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First Description of Intermediate Component Separation: A Novel Compartment-Preserving Technique for Medium and Large Incisional Hernia Repair

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Abstract

Complex incisional hernia repair requires effective abdominal wall reconstruction while minimizing anatomical disruption and postoperative complications. We describe a novel compartment-preserving technique, intermediate component separation (ICS), designed for medium-to-large defects. ICS provides broad prosthetic intermuscular coverage while preserving the functional core anatomy, avoiding entry into the peritoneal cavity, and eliminating the risk of neurovascular bundle injury.

In this single-center case report, a 65-year-old man presented with a giant midline incisional hernia measuring 16 cm × 25 cm, which developed following multiple open necrosectomies and debridements for severe necrotizing pancreatitis. A subfascial plane was developed bilaterally between the anterior rectus sheath and the rectus abdominis muscle. An incision in the anterior sheath, placed 5 mm medial and parallel to its lateral border, provided direct access to the avascular intermuscular space between the external and internal oblique muscles. Extensive lateral dissection created a continuous subfascial/inter-oblique compartment capable of accommodating a 45 cm × 30 cm mesh. Anatomical reconstruction of the EIT ambivium was achieved by suturing both cut edges of the anterior lamina of the internal oblique aponeurosis directly to the mesh. Midline restoration was completed through posterior layer suturing, approximation of the rectus muscles, and closure of the anterior sheath using the small-bites technique. The 90-day postoperative follow-up was uneventful.

By remaining beneath the anterior rectus sheath and avoiding entry into the peritoneal cavity, ICS is intended to minimize the risk of visceral adhesions and subcutaneous seroma or hematoma formation. The risk of bleeding is limited to minor anterior perforators, while the deep inferior epigastric vessels remain intact. This novel procedure represents a potentially biomechanically sound, compartment-preserving approach to the reconstruction of medium-to-large incisional hernias.

Categories: General Surgery, Anatomy
Keywords: abdominal wall reconstruction, compartment-preserving repair, incisional hernia, intermediate component separation, inter-oblique mesh placement, linea semilunaris, subfascial repair

Introduction

Incisional hernias represent a major global health burden, significantly impairing patients' quality of life [1,2], driving an increasing demand for surgical intervention [3], and imposing substantial financial strain on national healthcare systems. Inadequate repair or suboptimal surgical outcomes can lead to high recurrence rates, chronic pain, and severe postoperative complications [4]. Among the surgeon-dependent variables influencing outcomes after repair, two factors are particularly important: mesh dimensions, including the associated lateral overlap, and the anatomical plane selected for mesh placement.

The need for adequate mesh coverage depends on both biomechanical principles, such as physiological mesh shrinkage of 10%-30% [5-7] and Laplace-derived tension distribution [7-12], and supporting clinical evidence. Quantitative metrics highlight the mesh-to-defect area ratio (MDR) as an important predictor of outcomes. Hauters et al. demonstrated that an MDR ⩾ 16 significantly reduces recurrence in ventral hernia repair, whereas values below this threshold are associated with an exponential increase in recurrence due to inadequate tension distribution and tissue contraction [9]. Conversely, insufficient mesh overlap of less than 3-5 cm is a recognized cause of mechanical failure and marginal recurrence [10].

The human anterolateral abdominal wall is organized into distinct anatomical layers. Centrally, the rectus abdominis muscles are enclosed within the anterior and posterior laminae of the rectus sheath. Laterally, three distinct flat muscle layers overlap: the external oblique, internal oblique, and transversus abdominis muscles. Selecting the optimal anatomical plane for mesh implantation between or behind these layers significantly affects surgical outcomes [11].

Traditional repair techniques vary according to the anatomical plane used for mesh placement. (1) Retro-rectus (sublay) placement: Popularized by Rives and Stoppa, this approach places the mesh behind the rectus muscle and anterior to the posterior rectus sheath. Considered the gold standard for many ventral hernias, it minimizes wound morbidity [12,13]. However, its principal limitation is that the retro-rectus space is laterally bounded by the outer edge of the rectus sheath, restricting the transverse mesh width to approximately 10-12 cm. This limitation may result in inadequate mesh overlap in larger defects and increase the risk of visceral erosion when the posterior sheath is thin [13,14]. (2) Intraperitoneal onlay mesh (IPOM): This technique positions the mesh directly inside the abdominal cavity, against the parietal peritoneum. Although IPOM readily accommodates large meshes, direct contact between synthetic materials and abdominal viscera carries well-documented risks, including bowel adhesions, intestinal obstruction, and enterocutaneous fistulization [15]. (3) Subcutaneous (onlay) placement: In this approach, the mesh is placed superficial to the anterior fascia, directly beneath the subcutaneous fat. Although technically straightforward, a network meta-analysis by Holihan et al. and major clinical series have reported high rates of wound morbidity, including seromas, hematomas, and surgical site infections, as well as high recurrence rates associated with extensive subcutaneous flap elevation [11].

Modern techniques, such as anterior component separation (ACS) and posterior component separation (PCS), facilitate the closure of large abdominal wall defects but may disrupt or compromise one of the abdominal wall compartments. ACS involves incising the external oblique aponeurosis laterally to allow medial advancement of the rectus muscle. However, ACS creates extensive subcutaneous dead space, which is prone to wound complications, while still limiting mesh placement to the retro-rectus space [16]. PCS extends the dissection laterally behind the rectus muscle beyond the rectus sheath. Throughout this paper, PCS refers specifically to transversus abdominis release (TAR), as described by Novitsky et al. [17]. This technique has largely superseded the historical Carbonell PCS because of the high risk of rectus muscle denervation and irreversible atrophy associated with the latter. Although Novitsky's TAR preserves the main neurovascular bundles when performed meticulously, it requires division of the transversus abdominis muscle and extension of the dissection laterally between the muscle and the thin underlying transversalis fascia. These steps carry risks of deep bleeding, seroma formation, and potential visceral contact [17,18].

Recently, subfascial mesh placement between the anterior rectus sheath and the rectus abdominis muscle, using the Modified Uncovering Abdominal Reconstruction (MUAR) technique, was reported to yield favorable outcomes in a series of 80 cases [19]. However, in its original description, mesh width remained strictly confined to the pre-rectus space, limiting its applicability to large defects.

To address these biomechanical and anatomical limitations, we developed the intermediate component separation (ICS) technique. By exploiting the interconnectivity of the abdominal wall layers, ICS connects the pre-rectus subfascial plane medially with the avascular intermuscular space between the external and internal oblique muscles laterally. This novel, compartment-preserving approach is designed to provide extensive lateral mesh coverage (35-50 cm) while preserving the core anatomy, avoiding entry into the peritoneal cavity, and minimizing disruption of the subcutaneous tissues. This single-center case report aims to describe the technical feasibility, anatomical rationale, and initial postoperative outcomes of the ICS technique in the repair of a complex, high-risk giant incisional hernia.

Case Presentation

We report a single-center case involving a 65-year-old man who presented with a giant midline incisional hernia following a complex surgical history. The patient had previously experienced severe acute necrotizing-hemorrhagic pancreatitis, which required open necrosectomies and repeated abdominal debridements. Clinical examination and preoperative computed tomography revealed a large midline defect extending from the xiphoid process to 2 cm above the umbilicus (Figure *1*).

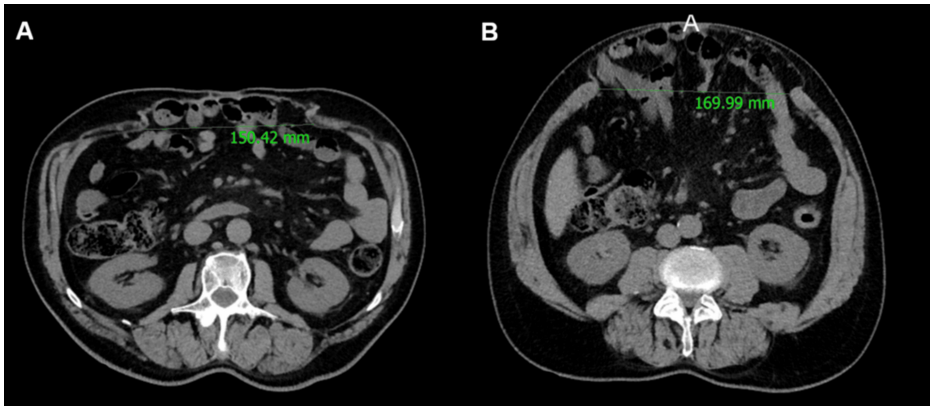


FIGURE 1: Preoperative computed tomography (CT) imaging documenting the presence of a giant incisional hernia, with an interrectus distance of 15 cm at rest (A) and 16.9 cm during straining (B).

According to the European Hernia Society (EHS) classification, the defect was categorized as EHS M1-M3, W3, L25, with a width of 16 cm and a length of 25 cm. Given the extensive history of intra-abdominal inflammation and previous open procedures, entry into the peritoneal cavity carried an exceptionally high risk of bowel injury, enterotomy, and complications associated with extensive adhesiolysis. Conversely, the massive dimensions of the defect necessitated an alternative to the classical Rives-Stoppa procedure because of the high risk of recurrence. Consequently, the ICS procedure was proposed to achieve reliable reconstruction without entering the abdominal cavity.

The procedure begins with a rhomboid xiphoumbilical skin incision, excision of the previous surgical scar, and isolation and reduction of the hernia sac without opening the adherent underlying peritoneum.

The anterior rectus sheath is incised bilaterally at 0 cm from its medial border, and a subfascial plane is developed between the anterior rectus sheath and the anterior surface of the rectus abdominis muscle. Meticulous sharp dissection is performed along the tendinous intersections, where the fascia adheres firmly to the muscle tissue. Minor perforating vessels are electrocoagulated before the fascia is divided (Figure *2*).

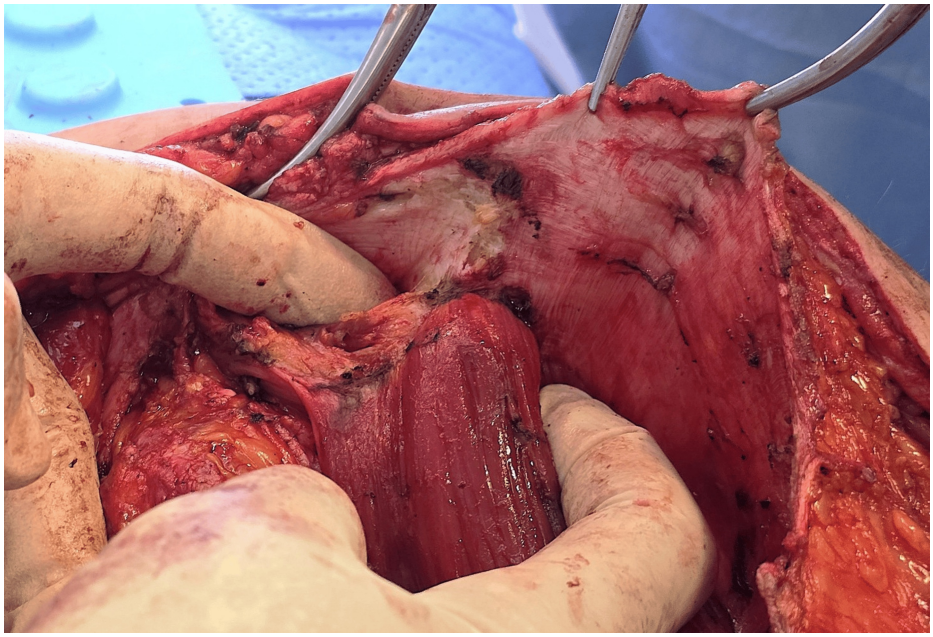


FIGURE 2: Dissection of the rectus muscle tendon intersections from the anterior rectus sheath.

Dissection proceeds laterally over the rectus abdominis muscle towards the lateral border of the rectus sheath, which modern descriptions of abdominal wall anatomy [20] identify as the EIT ambivium, the convergence zone of the aponeuroses of the external oblique, internal oblique, and transversus abdominis muscles at the lateral margin of the anterior rectus sheath. Consistent with this anatomical description, the aponeurosis of the external oblique muscle fuses with the anterior rectus sheath separately from the EIT ambivium, a few millimeters medially. Once subfascial plane dissection is complete, the EIT ambivium is clearly visible from within as a light-colored, approximately 2-mm-thick tendinous band (Figure 3).

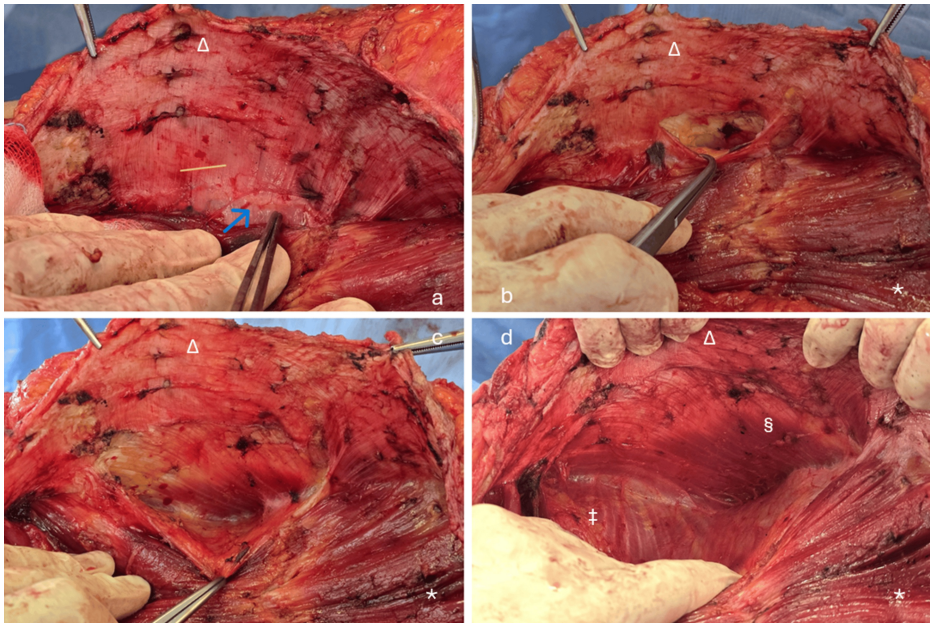


FIGURE 3: (a) Identification of the EIT ambivium. (b) Incision of the anterior rectus sheath above the EIT ambivium and dissection of the intermediate space between the external and internal oblique muscles. (c) Extending the dissection through the EIT ambivium, the internal oblique muscle is now clearly visible. (d) Dissection between the internal and external oblique muscles; the crossing direction of the oblique muscle fibers is manifest.

The blue arrow indicates the location of the EIT ambivium. The solid yellow line demarcates the planned longitudinal incision, executed 5 mm medial to the EIT ambivium to grant direct access into the avascular intermuscular plane between the external and internal oblique muscles. The triangle (Δ) represents the anterior rectus sheath; asterisk (*), rectus muscle; silcrow (§), external oblique muscle; and double dagger (‡), internal oblique muscle.

Under direct visual guidance, the anterior rectus sheath is then incised from within, 5 mm medial to the EIT ambivium. This incision provides direct, controlled access to the avascular intermuscular space between the external and internal oblique muscles without disrupting the two deeper layers of the lateral abdominal wall.

Precise control of this incision is the core technical element of the ICS procedure. An incision that is too medial fails to enter the intermuscular plane and instead accesses the subcutaneous plane by perforating the anterior rectus sheath. Conversely, an incision that is too lateral, beyond or directly through the EIT ambivium, risks entering the plane between the internal oblique and transversus abdominis muscles, the posterior rectus sheath, the Spigelian fascia, or the peritoneal cavity. In these circumstances, there is a high risk of injuring the main neurovascular bundles entering the lateral border of the rectus muscle. These bundles remain intact when preserved within the avascular plane between the internal oblique and transversus abdominis muscles.

Lateral blunt dissection within the inter-oblique space creates a broad, continuous intermuscular pocket on each side, extending to the lumbar region. This pocket accommodates a mesh with a transverse width of 40-50 cm, providing extensive lateral overlap that exceeds that achievable with traditional Rives-Stoppa repairs. Before anterior closure, the posterior rectus sheaths were sutured using interrupted running sutures with resorbable material, leaving the rectus abdominis muscles naturally supported over the reconstructed posterior layer (Figure 4).

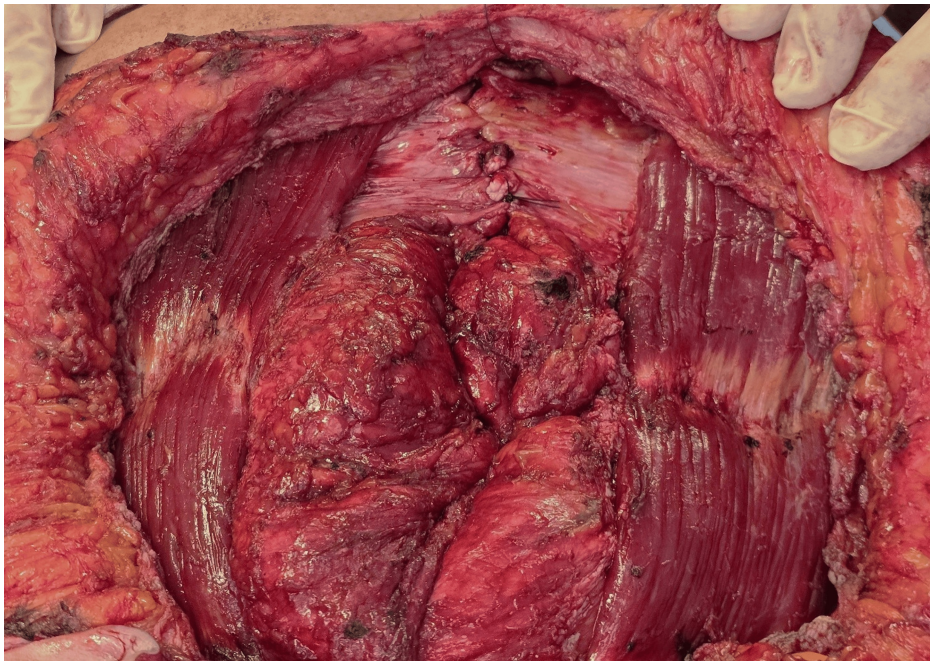


FIGURE 4: Closure of posterior rectus sheaths without opening the peritoneal cavity.

Interrupted X-shaped resorbable sutures are placed to gently approximate the medial borders of the rectus abdominis muscles over the reconstructed posterior layer (Figure 5). These supplementary, non-essential sutures are not intended to bear the primary mechanical tension of the repair. Instead, they aim to optimize muscle alignment and provide an additional soft-tissue barrier over the posterior fascial repair. By helping to prevent direct contact between the synthetic mesh and the underlying posterior sheath or peritoneum, this step is intended to reduce the risk of mesh-related complications. Interrupted X-shaped sutures are used specifically to minimize local tissue ischemia and avoid strangulation of the muscle fibers.



FIGURE 5: Complete closure of the posterior plane with the rectus muscles clearly in the anatomic position. Some X-shaped stitches bring the rectus muscles together.

A macroporous synthetic polyvinylidene fluoride (PVDF) mesh measuring 45 cm in width is placed flat

across the subfascial/inter-oblique space. The lateral margins of the mesh are anchored as far laterally as possible to the internal oblique muscle using interrupted resorbable monofilament sutures.

To restore the functional anatomy of the abdominal core and reconstruct a reinforced EIT ambivium, both cut edges of the longitudinal incision in the anterior lamina of the internal oblique aponeurosis are sequentially sutured directly to the mesh.

First, the medial cut edge of the anterior lamina of the internal oblique aponeurosis is secured to the mesh using a continuous locking monofilament suture (PDS 2-0). Particular care is taken to visualize and preserve the neurovascular bundles coursing along the posterior plane, just medial to this margin.

Second, the lateral cut edge of the anterior lamina of the internal oblique aponeurosis is sutured to the mesh along the same suture line using a second continuous PDS 2-0 suture (Figure 6).

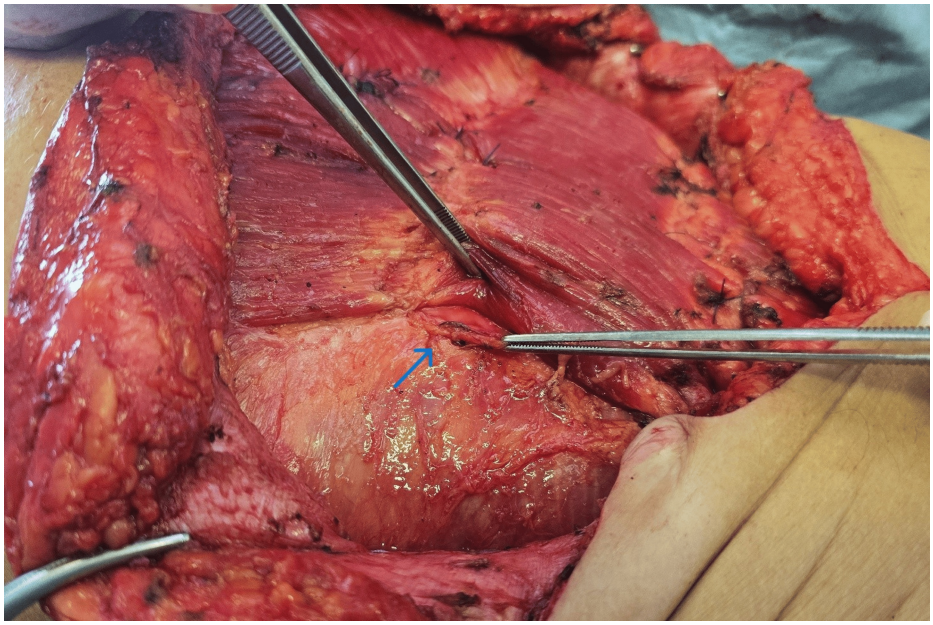


FIGURE 6: Preparing the remaining stump of the anterior lamina of the internal oblique muscle for mesh placement and fixation (blue arrow).

By securing both fascial margins to the prosthetic material, this two-step suturing technique aims to restore the aponeurotic continuity and biomechanical function of the EIT ambivium (Figure 7).

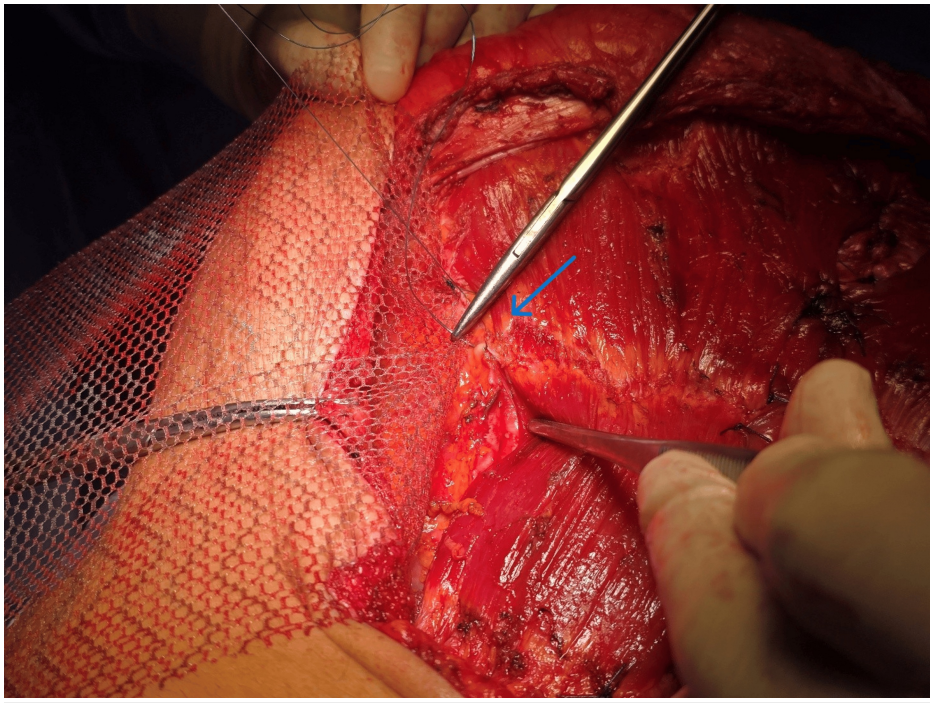


FIGURE 7: Securing the mesh to the remaining stump of the anterior lamina of the internal oblique muscle, reconstructing a new reinforced EIT ambivium.

Blue arrow: The medial cut edge of the anterior lamina of the internal oblique muscle is sutured onto the mesh using a second continuous PDS 2/0 suture.

The mesh is secured to the xiphoid process using interrupted non-absorbable sutures (Figure *8*). Given the location of the incisional hernia (EHS M1-M3), no dissection beneath the umbilicus was required. A subfascial suction drain is then placed. Finally, the anterior rectus sheath is closed along the midline using a continuous small-bite technique, and the subcutaneous tissues and skin are closed in layers (Figure *9*).



FIGURE 8: Final mesh placement.



FIGURE 9: Complete closure of the anterior rectus sheath. No subcutaneous dissection or dead spaces were observed.

The total operative time was 148 minutes, with an estimated intraoperative blood loss of less than 50 mL. Closed-suction subfascial drainage was maintained for four postoperative days, yielding a cumulative volume of 160 mL of serous fluid. The postoperative recovery was uneventful, and the patient was discharged on postoperative day 5. No surgical site occurrences (SSOs) or surgical site infections (SSIs) were recorded during the 30-day and 90-day clinical and radiological evaluations.

Discussion

The ideal surgical management of medium-to-large incisional hernias requires adequate mesh overlap, selection of an appropriate plane for mesh placement, and preservation of the anatomical and functional integrity of the abdominal wall compartments. The ICS technique offers a biomechanically based, anatomically oriented approach designed to address key limitations of conventional repairs. A major advantage of ICS is that it avoids entry into the peritoneal cavity. In patients with a hostile abdomen, such as the patient in this case with a history of severe necrotizing pancreatitis, avoiding intra-abdominal adhesiolysis may reduce the risk of iatrogenic enterotomy and associated postoperative complications. By confining the mesh to the subfascial and inter-oblique planes, direct contact between the synthetic material and the viscera is avoided, potentially reducing mesh-related visceral complications [15].

Furthermore, remaining beneath the anterior rectus sheath avoids extensive mobilization of the subcutaneous tissues, which is associated with increased rates of seroma formation and SSI in conventional onlay repairs [11]. Placement of the mesh between adjacent muscle layers, specifically the external and internal oblique muscles and the rectus abdominis, may provide continuous physiological compression. This anatomical arrangement may help limit dead space and reduce seroma and hematoma formation compared

with onlay or retromuscular sublay techniques.

Development of the pre-rectus subfascial plane requires careful sharp dissection at the tendinous intersections, where the anterior sheath adheres firmly to the rectus muscle. However, electrocautery and countertraction facilitate dissection of this plane. The risk of bleeding may be lower with ICS than with posterior component separation (PCS), as the deep inferior epigastric vessels lie within the retro-rectus compartment and are not directly dissected during the ICS procedure. Surgical trauma is primarily limited to minor anterior perforating vessels, which can be managed with electrocautery.

As Vierstraete et al. demonstrated in their study of the anatomy of the semilunar line [20], the external oblique aponeurosis fuses with the anterior rectus sheath separately from the fusion point between the anterior lamina of the internal oblique aponeurosis and the rectus sheath, which lies a few millimeters medially. Once the rectus sheath has been dissected from the rectus muscle, a distinct, dense, firm longitudinal line becomes visible on the lateral surface of the sheath, just lateral to the edge of the rectus muscle. This line corresponds anatomically to the insertion of the internal oblique aponeurosis and serves as an important landmark for accessing the space between the two oblique muscles. The anterior rectus sheath should be incised approximately 5 mm medial to this line, parallel to its course. Once access to the inter-oblique space has been established, the tissue plane can be separated, and the incision in the rectus sheath can be extended cranially and caudally. The ICS plane may facilitate neurovascular preservation because subfascial inter-oblique dissection remains anterior to the neurovascular bundles, which are protected beneath the internal oblique muscle plane (Figure *10*).

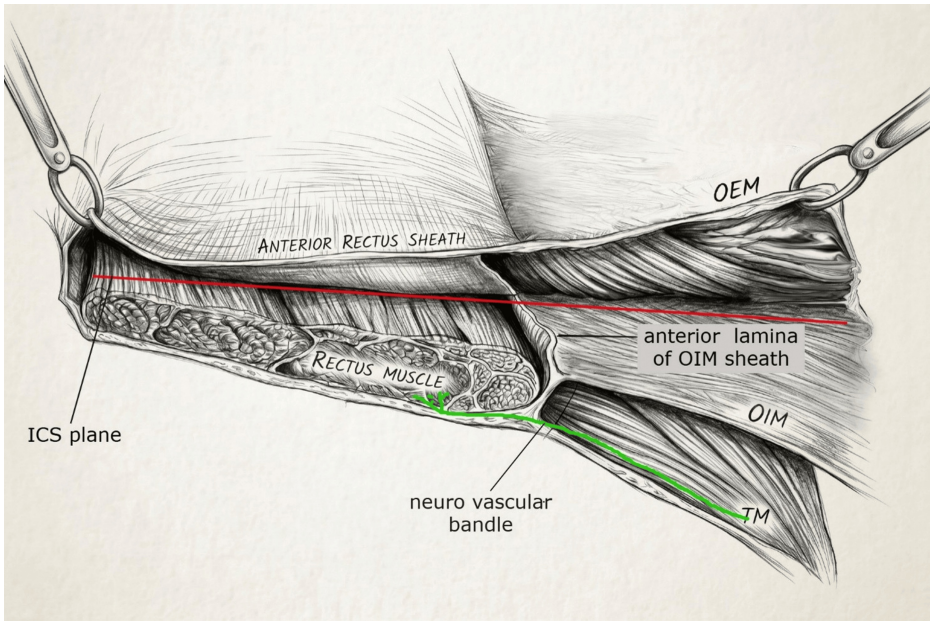


FIGURE 10: Intermediate component separation technique: the subfascial plane of the rectus muscle is connected to the inter-oblique muscle plane through the incision of the anterior lamina of the internal oblique muscle sheath.

ICS: intermediate component separation, OEM: external oblique muscle, OIM: internal oblique muscle, TM: transversus abdominis muscle

Image Credits: This illustration was created by the authors.

This approach may reduce the risks of intraoperative hemorrhage, focal muscle ischemia, and postoperative rectus denervation or atrophy. Unlike ACS and PCS, ICS is designed to preserve the abdominal wall compartments and maintain their function. Both the anterior and posterior abdominal wall compartments remain structurally intact. Suturing the incised margins of the anterior lamina of the internal oblique aponeurosis directly to the mesh aims to reconstruct a functional EIT ambivium. Anatomically, below the arcuate line, the internal oblique aponeurosis no longer divides into anterior and posterior laminae but passes entirely anteriorly, where it fuses with the external oblique aponeurosis. In this region, suturing both incised aponeurotic margins of the internal oblique directly to the mesh aims to maintain the functional continuity of this muscle with the medial abdominal wall compartment, thereby helping preserve trunk stability and core function.

ICS is a compartment-preserving technique and was not designed to advance the abdominal wall compartments to close massive defects. However, extensive lateral dissection between the oblique muscles allows the external oblique to slide over the internal oblique, facilitating anterior fascial closure. Nevertheless, when a defect is so large that complete reapproximation of the anterior rectus sheaths cannot be achieved, a bridging repair may be performed using a large mesh placed in the subfascial-muscular plane. The anterior sheath margins are anchored directly to the underlying mesh. Because the rectus muscles lie against the reconstructed posterior layer, they remain naturally flanked and supported beneath the mesh, providing a stable anatomical construct and helping prevent direct mesh contact with a thin posterior layer.

When defects are so extensive that neither the anterior nor the posterior compartment can be closed, combining ACS with PCS may excessively compromise abdominal wall integrity by disrupting the external oblique and transversus abdominis muscle layers. Conversely, combining PCS with ICS may be theoretically feasible because ICS is designed to preserve the structural integrity of the abdominal wall compartments. The fascial incision medial to the EIT ambivium does not, in itself, disrupt an entire compartment but separates the anterior layer from the posterior layer. Nevertheless, to help preserve the functional integrity of the abdominal core, the EIT ambivium is reconstructed during the final stage of the procedure by suturing both edges of this incision to the mesh.

This study has several methodological and technical limitations that warrant consideration. First, as a single-patient case report with a short-term follow-up of 90 days, the level of evidence is inherently limited, restricting the generalizability of the findings regarding safety and long-term efficacy. Nevertheless, as is typical of initial clinical descriptions of novel surgical techniques, this report demonstrates the technical feasibility of the ICS approach and describes its anatomical basis and biomechanical rationale. These encouraging early findings provide a basis for future prospective, multicenter studies involving larger patient cohorts and longer follow-up periods to evaluate long-term recurrence rates and mesh-related complications.

From a technical standpoint, ICS presents specific procedural challenges. Developing the subfascial plane requires careful sharp dissection to separate the anterior rectus sheath from the rectus abdominis muscle along the tendinous intersections, as well as a precise incision of the anterior lamina of the internal oblique aponeurosis. These steps are performed under direct visualization, making the procedure technically demanding and potentially more time-consuming than conventional repairs. Furthermore, ICS may be subject to anatomical constraints in boundary defects, such as subcostal or suprapubic incisional hernias. Because dissection is confined to the musculoaponeurotic layers of the abdominal wall, extending mesh overlap beyond bony or ligamentous attachment boundaries, such as the costal margin or iliopubic tract, may be inherently restricted. Finally, ICS was performed using an open approach in this case. Although a minimally invasive adaptation has not yet been implemented, future advances in endoscopic techniques and platforms, including laparoscopic and robotic approaches, may make minimally invasive application of this compartment-preserving technique feasible.

Conclusions

ICS is a novel and promising compartment-preserving technique for the repair of medium-to-large incisional hernias, including complex EHS W2-W3 defects. By extending the pre-rectus subfascial plane into the inter-oblique compartment through anatomical dissection at the EIT ambivium, ICS enables the placement of a wide mesh within an anatomically defined plane. This technique may reduce the risk of complications typically associated with mesh placement in other anatomical planes while preserving abdominal wall biomechanics.

To establish the safety and efficacy of the ICS technique, future prospective, multicenter studies involving larger patient cohorts should evaluate both short-term outcomes, including postoperative pain, surgical site occurrences, and length of hospital stay, and long-term outcomes, including hernia recurrence, chronic pain, and abdominal core function.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Acquisition, analysis, or interpretation of data: Giovanni Scudo, Carrara Alessandro, Marinella Menegazzo, Federico Accordini, Matteo Rivelli

Drafting of the manuscript: Giovanni Scudo, Carrara Alessandro, Marinella Menegazzo, Federico Accordini, Matteo Rivelli

Critical review of the manuscript for important intellectual content: Giovanni Scudo, Carrara Alessandro, Marinella Menegazzo, Federico Accordini, Matteo Rivelli

Supervision: Giovanni Scudo, Carrara Alessandro, Marinella Menegazzo, Federico Accordini, Matteo Rivelli

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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