


“Delayed-Immediate” Hernia Repairs in Infected Wounds: Clinical and Economic Outcomes

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Abstract

Background: Wound class in hernia repairs impacts surgical technique and outcomes. Hernia recurrence and complications are high when dirty wounds are treated in one stage. We hypothesize patients who undergo intentionally staged repairs are less likely to have adverse outcomes and associated costs.

Methods: Patients were identified by retrospective chart review. Patient characteristics and outcome variables were collected. An economic analysis of cost variables was performed using medical records and published meta-analyses.

Results: There were 8 patients in the staged repairs group and 10 patients in the control group. Length of stay was 14.9 days (± 8.8), and 8.7 days (± 6.4), respectively. Rate of hernia recurrence within 1 year was 14.3% and 37.5%. Rate of mesh infection at 30 days was 0% and 10%. Compared to controls, delayed-immediate repairs had a nearly 2-fold index surgical cost.

Discussion: Although there is an increased cost associated with delayed-immediate repairs, this cost may be offset by the decreased infection, seroma, dehiscence, enterocutaneous fistula formation, and hernia recurrence rate that necessitates future interventions. Further data collection is required to determine if clinical and economic benefit is seen long-term.

Keywords

economic, Hernia, outcome, surgical infection, wound class

Key Takeaways

- CDC class IV hernia wounds often have frequent recurrences and/or postoperative complication rates.
- Performing a staged, “delayed-immediate” hernia repair can control for contamination which allows for more definitive hernia repair to be considered.
- Cost of longer hospitalization associated with staged repairs must be offset with economic benefits of reduced rate of complications and/or hernia recurrences.

Introduction

In complex abdominal wall reconstruction, the degree of contamination can dramatically impact surgical technique and expected outcomes.^{1,2} In patients presenting with infected abdominal wounds, infected

mesh, or enterocutaneous fistulae (ECF), complete debridement coupled with definitive repair is challenging. A higher Centers for Disease Control and Prevention (CDC) wound classification (Table 1) can be a limiting factor in definitive surgical repair options.^{3,4} Current evidence emphasizes a single-stage approach during which the ECF and/or infected mesh are debrided and the fascial defect is repaired.^{5,6}

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Table I. CDC Wound Classifications.¹

I: Clean	An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered
II: Clean-Contaminated	An operative wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination
III: Contaminated	Open, fresh, accidental wounds or operative wounds with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered
IV: Dirty-infected	Old traumatic wounds with retained devitalized tissue and those that involved existing clinical infection or perforated viscera suggesting that organisms causing postoperative infection were present in the operative field before the operation

In these inherently dirty cases, surgeons may favor biologic materials, because synthetic meshes can harbor bacteria and biofilms.^{7,8} While use of biologic meshes may be preferred in the short-term to prevent recurrent infection, there is mixed evidence on their long-term results and durability.^{9,10} Additionally, dirty hernia cases often involve large defects and significant patient comorbidities which place patients at high-risk for complications requiring reoperation. Management of these complications comes at high costs to both the patient and hospital system.

We propose an alternative approach to surgical repair in this population: a single admission, multi-staged (“delayed-immediate”) method to help mitigate complications and their associated costs. This three-stage approach begins with exploratory laparotomy, lysis of adhesions, ECF takedown and/or removal of infected mesh, and temporary abdominal closure (i.e. Wittmann Patch, Starsurgical). This is followed approximately 2 days later by a second-stage washout and reinspection of any relevant repairs. Finally, a third stage is performed typically 2 days later, during which definitive abdominal wall reconstruction is executed with synthetic mesh reinforcement. Appropriate timing was determined by the discretion of the senior authors, prioritizing a balance between decreased time to final musculofascial closure (time of “open abdomen”) while allowing sufficient time for wound down-classification to justify the delayed-immediate surgical method described.

We hypothesized that the delayed-immediate approach to CDC class IV wounds would result in lower post-operative infection and hernia recurrence rates that would offset the increased up-front cost of multiple operations.

Methods

IRB approval was obtained through the Ohio State University Office of Responsible Research Practices (IRB #2015H0105). Patients undergoing single-stage versus delayed-immediate multi-staged hernia repairs performed by the senior authors between 2014-2018 were

identified by retrospective chart review. Control group patients were identified as those who underwent CDC class IV single-stage abdominal wall reconstruction. Delayed-immediate hernia repairs were classified as elective, CDC class IV single admission multi-staged reconstructions during the same time period.

Patient pre-operative characteristics (age, BMI, prevalence of: hypertension, COPD, diabetes, immunosuppression, smoking), hernia history (prior hernia repairs, hernia size), and indications for repair (mesh infection, enterocutaneous fistula, other intra-abdominal infection) for both groups were recorded (Table 2). Outcome variables collected for each group included length of admission, average daily oral morphine equivalents (OME) administered, surgical site occurrences (SSOs), and hernia recurrence rates (Table 3).

Costs for index surgeries and admissions for both study groups were acquired from medical record data and adjusted for inflation rates to \$USD for the year 2018. This included total cost and breakdowns of total indirect and direct costs for both groups (Table 4).

Continuous variables were analyzed for mean, median, mode, standard deviation, and quartiles. Ordinal and categorical variables were summarized in tables. Statistical analysis was performed utilizing Microsoft Excel (Redmond, WA, USA) and considered significant with P -value < .05.

Results

A total of 8 patients comprised the delayed-immediate group. Ten patients comprised the control group. There was no statistically significant difference in patient pre-operative characteristics, hernia history, or hernia size between the 2 groups. Biologic mesh was used for 9 of the control patients, 1 control patient had no mesh.

Seven (87.5%) of the delayed-immediate group underwent bilateral minimally-invasive anterior component separation, one patient did not require component separation of any kind. In the control group, 1 (10%) patient underwent unilateral transversus abdominis release, 2

Table 2. Patient Characteristics and Surgical Indication.

Part I: Patient Characteristics by Study Group		
	Delayed-immediate	Control
Sample size	8	10
Average BMI	30.32	38.69
HTN prevalence	63%	40%
COPD prevalence	13%	10%
Diabetes prevalence	50%	10%
Immunosuppression prevalence ^a	13%	20%
Average smoking status ^b	1.0	1.0
Average number of prior hernia repairs	1.63	.90
Average total hernia size (cm ²)	153.7	156.6
Part II: Indication for Hernia Repair by Study Group		
	Delayed-immediate	Control
Mesh infection	50% (4)	50% (5)
Enterocutaneous fistula	37.5% (3)	50% (5)
Other intra-abdominal infection	12.5% (1) ^c	0% (0)

^aImmunosuppression defined as any medication whose intent it is to suppress the immune system (i.e. steroids, antimetabolites, monoclonal or polyclonal antibodies, and anti-rejection medications).

^bSmoking status defined as follows: 0 = never smoker, 1 = distant former smoker (>1 year since quit date), 2 = recent former smoker (<1 year since quit date), 3 = current active smoker.

^cPancreatic abscess requiring laparotomy drainage and distal pancreatectomy.

Table 3. Surgical Outcomes.

	Delayed-immediate	Control
Median length of stay (Days)	14.5	6
Average OME/Day ^a	108	126
Hernia recurrence	14.3% (1/7)	37.5% (3/8)
Early (within 1 year)	14.3% (1/7)	25% (2/8)
Late (after 1 year)		
Mesh infection	0%	10%
Surgical site occurrence	14.3%	37.5%
Infection	0%	12.5%
Seroma	0%	0%
Hematoma	14.3%	25%
Dehiscence	14.3%	0%
Skin necrosis	28.6%	37.5%
Enterocutaneous fistula		

^aAverage oral morphine equivalent (OME) doses per day during patient hospital admission.

(20%) underwent bilateral minimally-invasive anterior components separation, and 7 (70%) control patients did not require component separation of any kind. Primary fascial re-approximation was achieved in 7 (87.5%) of delayed-immediate group patients and 8 (80%) of control patients. Delayed-immediate group mesh placements were: 5 (62.5%) sublay, 2 (25%) retrorectus, and 1 (12.5%) bridging. In the control group, mesh placements were: 7 (70%) sublay, 1 (10%) retrorectus, and 2 (20%) bridging.

Table 4. Average Cost of Index Operation(s) and Admission (\$USD).

	Delayed-immediate	Control
Surgery		
Indirect cost	\$19,966	\$11,793
Direct cost	\$26,530	\$14,884
Total surgical cost	\$46,496	\$26,677
Admission		
Total admission cost	\$104,857	\$53,963

Five (62.5%) of the delayed-immediate patients underwent 3 surgeries, 3 (37.5%) of the delayed-immediate patients underwent 2 surgeries. Total number of operations in the delayed-immediate group was 21. The average number of days between operations in the delayed-immediate group was 2.6 days. All control patients underwent one surgery. Median length of stay for the delayed-immediate group was 14.5 (range 5-34) days, and 6 (range 5-22) days for the control group. Average rate of hernia recurrence within 1 year post-operatively was 14.3% and 37.5%, respectively. Average rate of mesh infection at 30 days post-operatively for the delayed-immediate and control groups were 0% and 10%. Follow-up greater than 30 days for 7 of the 8 delayed-immediate patients and 8 of the ten control patients was obtained. Rate of post-operative infection for the delayed-immediate and control groups respectively was 14.3% and

37.5%. Rate of seroma was 0% and 12.5%. Wound dehiscence was noted in 14.3% of delayed-immediate patients and 25% of control patients. Skin necrosis occurred in 14.3% and 0% of patients, respectively. Finally, recurrent enterocutaneous fistula (ECF) was seen in 28.6% of delayed-immediate and 37.5% of control patients.

An economic analysis relied on the following cost data. The average total cost for a single-stage surgery in our control group was \$26,677. The average cost of the corresponding inpatient admission for control group patients was \$53,962. The average total surgical cost and inpatient cost for the delayed-immediate group was \$46,495 and \$104,856, respectively.

Discussion

This pilot study highlights several clinical and economic outcome observations among patients undergoing abdominal wall reconstruction in CDC class IV wounds. Complex hernia patients with dirty or infected wounds have notoriously high rates of post-operative hernia recurrence, mesh infections, and other associated complications.^{9,11-13} While debridement can certainly be performed during the same operation as the definitive repair, we suggest that patients with ECF, mesh infection, or active intra-abdominal infections be optimized by considering completing these steps in a single-admission, multi-staged approach.

Our pilot data suggests that this “delayed-immediate” technique can offer greater control of the abdominal environment through de-escalation of CDC wound classification by the time of definitive abdominal wall repair while preserving reconstructive options and mitigating historically high complication rates. This is reinforced by the lower rate of observed hernia recurrence seen in our study population (28.6%) versus control patients (62.5%).

To provide full context to our findings, we also considered the economic impact of both methods. Based on cost data from our institution, the index surgery and associated hospitalization of the delayed-immediate approach was nearly twice as expensive compared to control patients. This is attributed to multiple trips to the operating room as well as a prolonged length of stay. The prevention of hernia recurrence is particularly important, as delayed-immediate reconstruction led to hernia recurrence in only 14.3% of patients within 1 year after the definitive reconstruction, a rate far lower than the reported average of 32.3% in patients in this wound class.¹¹ We also observed that the delayed-immediate group had fewer overall surgical site occurrences than our control groups patients, including fewer infections, seromas, wound dehiscence, and recurrent ECFs which are likely to reduce postoperative clinic

visit, treatment, and/or readmission costs significantly. However, the delayed-immediate group notably did have a higher rate of skin necrosis. This is likely due to the repeated tissue handling of incisional edges throughout multiple operative cases over a short period of time. This outcome underlines the importance of non-traumatic technique and wound edge revisions as needed.

While the savings seen in recurrence and SSO prevention does not yet prove more cost-effective given the greater up-front expense of the index repair in the delayed-immediate group, separating these repair stages also provides an additional opportunity to surveil the abdomen, which can prevent catastrophic complications and improve patient quality of life. In our “delayed immediate” cohort, 2 patients were initially planned to undergo a definitive single admission, multi-staged reconstruction, but during the planned washout and re-evaluation stages were found to have anastomotic breakdown from their first surgery. This is a highly-morbid complication which occurs in 2.7% of laparotomies requiring small bowel resection.¹⁴ While plans for these patients’ definitive abdominal wall repairs were aborted and they were not considered in the study population as a result, this early observation of an intrabdominal process requiring intervention provided a great benefit.¹⁵ If not identified, these patients would have required re-operation for source control and higher morbidity and greater chance of mortality from sepsis.^{14,16-18} Additionally, early recognition of this adverse outcome provided an economic savings by avoiding placement of expensive mesh material which would have required removal, ICU care costs, and extended lengths of stay.^{18,19} Despite this, the use of “damage control laparotomy” for non-trauma patients, in which the abdomen is intentionally left open remains controversial and typically is not encouraged in settings where musculofascial abdominal closure can be safely completed in one stage.²⁰ While a <3% risk of anastomotic breakdown may not be justified by an additional \$50,000 of cost per case, our study simply reports findings and possible implications. We hope that our data may guide other institutions to track and publish results for similar cases that may help delineate individuals who are most likely to benefit clinically and economically from a delayed-immediate approach while avoiding unnecessary costs to those for whom it is economically detrimental.

Our study is limited by several factors. This includes the small sample size of both study and control populations, and lack of generalizability to other institutions and geographic regions where costs certainly vary. Due to the retrospective nature of our study design, a specific protocol for patient selection was not tested. We hope to introduce this surgical approach to others in the field of complex hernia repairs so that more corroborating

evidence can be acquired to assess the long-term potential benefits and inform a potential future decision algorithm to identify patients who may benefit most from this method. As a pilot study, we hope this will prompt other institutions to evaluate their own practices for hernia repair in CDC Class IV patients that may benefit from the delayed-immediate technique.

Conclusions

This pilot study highlights an alternative approach to the challenge of treating ventral hernia patients with class IV wounds by reducing the wound classification through staged operations rather than the traditional single-stage fashion.

Declaration of Conflicting Interests

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