerated or strangulated inguinal hernias. These were performed either laparoscopically or through a small laparoscopically guided minilaparotomy [8]. Sartori et al. similarly described resections performed intracorporeally or following enlargement of the umbilical incision [6]. These approaches allow laparoscopic exploration and hernia repair to be combined with extracorporeal resection when considered more practical or safer.

TEP may also be used in selected cases, although its limited access to the peritoneal cavity restricts direct bowel assessment. Hoffman et al. described a combined approach involving intraperitoneal laparoscopy for reduction and inspection, followed by TEP mesh repair. Eleven patients underwent successful laparoscopic exploration and TEP repair, while one required conversion because safe reduction was not possible [16]. This demonstrates that different minimally invasive techniques can be combined according to the operative findings rather than treated as mutually exclusive approaches.

Evidence for ventral and incisional hernias is more limited but also supports technical feasibility. In an ACS-NSQIP study, Pechman et al. identified 1,130 emergency laparoscopic repairs of incarcerated or strangulated ventral, umbilical and incisional hernias [1]. Although database studies provide limited information about operative technique, the number of procedures demonstrates that emergency laparoscopic repair has been undertaken on a substantial scale. More detailed findings were reported by Jacob et al., whose series included 25 acute ventral hernias approached laparoscopically. Most were repaired using IPOM+, with reduction, bowel assessment, fascial closure and mesh placement completed laparoscopically in the majority of cases. Two patients required conversion because adhesions prevented safe reduction [4].

These findings demonstrate that MIS can be technically feasible in selected emergency cases, but feasibility alone does not establish superiority over open surgery. The results also depend on patient selection, hernia anatomy, contamination, operative technique and the experience of the surgical team.

Short-term and long-term outcomes

Evaluation of emergency hernia repair should extend beyond immediate postoperative outcomes. SSI, length of hospital stay and perioperative morbidity are important, particularly in patients with bowel compromise or contamination. However, recurrence, chronic pain, local discomfort, functional recovery and reoperation are also relevant when assessing the overall effectiveness of repair. A favourable short-term outcome does not necessarily indicate a more durable repair, just as a lower recurrence rate does not by itself establish superiority across all clinical outcomes.

In selected patients, minimally invasive techniques such as TAPP and IPOM+ have been associated with shorter hospital stays and fewer wound complications compared with open repair [4,7,22]. These findings must be interpreted in the context of patient selection, since patients with severe contamination, physiological instability or extensive bowel compromise are more likely to undergo open surgery. Consequently, some of the observed differences may reflect baseline differences between the groups rather than the operative approach alone.

Mesh use presents a related trade-off. Primary tissue repair may be preferred when contamination raises concern about prosthetic infection, but it carries a greater risk of recurrence than mesh repair in the available emergency groin hernia literature [9]. Conversely, mesh reinforcement reduces recurrence in appropriately selected patients, although the risk of SSI becomes more important when bowel resection or contamination is present [9,12,26]. The decision therefore involves balancing the immediate risks of infection against the longer-term durability of the repair, rather than prioritising either outcome in isolation.

Long-term studies with follow-up periods exceeding 20 -29 months have reported differences in pain and functional outcomes between open and laparoscopic emergency hernia repair [4,7]. In the study reported by reference [4], recurrence rates after open and laparoscopic mesh repair were broadly comparable, while laparoscopic repair was associated with more favourable patient-reported outcomes. The reported incidence of chronic pain at rest was 2% after laparoscopic repair compared with 5% after

open repair. Local discomfort was reported in 4% and 20%, respectively, while difficulty with physical exercise was reported in 4% of laparoscopic patients compared with 25% of those undergoing open repair [4].

These findings suggest that the benefits of laparoscopic repair may extend beyond hospital discharge, particularly in relation to chronic discomfort and functional recovery. However, they should not be assumed to apply equally to all emergency hernias. The results depend on the populations studied, the operative techniques used and the experience of the surgical teams. They also do not establish that the same advantages would be observed in patients with extensive contamination or severe bowel compromise.

Reoperation is another relevant long-term outcome. Recurrent hernia and subsequent complications may necessitate further surgery, but the available findings should be interpreted cautiously when comparing open and laparoscopic approaches. Differences in initial case severity and follow-up duration may influence the observed rates of reoperation [4,7].

Overall, the available evidence supports the technical feasibility of MIS in selected acute incarcerated and strangulated abdominal wall hernias. Laparoscopic reduction, bowel inspection, adhesiolysis, resection, defect closure and mesh placement have all been performed successfully, with the strongest evidence available for TAPP in groin hernias. However, feasibility does not establish superiority over open surgery, and the need for conversion in technically difficult cases reinforces the importance of patient selection, bowel viability, contamination and surgical expertise [2,4,6,8,10]. Assessment of outcomes should also extend beyond the immediate postoperative period to include recurrence, chronic pain, functional recovery and reoperation, while recognising the limitations of the available comparative evidence [4,7,9].

Section V. Patient Selection and Choosing the Operative Approach

Patient selection is an important factor in determining whether MIS is appropriate for an incarcerated or strangulated hernia. The decision should not depend on a single feature, such as age or the presence of strangulation, but on the patient's physiological condition, the extent of bowel compromise, the expected technical difficulty and the experience of the surgical team. Current evidence therefore supports an individualised approach rather than recommending laparoscopic or open repair for every patient [3,6].

Physiological condition and bowel compromise

Physiological stability is an important starting point. Patients who are haemodynamically unstable, severely septic or unlikely to tolerate pneumoperitoneum are generally poor candidates for a laparoscopic-first approach. In the study by Gökdere and Kesikli, laparoscopy was attempted only in haemodynamically stable patients without generalised peritonitis, bowel perforation or severe intra-

abdominal contamination [10]. In patients with advanced sepsis or extensive contamination, rapid exposure and source control may take priority, making open surgery more appropriate.

The degree of bowel compromise also influences the choice of approach. Strangulation alone does not appear to be an absolute contraindication to MIS, as successful laparoscopic repairs have been reported even when bowel resection was required [6,10]. However, bowel perforation, diffuse peritonitis and gross contamination suggest more advanced disease and should lower the threshold for open surgery. Aragone et al. excluded patients with perforation or peritonitis from definitive laparoscopic hernia repair and managed the intra-abdominal contamination separately [7]. Patients requiring bowel resection also represent a higher-risk group, particularly in relation to infection [9,23]. Resection does not automatically rule out MIS, but it adds technical complexity and may increase the likelihood of conversion.

Symptom duration may provide further clues about the severity of bowel compromise. The EAST guideline found that intervention within six hours of symptom onset was associated with a lower likelihood of bowel resection, although the overall quality of evidence was very low [3]. In the TAPP series by Gökdere and Kesikli, patients requiring bowel resection had a median symptom duration of 20 hours, compared with four hours among those who did not [10]. Prolonged symptoms should therefore raise concern for advanced ischaemia and may justify a lower threshold for open surgery or intraoperative conversion.

Bowel obstruction and marked intestinal distension can also make MIS more difficult. Brown et al. found that obstruction and strangulation were associated with worse outcomes and a greater likelihood of bowel resection [24]. Significant distension reduces the available laparoscopic working space and may increase the risk of bowel injury. Aragone et al. reported bowel distension and adhesions among the reasons for conversion, while patients with marked distension were more often managed by open surgery [7]. Obstruction alone should not exclude MIS, but severe distension is an important consideration when assessing whether a safe laparoscopic approach is feasible.

Previous abdominal surgery should be interpreted similarly. Adhesions may complicate entry, limit exposure and make reduction more difficult. In the series by Aragone et al., previous operations were considered when selecting the operative approach, and adhesions were among the reported reasons for conversion [7]. Previous surgery is therefore a relative rather than an absolute contraindication. The likely extent of adhesions, their location and the surgeon's experience are more relevant than the presence of an abdominal scar alone.

Age, comorbidity and hernia anatomy

Age and comorbidity also require individual assessment. Patients presenting with acute groin hernias are often elderly and medically complex. Brown et al. reported a median age of 73 years, with increasing age and comorbidity independently associated with higher mortality [24]. However, age alone should

not determine the operative approach. Physiological reserve and the ability to tolerate general anaesthesia and pneumoperitoneum are more relevant to suitability for MIS. Similarly, obesity does not appear to be a clear contraindication. In the nationwide analysis by Lee et al., obesity distribution did not differ significantly between the laparoscopic and open emergency inguinal hernia groups [5].

Hernia type also influences the likelihood of bowel compromise. Femoral hernias are more likely than inguinal hernias to present with obstruction, strangulation and a need for bowel resection. Brown et al. reported bowel resection in 14.7% of femoral hernias compared with 3.5% of inguinal hernias [24]. This does not mean that femoral hernias should routinely be treated by open surgery, but the greater likelihood of compromised bowel should be considered when planning the operation.

Surgical expertise and practical suitability

Clinical suitability does not necessarily mean that MIS is the best practical option. Emergency laparoscopic hernia repair is more demanding than elective repair, particularly when the bowel is distended or ischaemic. Lee et al. found that laparoscopic repair accounted for only a small proportion of emergency inguinal hernia operations and suggested that limited training and experience may partly explain its low use [5]. Successful emergency laparoscopic series have also been reported from centres with substantial experience in minimally invasive hernia surgery [7]. Where the required expertise is unavailable, open surgery may be the safer option even when the patient's clinical condition does not independently preclude MIS.

The WSES guidelines support laparoscopic repair of incarcerated hernias when strangulation is not suspected and bowel resection is not anticipated. Where strangulation or bowel resection is suspected, the guidelines favour an open preperitoneal approach, although this recommendation is based on low-quality evidence (grade 2C). Diagnostic laparoscopy may also be used following spontaneous reduction of a strangulated groin hernia to assess the bowel and determine its viability, supported by a grade 2B recommendation [12].

One advantage of laparoscopy is that it allows inspection of the abdominal cavity, identification of the herniated contents and associated pathology, controlled reduction under direct vision, and assessment of bowel perfusion [4,6,7]. Pneumoperitoneum may facilitate reduction in selected cases, while direct visualisation allows the surgeon to reassess bowel viability after the constriction has been relieved [7]. This may help avoid unnecessary bowel resection, although uncertainty about viability should not be resolved by simply continuing observation to preserve the minimally invasive approach [4,7].

In a database study of 13,126 emergency ventral, umbilical and incisional hernia operations, only 8.6% were performed laparoscopically. Laparoscopic repair was associated with shorter operating times and hospital stays, lower rates of superficial and deep SSI, and lower 30-day mortality [1]. The reported benefits were particularly evident among patients classified as ASA I -III, who also had fewer wound complications, cases of pneumonia and episodes of postoperative sepsis after laparoscopic repair [1]. However, patients with more comorbidities were less likely to undergo laparoscopy, and the retrospective database lacked sufficient detail on defect size to fully address selection bias [1].

Evidence from emergency groin hernia studies also supports the feasibility of MIS in selected patients. A systematic review associated laparoscopic repair with shorter hospital stays and lower wound infection rates, without demonstrating an increase in recurrence or mortality [2]. Another review reported successful laparoscopic repair in approximately 98% of cases and significantly lower wound infection rates than with open repair, although most included studies were retrospective and heterogeneous [6]. A high-volume centre also reported shorter operating times and hospital stays, fewer overall complications and no difference in recurrence following TAPP repair [7]. These results are encouraging, but their applicability depends on patient selection and the expertise available at the treating centre.

In practice, MIS is most reasonable when the patient is haemodynamically stable, can tolerate pneumoperitoneum, has anatomy that permits safe access and adequate working space, and is likely to undergo controlled reduction and reliable assessment of bowel viability. The absence of perforation, generalised peritonitis and gross enteric contamination strengthens the case for MIS, as does the immediate availability of an experienced surgeon and the resources needed for bowel resection or conversion if required [4,6,7,12].

Conversely, haemodynamic instability, severe physiological compromise, extensive contamination, perforation, prohibitive bowel distension, extensive adhesions, unsuitable anatomy or the absence of appropriate emergency MIS expertise should favour open surgery [6,7,12]. For stable patients in whom bowel compromise is suspected but not confirmed, planned MIS with readiness to convert provides a reasonable middle ground [4,6]. Conversion should be treated as a safety measure rather than a failure of the initial approach.

Section VI. Robotic and Hybrid Surgery

Robotic emergency ventral hernia repair (rEVHR) and hybrid procedures represent developing options within emergency hernia surgery [1,8,11]. Rather than replacing established open and laparoscopic approaches, they may offer alternatives for selected complex cases in centres with the necessary expertise and resources. However, high-quality prospective evidence in emergency settings remains limited, and their role in acute ventral hernia repair is not yet well established [1,8,11].

Robotic emergency hernia repair can require longer operating times than conventional laparoscopic or open repair, particularly during setup and docking of the robotic system [1,8]. Robotic instruments may facilitate precise dissection, adhesiolysis, fascial closure and mesh placement, although whether these features independently improve postoperative recovery or reduce complications in emergency cases remains uncertain [1,11]. Hybrid procedures may be useful when a limited incision is required for bowel resection or decompression, followed by laparoscopic or robotic assessment and hernia repair [1,8,11].

The use of permanent synthetic mesh in contaminated or dirty fields requires particular caution, regardless of whether the operation is open, laparoscopic or robotic [8,11]. Depending on the degree of contamination, the patient's condition and the size of the defect, options may include primary fascial closure, an alternative repair strategy or delayed reconstruction. Evidence on long-term recurrence

following emergency robotic ventral hernia repair remains preliminary, and it is unclear whether robotic repair produces lower recurrence rates than laparoscopic IPOM+ or open reconstruction [1,8,11].

The cost and logistical requirements of robotic systems remain important barriers to their wider use in emergency surgery. Emergency use requires equipment availability, trained theatre personnel and institutional support, which may be difficult to arrange at short notice [1,8,11]. Overall, robotic and hybrid approaches are potential options for selected emergency ventral hernias in stable patients at centres with the necessary expertise and resources. Their technical feasibility is promising, but evidence of superiority over conventional laparoscopic or open repair remains insufficient [1,8,11].

Section VII. Limitations of the Evidence and Future Research

The evidence on emergency hernia repair remains limited by study design, differences in patient selection and inconsistent follow-up. Most comparative studies are retrospective, and patients with larger defects, extensive contamination or haemodynamic instability are more likely to undergo open repair, potentially favouring MIS in unadjusted comparisons [1 -3,6,7]. Inconsistent definitions of incarceration, strangulation and contamination further limit comparisons, particularly in patients requiring bowel resection [2,3,6,9].

Selection bias is a major problem in the existing literature. Patients selected for laparoscopic repair are often younger, have fewer comorbidities and are in better physiological condition than those undergoing open surgery. In the emergency ventral hernia cohort, the observed mortality difference between approaches lost statistical significance when analysis was restricted to patients with ASA classes I -III, illustrating the difficulty of isolating the effect of surgical approach from baseline patient risk [1,2,6]. Future prospective multicentre studies should use predefined eligibility criteria, document the rationale for procedure selection and account for comorbidities, haemodynamic status, previous abdominal surgery, hernia characteristics, bowel viability and surgeon expertise.

The definitions used to classify incarcerated and strangulated hernias also need to be standardised. These conditions are frequently analysed as a single entity despite representing different stages of disease. Lai et al. proposed a classification distinguishing acute irreducible, chronic irreducible and strangulated hernias, reserving the term strangulated for cases in which ischaemic compromise is confirmed by imaging or operative findings [2]. Such distinctions would allow outcomes to be compared between uncomplicated irreducibility, reversible ischaemia and non-viable bowel requiring resection. Hernia location and defect dimensions should also be recorded systematically, with groin and ventral hernias analysed as distinct groups [1,2].

Future research should report bowel resection, perforation, spillage and contamination separately. The EAST guidelines identified a lack of comparative evidence in patients requiring bowel resection, while Aragone et al. excluded patients with bowel perforation or peritonitis from their comparison of definitive repairs [3,7]. The favourable laparoscopic outcomes reported in selected cohorts therefore cannot be generalised to heavily contaminated cases. Studies should also document the precise

operative approach, mesh material and fixation method, as well as whether resection and anastomosis were performed intracorporeally, through a mini-laparotomy or following conversion to open surgery. Evidence comparing TAPP and TEP remains insufficient, and differences in mesh use between laparoscopic and open cohorts make it difficult to isolate the effect of surgical access alone [2,3,6].

Conversion rates and criteria are also inadequately characterised. Lai et al. reported a pooled conversion rate of 2.78%, but this estimate was based on only 216 laparoscopic cases across five studies and had a wide 95% confidence interval of 0.60% -11.92% [2]. Some studies excluded converted cases, meaning that their results describe completed laparoscopic procedures rather than the outcomes of an initial laparoscopic strategy. Future studies should include converted cases according to the initially intended approach and record the reason for conversion, its timing, the final procedure and subsequent outcomes [2,6,7]. This would help establish when conversion is appropriate and provide a more representative assessment of the risks and benefits of attempting MIS.

Long-term durability is another important evidence gap. The ACS-NSQIP ventral hernia dataset tracked outcomes only through 30 days, precluding assessment of longer-term recurrence and morbidity [1]. Lai et al. could not pool recurrence, reoperation or mortality because follow-up varied substantially between studies, while Sartori et al.'s recurrence analysis included only two studies and 241 patients, with unequal follow-up periods and wide confidence intervals [1,2,6]. Although the EAST review found a lower pooled recurrence risk following laparoscopic repair, the certainty of evidence remained very low [3]. Future studies should adopt consistent follow-up intervals, objective definitions of recurrence and transparent reporting of patients lost to follow-up. Chronic pain, health-related quality of life and return to normal activity should also be assessed, as short-term recovery alone does not establish the durability of repair [1-3,6,7].

The influence of surgeon experience and institutional volume requires further study. Emergency laparoscopic repairs have often been performed by experienced surgeons, and favourable results from specialist centres may not be reproducible in hospitals with fewer resources or less experience [2,6,7]. Multicentre studies should account for surgeon experience, emergency laparoscopic volume, institutional volume and the availability of trained staff and equipment. Current evidence has not established a minimum experience threshold for emergency MIS or demonstrated that outcomes from specialist centres can consistently be reproduced in general surgical settings [2,3,6,7].

Evidence for robotic and hybrid emergency repair is even more limited. The EAST review included robotic-assisted cases but did not report a separate pooled estimate for robotic techniques, and existing hybrid reports demonstrate feasibility rather than comparative superiority [3,6,7]. Dedicated comparative studies are needed to determine whether these approaches offer meaningful clinical advantages over conventional laparoscopy or open surgery. Formal economic evaluations are also required to balance equipment and operative costs against potential savings from shorter hospital stays, fewer complications and earlier return to usual activities. Conventional laparoscopy, robotic surgery and hybrid approaches should be evaluated separately because their resource requirements differ [1-3,6,7].

Overall, future research should establish whether the short-term benefits associated with MIS translate into improved long-term outcomes across different hernia types and degrees of contamination. This will require prospective multicentre studies with standardised definitions, detailed operative reporting, appropriate adjustment for confounding and adequate long-term follow-up.

Conclusion

Minimally invasive surgery has a role in the emergency repair of incarcerated or strangulated abdominal wall hernias, but current evidence does not support its routine use in place of open surgery. Across the available comparative studies, the most consistent advantages are lower wound morbidity and shorter hospital stays, with some studies also reporting more favourable chronic pain and functional outcomes. However, much of this evidence comes from retrospective cohorts in which patients selected for MIS were often less severely ill and more suitable for minimally invasive treatment. The extent to which these benefits are attributable to the operative approach itself therefore remains uncertain [1-3].

The choice between MIS and open repair should be guided by the patient's physiological condition, hernia anatomy, the ability to achieve safe reduction and assess bowel viability, the degree of contamination and the expertise available. Suspected bowel ischaemia or the possibility of resection does not automatically rule out MIS, provided that bowel assessment, any necessary resection and contamination control can be undertaken safely. Conversely, haemodynamic instability, generalised peritonitis, perforation, inadequate working space or an inability to assess the bowel reliably may favour open surgery. Conversion should remain an appropriate safety decision whenever minimally invasive access compromises the conduct of the operation. Mesh use should likewise be determined by bowel viability and contamination rather than by the operative approach alone.

The evidence remains less conclusive regarding mortality, major complications, reoperation and long-term recurrence. Differences in hernia type, operative technique, mesh use, contamination and follow-up further limit comparisons between studies. Further progress depends on prospective multicentre research with consistent definitions, detailed operative reporting and adequate long-term follow-up, accounting for surgeon experience and distinguishing outcomes by hernia type, bowel viability, resection and contamination. Until stronger evidence is available, MIS is best regarded as a selective approach for patients in whom it can be performed safely by an appropriately experienced team, rather than as a universally superior alternative to open repair.

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