Surgical Endoscopy
https://doi.org/10.1007/s00464-025-11524-8

2024 SAGES ORAL

Short-term outcomes of mesh-suture repair in the treatment of ventral hernias: a single-center study

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Received: 20 April 2024 / Accepted: 30 December 2024

Abstract

Background Defect closure with mesh suture is a novel technique for hernia repair. Originally described as the construction of lightweight macroporous polypropylene mesh strips as a suture material, it is now available as an FDA-approved product. Mesh suture better distributes tensile forces and reduces fascial tearing compared to traditional suture but requires less implanted material and tissue dissection compared to planar mesh. Limited studies have demonstrated mesh suture's effectiveness in short-term recurrence rates. This study describes the short-term outcomes of our initial experience with mesh-suture-based herniorrhaphy.

Methods This study is an IRB-approved, single-center, retrospective review of surgeon case logs from May 2023 to February 2024. All patients who had undergone hernia repair utilizing mesh suture (Duramesh, Mesh Suture Inc, Chicago, IL) as the method of repair at our medical center were enrolled. A descriptive analysis regarding patient and hernia characteristics was performed and short-term outcomes were analyzed.

Results We identified 63 patients (Mean age 61, Mean BMI 31.0 kg/m2, 60% female) who had undergone mesh-suture repair since its availability at our institution. Hernias included 31.7% primary, 27.0% incisional, 34.9% parastomal, and 6.4% other. Of these, 8 (12.7%) were recurrent hernia repairs. The average defect size was 41.0 cm2, with a range from 0.25 to 459 cm2. Average length of stay was 3.2 days, with a range of 0 to 20. Eleven patients (17.5%) were readmitted in the 90-day postoperative period. With an average follow-up of 45 days, there were ten surgical site occurrences (including four surgical site infections) and three recurrences (4.8%).

Conclusions Our initial experience with mesh-suture herniorrhaphy has demonstrated acceptable short-term rates of surgical site occurrences and recurrences. This provides additional support for its use, particularly in patients where a planar mesh-based repair might traditionally be avoided. Further studies of mesh-suture herniorrhaphy long-term recurrence rates and cost-effectiveness are needed.

Keywords Ventral hernia · Mesh suture · Herniorrhaphy · Duramesh

Incisional hernias are a common cause of reoperation following abdominal surgery with an overall incidence of around 10%–30% [1–4]. It is well established that mesh-based ventral hernia repair is most effective for reducing hernia recurrence compared to primary suture-based repair [5–7], which can largely be explained by the biomechanical properties of the abdominal wall.

The suture tension interface (STI) is the interaction that occurs between the tissue and suture during tissue repairs and involves multiple immunomodulatory [8–10] and tensile forces [11–14]. Suture pull-through occurs when the forces applied at the STI surpass the ultimate tensile strength (UTS) of the surgical repair resulting in dehiscence (short-term) and hernia formation (long-term).

Planar meshes work by supporting the initial and long-term repair strength and better distribution of forces across

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Published online: 27 January 2025

the repair, thereby improving the UTS of the repair [7]. This strength is determined by the quality of mesh fixation and tissue incorporation by the mesh. Supported mesh-based repairs, where the fascial closure is reinforced by mesh in a sublay or onlay position [15], are more effective at reducing hernia recurrence compared to a bridged repair [16] due to the overall decrease in tensile forces applied to the closure in a supported repair. However, drawbacks to mesh implantation, including increased tissue dissection, increased operative time, and associated infection risk, may preclude mesh use in certain clinical scenarios. This is particularly the case in contaminated or dirty fields (CDC wound class III/IV) where the risk of mesh infection, associated wound morbidity, potential recurrence, and need for mesh explanation may outweigh the benefit of mesh placement [17, 18].

Duramesh mesh suture (Duramesh, Mesh Suture Inc, Chicago, IL) is a macroporous polypropylene suture that became commercially available in September 2022 following FDA approval [19]. This design allows the suture to flatten across the tissue upon placement and increases the overall surface area of the suture. This, in turn, allows for better distribution of the tensile forces at the STI and theoretically reduces fascial tearing and suture pull-through compared to traditional suture material [20]. It additionally allows for fibrovascular tissue incorporation of the polypropylene material seen with traditional planar meshes without the aforementioned drawbacks.

Preclinical studies have demonstrated that the small filament design of mesh suture has favorable biomechanical properties compared to traditional sutures due to the improved force distribution and decreased suture tension [21] compared to traditional suture. Multiple animal studies have demonstrated greater resistance to suture pull-through, both in abdominal wall repairs [20, 22] and tendon-based repairs [23]. Additionally, retrospective analysis has demonstrated short-term effectiveness across multiple surgical specialties [24] and potential effectiveness in treating contaminated abdominal wall defects, with non-inferior outcomes and complication rates to traditional hernia repair methods [25], providing a potential alternative to mesh-based repairs in contaminated fields.

Despite this, both the short- and long-term clinical effectiveness of mesh-suture use in herniorrhaphy remains to be fully evaluated, with the majority of studies thus far aimed at preclinical animal models or surgical uses beyond the management of ventral hernias. This study sought to evaluate the short-term effectiveness of mesh-suture use for herniorrhaphy at our institution.

Materials and methods

This was a prospectively collected, retrospective review of surgeon case logs from May 2023 to February 2024 at a single center. May 2023 served as the starting point for this study as it represents when Duramesh suture became available at our institution for surgical use. Approval for this study was granted by the Penn State Health Institutional Review Board (IRB). Patients were included if the patient had a known hernia and mesh suture was used for repair at the time of operation. Operative reports were reviewed to verify the use of mesh suture for inclusion in this study. Pre-operative imaging and exam documentation were also reviewed to verify hernia presence. Additional review of the medical record was performed and information regarding demographics, patient characteristics, surgical details, and surgical outcomes was collected.

Mesh-suture use

Due to the retrospective nature of this study, patient selection for mesh-suture use was at the individual surgeon's clinical discretion. No incentive for mesh-suture use was provided. The instructions for use [26] were available for review for each case as needed; however, technical aspects of suture use, including suture gauge, interrupted vs. running closure, and suture spacing/width, were based on surgeon preference and clinical decision making (Fig. 1).

Common indications for mesh-suture use included (1) parastomal hernias that were only candidates for a primary repair based on hernia or patient characteristics; (2) primary umbilical/epigastric hernias with small to midsized defects in patients with significant comorbidities or preference against mesh placement; and (3) patients undergoing a large abdominal operation who were not candidates for a large hernia repair at the time of reoperation.

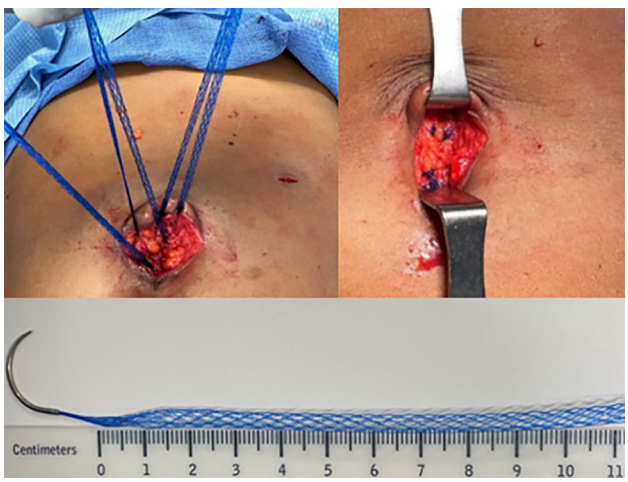

Fig. 1 Ventral hernia repair utilizing size 1–0 Duramesh suture (bottom) before (left) and after (right) being tied down

Outcomes

The primary outcome for this study was incisional hernia recurrence and overall time to recurrence. Recurrence for this study was defined as a clinical recurrence documented in the electronic medical record by surgeon clinical exam or radiographic evidence of recurrence (if present). Secondary outcomes included incidence of surgical site infections (SSI) and surgical site occurrences (SSO) within 30 days, postoperative hospital readmission, and reoperation rates. The average time of follow-up was also recorded and was calculated from the date of operation to the last clinical follow-up with a surgeon or abdominal cross-sectional imaging available in the electronic medical record, whichever was later.

Statistical analysis

Data were managed and statistical analyses were performed using Microsoft Excel. Standard descriptive statistical analysis was used to report demographic/patient characteristics, operative details, and postoperative outcomes. Continuous variables were reported as means with their standard deviation. Categorical variables were reported in percent. Outcomes between hernia subgroups were compared using Chi-squared test. A p-value of < 0.05 achieved statistical significance.

Results

A total of 63 patients underwent mesh-suture placement for hernia repair at our institution from May 1, 2023 to February 29, 2024. A complete list of patient demographic information can be found in Table 1. The average patient age was 61.3 ± 16.8 years old, with 60% female and 89% white/Caucasian. The average body mass index (BMI) across all patients was 31.0 ± 6.7 kg/m^2. 73% of patients were never smokers and 19% had quit at least 1 year prior. A minority (14.3%) of patients had known diabetes preoperatively with an average A1c of 6.3 ± 0.91 mg/dL.

A total of eight general surgeons utilized mesh suture at our institution during the study period, five of whom were fellowship-trained in minimally invasive surgery/abdominal wall reconstruction. Hernia types included 25.4% primary umbilical hernias, 27.0% incisional, 34.9% parastomal, 6.3% epigastric, 3.2% Spigelian, and 3.2% other (Table 2). Of these, 12.7% represented recurrent hernias and 49% of cases were associated with a concomitant procedure at the time of mesh-suture usage. 95% of cases were elective, with three patients (5%) requiring urgent operation for an incarcerated hernia. The average hernia size was 41.0 ± 100.4 cm^2. The Center for Disease Control (CDC) wound class included clean (58.7%), clean-contaminated (31.8%), contaminated (7.9%), and dirty (1.6%).

Table 1 Patient demographic information for mesh-suture use

Patient demographic	$N = 63$
Age, y	61.3 (± 16.8)
Sex, female	60.3% (38)
Race	
White	88.9% (56)
Black	3.2% (2)
Other	7.9% (5)
Ethnicity	
Hispanic	7.9% (5)
Non-Hispanic	92.1% (58)
BMI, kg/m^2	31.0 (± 6.7)
Comorbidities	
HTN	38.1% (24)
Diabetes	14.3% (9)
Cancer	15.9% (10)
Inflammatory bowel disease	14.3% (9)
Immunosuppressive medication	12.7% (8)
Anticoagulation use	34.9% (22)
Smoking status	
Never	73.0% (46)
Prior > 1y	19.0% (12)
Prior < 1y	1% (1.6)
Current	4.8% (3)

Additional operative details regarding mesh-suture technique can be found in Table 2. Size 1 mesh suture was used in 85.7% of cases. Multiple closure techniques were utilized based on surgeon discretion. Figure-of-eight closure was the most commonly used technique in 63.5% of cases, followed by a running closure (20.6%), simple interrupted (11.1%), combination (6.3%), and other/unknown (11.1%). The average operative time was 146 min (± 120.3) with an average postoperative length of stay of 3.2 days (± 4.4).

96.8% of patients completed at least 30-day postoperative follow-up with an average time to follow-up of 45.6 ± 38.1 days. Of these patients, 59% had no short-term postoperative complications. Eleven (17%) patients required postoperative readmission within 90 days with an average time to readmission of 23.3 ± 15.9 days. The most common causes for readmission were surgical site infection (4.8%), PO intolerance/dehydration (4.8%), and small bowel obstruction (3.2%). Additionally, two patients were readmitted for pneumonia at 9 and 11 days postoperatively and one patient was admitted for a pulmonary embolism requiring therapeutic anticoagulation.

There were no recurrences within 30 days and 3 recurrences (4.8%) after 30 days. The average time to recurrence was 75.0 ± 37.4 days. All recurrences were associated with a

Table 2 Baseline hernia and operative characteristics

Type of hernia	
Incisional	27.0% (17)
Umbilical	25.4% (16)
Parastomal	34.9% (22)
Epigastric	6.3% (4)
Spigelian	3.2% (2)
Other	3.2% (2)
Recurrent	12.7% (8)
Incarcerated	4.7% (3)
Average hernia area (cm^2)	41.0 (± 100.4)
CDC wound classification	
Class 1	58.7% (37)
Class 2	31.8% (20)
Class 3	7.9% (5)
Class 4	1.6% (1)
Elective	95% (60)
Additional procedure performed	49% (31)
Colorectal	16.3% (10)
Skin/soft tissue	6.3% (4)
Small bowel resection	3.2% (2)
Cholecystectomy	3.2% (2)
Additional hernia	7.9% (5)
Gynecologic	3.2% (2)
Urologic	1.6% (1)
Oncologic	1.6% (1)
VP shunt placement	3.2% (2)
Other	3.2% (2)
Operative time, min	146 (± 120.3)
Suture size	
Size 1	85.7% (54)
Size 0	14.3% (9)
Technique	
Interrupted	11.1% (7)
Figure-of-eight	63.5% (40)
Running	20.6% (13)
Purse-string	3.2% (2)
Combination	6.3% (4)
Unspecified	7.9% (5)

Table 3 Postoperative outcomes

Postoperative LOS, days	3.2 (± 4.4)
Postoperative follow-up, days	45.2 (± 38.3)
Postoperative complication	
Bowel obstruction	4.8% (3)
Ileus	4.8% (3)
Sepsis	0% (0)
Pneumonia	6.3% (4)
UTI	3.2% (2)
DVT/PE	3.2% (2)
Acute respiratory failure	1.6% (1)
Surgical site infection (SSI)	6.3% (4)
Superficial	4.8% (3)
Deep	1.6% (1)
Organ space	0.0% (0)
Surgical site occurrences (SSO)	15.9% (10)
Seroma	6.3% (4)
Hematoma	3.2% (2)
Superficial wound breakdown	3.2% (2)
Fascial dehiscence	0.0% (0)
Suture sinus	0.0% (0)
Other	3.2% (2)
SSO/I PI	7.9% (5)
Drain placement	4.8% (3)
Wound exploration	3.2% (2)
Readmission < 90 days	17.5% (11)
Recurrence, total	4.8% (3)
< 30d	0.0% (0)
> 30d	4.8% (3—parastomal)
Time to recurrence	75 (± 37.4)
Reoperation	6.3% (4)
Recurrence	1.6% (1)
Stoma revision (unrelated to recurrence)	3.2% (2)
Parastomal skin excision and biopsy	1.6% (1)
Mesh-suture excision	0.0% (0)

parastomal hernia repair. Only one recurrence required reoperation. Additional postoperative complications included surgical site occurrences (15.9%), surgical site infection (6.3%), SSO requiring procedural intervention (7.9%), bowel obstruction (4.8%), ileus (4.8%), and pneumonia (4.8%) (Table 3). There were no cases of suture sinus formation and no patients required reoperation for mesh explantation. Further subclassification of SSI/SSO and additional postoperative complications can be found in Table 3. The complication rate between hernia types did not reach statistical significance (Table 4).

Discussion

This study represents one of the first studies to highlight clinical outcomes of Duramesh suture use in herniorrhaphy, with an evaluation of 63 total patients within a ten-month timeframe. The outcomes of this study support the effective use of mesh suture for herniorrhaphy, with overall positive outcomes regarding short-term complication rates.

Our complication rates for overall recurrence (4.8%), SSO (15.9%), and SSI (6.3%) are comparable to two prior studies that evaluated mesh-suture use for abdominal wall closure. Both these studies, however, were not limited to ventral herniorrhaphy and included cases involving primary fascial closure. The first was performed before commercialization and FDA approval of Duramesh suture and examined 107 patients who underwent abdominal wall closure, 76 of whom had a ventral hernia [27]. Overall complication rates for hernia recurrence in this study were 4.1%, SSI (4.6%), SSO (17%), and SSOPI (10.3%). More recently, a subgroup

Table 4 Postoperative complications by hernia type

Complication	Parastomal ($N=22$)	Primary ventral ($N=20$)	Incisional ($N=17$)	Spigelian ($N=2$)	p-value
Surgical site infection (SSI)	4.5% (1)	4.5% (1)	4.5% (1)	0.0% (0)	0.77
Superficial	0.0% (0)	5% (1)	5.9% (1)	0.0% (0)	0.71
Deep	4.5% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.61
Organ space	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	–
Surgical site occurrences (SSO)	27% (6)	10% (2)	5.9% (1)	50% (1)	0.13
Seroma	9% (2)	5% (1)	0.0% (0)	50% (1)	0.05
Hematoma	9% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.30
Wound breakdown	0.0% (0)	5% (1)	5.9% (1)	0.0% (0)	0.71
Other	9% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.30
SSO/I PI	14% (4)	0.0% (0)	5.9% (1)	0.0% (0)	0.34
Bowel Obstruction	14% (3)	0.0% (0)	0.0% (0)	0.0% (0)	0.13
Ileus	9% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.30
Recurrence	14% (3)	0.0% (0)	0.0% (0)	0.0% (0)	0.08
Reoperation	18% (4)	0.0% (0)	0.0% (0)	0.0% (0)	0.06

analysis of ventral hernia repairs utilizing mesh suture demonstrated an overall surgical complication rate of 20.7% [24].

96.9% of repairs in this study involved the management of a ventral hernia: parastomal (34.4%) primary umbilical (25.0%), incisional (26.6%), epigastric (6.3%), and Spigelian (3.2%). When complication rates were further subdivided based on hernia type, we found that all three recurrences were associated with parastomal hernia repair. 4.5% of parastomal repairs developed an SSI and 27% developed an SSO (Table 4). This represented 25% and 55% of all SSI/SSO, respectively, across all hernia types and 75% of SSO/I requiring procedural intervention. Additionally, all cases of postoperative bowel obstruction, ileus, and reoperation were related to a parastomal hernia repair (1 recurrence, 2 stoma revisions unrelated to hernia recurrence, 1 parastomal skin excision). However, no complication rate between hernia types achieved statistical significance.

Previous literature has established that recurrence rates following parastomal hernia rates are high, ranging from around 10.7–36% for retromuscular and laparoscopic repairs [28–30] to upwards of 69% for suture repairs [31] with the European Hernia Society recommending against the use of suture-based repairs when clinically able [32]. While long-term follow-up for recurrence is needed, our short-term recurrence rates are optimistic and mesh suture may offer an alternative treatment in parastomal hernia management. This may be particularly relevant in cases where mesh is contraindicated or surgeons wish to preserve surgical planes and repair options for potential future reoperation.

Our outcomes regarding primary and incisional ventral hernias are comparable to prior literature for laparoscopic and open techniques [33–35]. The majority of these hernias in our study were small- or medium-sized defects where surgical management remains nuanced and many patients had associated cardiac and pulmonary comorbidities that could preclude long periods of general anesthesia. While the optimal hernia size for mesh-suture usage remains to be determined, we have had promising short-term recurrence rates for both small- and large-sized defects for incisional and parastomal hernias.

Interestingly, across all patients, almost half (49%) were associated with a concomitant gastrointestinal, gynecologic, urologic, or oncologic abdominal operation, many of which involved a colonic or small bowel resection. An argument in these cases can be made for mesh-suture use compared to planar mesh as this has previously been associated with an increased risk of mesh explantation [36]. However, while our overall infectious rates remain low, mesh suture still involves the use of implantable material, and further follow-up is needed to evaluate its efficacy in clean-contaminated and contaminated fields.

We hypothesize our results are largely due to the design of mesh suture to allow for individual fibril incorporation and tissue ingrowth histologically [20–23]. This is advantageous to traditional suture due to the decrease in suture pull-through and increased tensile repair strength. We hypothesize this will potentially lead to lower overall recurrence rates, or at least potentially delay the time to recurrence compared to primary suture repairs. However, ongoing follow-up regarding long-term recurrences is needed to determine this.

This study is limited by its retrospective aspect and follow-up duration. As Duramesh has only recently received FDA approval and has only received approval for use at our institution within the last year, only short-term outcomes were able to be identified with a relatively small sample size of patients. This small sample size in each repair group made it difficult to statistically compare outcomes between groups.

Additionally, patients were also not prospectively enrolled or randomized to mesh-suture use, and operative technique was based on the discretion of the operating surgeon, creating the potential for uncaptured confounding variables based on patient and surgeon characteristics. Ongoing research is needed to address the overarching question of which hernia patients most benefit from mesh-suture usage.

Conclusions

The implementation of mesh suture by both abdominal wall specialists and acute care surgeons highlights the need for an alternative to planar mesh for managing ventral hernias, particularly in cases where a large planar mesh placement may not be ideal. Our results demonstrate promising short-term results with use across a variety of hernia types. Additional long-term follow-up is needed to further characterize mesh-suture use for the management of ventral hernias.

Funding The authors have not disclosed any funding.

Declarations

Disclosures Dr. Alli is a speaker for Baxter Healthcare and receives research support from Actuated Medical and Galvani Bioelectronics. Dr. Horne is a speaker for MedTronic and Bard Davol. Dr. Pauli is a speaker for Becton–Dickinson and Medtronic and is a consultant for Boston Scientific Corp., Actuated Biomedical, Inc., Cook Biotech, Neptune Medical, Surgimatix, Noah Medical, Allergan, Intuitive Surgical, ERBE, Integra, Steris, Vicarious Surgical, Telabio, and Mesh Suture Inc. He has royalties in UpToDate, Inc. and Springer and financial interests in IHC, Inc., Cranial Devices Inc, and Actuated Medical. Drs. Quattrone, Moyer, Zolin, and Sodomin have no conflicts of interest or financial ties to disclose.

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