Timing of Ostomy Reversal in Trauma and Acute Care Surgery

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Introduction

The management of colon and small bowel hollow viscus injuries or emergent pathology requiring surgical intervention has evolved significantly over the past three decades, and the complications associated with delays in diagnosis of these injuries are increasingly recognized [1, 2]. Because of the high mortality and morbidity of destructive colon injuries, during World War II the Surgeon General mandated "exteriorization of the colon" or proximal diverting colostomy for all colorectal injuries [3]. In the 1990s, however, several small prospective trials reported the benefit and safety profile of resection and anastomosis or primary suture repair over routine fecal diversion [4–6]. These findings have since been supported by larger multicenter trials from the American Association for the Surgery of Trauma [7, 8], the Western Trauma Association [9], a large Cochrane review [10], and most recently reinforced by national trauma organization guidelines [11–13]. Overall, stoma creation for both blunt and penetrating injuries is low and has decreased over the past two decades supporting a trend toward primary repair [3]. Nonetheless, less experienced trauma surgeons tend to favor diversion for the management of colon injuries [14] and data suggests that colostomy remains the most common response when surgeons are given trauma scenarios [15]. There is also

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K. Wilson, S. O. Rogers (eds.), *Difficult Decisions in Trauma Surgery*, Difficult Decisions in Surgery: An Evidence-Based Approach,
https://doi.org/10.1007/978-3-030-81667-4_22

persistent and considerable confusion in the literature between risk factors for enteric/anastomotic leaks and indications for ostomy creation. For example, transfusion during an index operation is a commonly cited reason for performing a colostomy, when in fact transfusion is a risk factor for complications regardless of whether an ostomy is performed. It is critical in reading and interpreting the existing literature that surgeons have a clear understanding of specific factors that would indicate a possible benefit of a diverting proximal stoma versus risk factors that simply point to a higher rate of morbidity regardless of whether an ostomy is performed.

Despite a clear trend away from ostomy creation, stomas may be indicated in cases of severe patient comorbidities, extremes of age, clinical instability, or multiple high-risk injuries such as combined pancreatic and colon injuries. In addition to the potential immediate benefits versus harms of an ostomy, it is also important to consider the longer-term impacts and problems. These patient populations, and particularly victims of trauma, have a well-documented higher rate of being uninsured or underinsured and resulting difficulties with follow-up and navigating the healthcare system. Follow-up postoperatively for ostomy closure has been shown to be highly sporadic, with widely varying rates of subsequent ostomy reversal [16]. In the elective literature 6–32% of "temporary stomas" become permanent loop or end ileostomies, and less than 50% of colostomies are subsequently reversed. Recent data, however, suggests that reversal rates in trauma patients may be higher than previously thought. In a recent analysis of trauma patients using a statewide database, investigators found that 41% of all stomas were reversed at 6 months and 72% at 5 years [3]. Because the surgery for ostomy closure or reversal carries significant morbidity [17, 18], the existing colorectal data suggests waiting 60–90 days prior to reversal [18]. Data from the 1980s suggested that there may be increased morbidity if colostomy closure is performed within 6 weeks [19], while other more recent data suggests that the morbidity of colostomy closure may increase with passage of time with the lowest complications rate between 1 and 2 months [20]. These studies also highlight the fact that in analyzing and discussing the risk versus benefit profile of ileostomy or colostomy versus a primary repair/anastomosis, the morbidity and cost of the subsequent ostomy reversal surgery must also be factored in. This is a well-known limitation of the majority of literature comparing ostomy versus primary repair or anastomosis, and falsely lowers the complication and risk profile in the ostomy cohort. In fact, we are unaware of a single existing study comparing ostomy versus primary repair/anastomosis in trauma or emergency general surgery that shows a benefit of ostomy placement when this data is included in the analysis.

Given animal studies that suggest colon wounds are healed after 7 days and contrasted radiographic studies in humans demonstrating wound healing as early as a week from injury [21], surgeons have sought to decrease the time interval between the index operation and stoma creation to a subsequent reversal surgery. Some studies have even examined the same admission ostomy reversal in select patients, although this represents a minority of published experiences. This chapter will review the evolution of evidence supporting early stomal closure in two distinct

patient populations, trauma, and general surgery (emergency and colorectal surgery). We will additionally review the available evidence for both temporary ileostomy and colostomy early reversal. Current data suggests that less than 15% of stomas created are reversed during the same hospital admission [3].

Search Strategy

Our search strategy utilized PUBMED using the keywords, stoma, ostomy, colostomy, ileostomy, early, late, closure, trauma, timing, same admission, and reversal. The references of selected papers were also reviewed to identify additional papers that may have been missed by the primary search. We focused on four patient populations and four PICO questions (see Table 22.1). For purposes of recommendations based on modern practices and literature we limited our search to include only manuscripts from 1990 to 2020.

Results

Early Versus Delayed Stomal Closure for *Trauma Patients* Requiring Fecal Diversion with an *Ileostomy*

There is insufficient evidence to support early ileostomy reversal in the setting of colorectal trauma. While Velmahos et al. included diverting loop ileostomies for ascending colon trauma in their randomized investigation in trauma patients, due to the small sample size of the study, none of these patients were randomized to the early reversal intervention group [22]. Early reversal of diverting loop ileostomies matured in order to "protect" a colorectal anastomosis or a primary repair in the setting of trauma has not been studied. However, there is ample evidence from both

Table 22.1 PICO questions for early versus late ostomy reversal

P (patients)	I (intervention)	C (comparator)	O (outcomes)
Trauma patients requiring fecal diversion following small bowel or colorectal trauma with ileostomy	Reversing ostomy early (<30 days)	Reversing ostomy late (>8 weeks)	Morbidity
Trauma patients requiring fecal diversion following small bowel or colorectal trauma with colostomy	Reversing ostomy early (<30 days)	Reversing ostomy late (>8 weeks)	Morbidity
General surgery patients (general, emergency, colorectal) requiring fecal diversion with ileostomy	Reversing ostomy early (<30 days)	Reversing ostomy late (>8 weeks)	Morbidity
General surgery patients (general, emergency, colorectal) requiring fecal diversion with colostomy	Reversing ostomy early (<30 days)	Reversing ostomy late (>8 weeks)	Morbidity

elective and emergent colorectal procedures that early ileostomy reversal is a feasible and safe option, and little reason to suspect that there would be significant differences between the healing and leak rates seen with emergent colorectal resections versus emergent trauma resections. Further study in the trauma population is necessary to confirm this, particularly as resection with anastomosis and proximal diverting loop ileostomy is becoming a more widely appreciated option for higher-risk anastomoses.

Early Versus Delayed Stomal Closure for *Trauma Patients* Requiring Fecal Diversion with a *Colostomy*

Studies supporting early stomal closure in patients suffering from colorectal trauma are mainly limited to proximal diverting or end colostomies. While the literature dates back three decades, the quality and quantity of the literature remain low and recently updated practice management guidelines from the Eastern Association for the Surgery of Trauma for both extra- and intra-peritoneal colorectal injuries do not address the timing of colostomy reversal [11, 13]. The Western Trauma Association's critical decisions algorithm, suggests an early reversal is feasible based on two studies conducted in the mid-1990s [12]. The first, from Renz et al., introduced the concept of same admission colostomy closure (SACC) for trauma patients and has laid the groundwork for subsequent similar trials. Sixteen patients in this report underwent SACC following diversion for either blunt or penetrating injury mechanisms at a median of 12 days after the index operation. Three patients had postoperative complications, none related to the traumatic colorectal wound or anastomotic leak [16].

Two years later in 1995, *Velmahos* et al. randomized 38 patients to early versus late colostomy closure following colorectal trauma. Eighteen patients underwent early closure. The investigator found no difference in morbidity or mortality between the two groups [22]. Patients all underwent contrast enema in the second postoperative week. However, the authors did identify multiple benefits associated with earlier ostomy reversal including shorter operative times, less blood loss, and a decreased length of stay. They also demonstrated significantly greater technical difficulty with reversing end colostomies versus loop colostomies. Some of these findings have since been challenged by larger studies in elective patient populations that demonstrated generally equivalent complication rates [23, 24]. However, they did similarly find several benefits including shorter hospital stay, lower costs, and improved quality of life scores in the groups randomized to early ostomy reversal [23, 24].

A decade later in 2005, Khalid et al. performed a larger randomized trial of 60 patients undergoing SACC, with the majority of patients (80%) suffering from traumatic colon injuries. The authors concluded that early closure group ($n = 30$) had a shorter length of stay, reduced cost, improved quality of life, and early return to work [25]. Most recently, Nelson et al. reported the benefits of early stomal closure

in a mixed patient population but their analysis does not include a breakdown of the percentage of patient that underwent diversion for trauma [24]. Taken together, these series indicate that early or same admission colostomy reversal in select patient populations can be performed safely and with equivalent or better complication and quality of life profiles.

Early Closure Versus Delayed Closure for *General Surgery* (*Emergency and Colorectal*) Patients Requiring Fecal Diversion with *Ileostomy*

The most robust evidence supporting early stomal closure is in elective colorectal surgery for patients undergoing diversions following low colorectal anastomoses with a temporary ileostomy. While retrospective data supporting early closure (within 14 days) [26, 27] and small randomized pilots trials have been published [28–31], the best evidence is from three larger, randomized trials. Most recently, Danielsen et al. reported the results of the EASY Trial a multicenter European trial in 2017 [32]. Fifty-five patients who were diverted following rectal cancer operations underwent early ileostomy closure between 8 and 13 days after the index operation. All patients underwent preoperative radiographic evaluation to confirm the absence of an anastomotic leak or stricture prior to reversal. The investigators found that patients undergoing early reversal had a significantly lower rate of complications at 3, 6, and 12 months (OR 1.2 vs. 2.9, $p < 0.05$).

In a 2010 study, Khan et al. compared two large groups with over 150 patients in each cohort [33]. These investigators compared early closure (within 4 weeks) to late closure (after 8 weeks). The authors concluded that the total hospital length of stay was shorter, but the incidence of surgical site infection was higher in the early group. Importantly, the absolute rates of anastomotic leak and wound dehiscence were lower in the early closure group, although the difference did not reach statistical significance. While their conclusions are similar to other studies and support the safety and efficacy of early ostomy reversal, it is important to note that their definition of "early" (4 weeks after index operation) differs from other studies.

Finally, Aveles et al. reported the largest randomized trial to date in 2008 in patients undergoing early ileostomy reversal after proctectomy. These investigators similarly found that patients undergoing early closure ($n = 90$) had an equivalent overall rate of complications, fewer obstructive and medical complications, but an increased incidence of surgical sites infections [23]. Interestingly, despite the increased wound infection rate in the early closure group, the hospital length of stay was shorter after early closure. In addition, and unlike prior studies, this study did not find that delayed closure was associated with increased operative times. In summary, this literature appears to strongly support the safety and efficacy of early ileostomy reversal in a variety of general surgery populations, with most outcomes being equivalent or superior to delayed stoma reversal.

Early Closure Versus Delayed Closure for *General Surgery* (*Emergency and Colorectal*) Patients Requiring Fecal Diversion with *Colostomy*

There is insufficient evidence to support early closure of colostomies performed in the setting of emergency surgery and colorectal surgery. In 2018, Nelson et al. reported a randomized controlled trial that included >80% emergency general surgery patients and a mix of diverting stomas that were closed at a range of 14–26 days in the early group. However, it is critical to note that of the 50 patients in the early cohort, only 18 patients had colostomies [24]. The investigators found no difference in postoperative complications, but did demonstrate decreased costs and an improved quality of life with early colostomy reversal. Similar to other investigations, these authors also reported higher surgical wound infections in the early group, but this did not seem to adversely impact the length of stay, costs/charges, or patient quality of life. Some small retrospective series with mixed patient populations have also confirmed similar outcomes [34].

A more recent large database analysis examined 1660 patients who underwent an emergent Hartmann's procedure (sigmoid resection and end colostomy) for diverticulitis [35]. They found that earlier ostomy reversal (defined as 45–110 days from the index surgery) was associated with a shorter length of stay and 90-day readmission rate, and no increased risk of anastomotic leak or other complications. Of interest, they demonstrated that less than one-third of patients underwent colostomy reversal within 1 year and that socioeconomic factors influenced this metric.

Systematic Reviews for Early Closure Versus Delayed Closure

Several meta-analyses have been published investigating the timing of stomal closure [36–40], taken together and taking into account the heterogeneity of the data, these data suggest and favor early stomal closure with comparable and improved outcomes compared to delayed closure with the exception of wound complications. However, it is important to note that four of the five analyses focused on diverting loop ileostomies, and they included a wide mixture of patient populations including non-emergent elective colorectal resections. They also used a wide and variable definition of "early" ostomy reversal ranging from as early as 7 days to as late as several months after the index operation.

Examining the Need for Diverting or "Protective" Ostomies

This chapter focuses on the question of early versus late ostomy reversal and starts with the presumption that a diverting or protective ostomy has been created. The cumulative data appear to indicate that early ostomy reversal in the properly selected patient is safe and associated with improved outcomes versus delayed closure.

However, it is also critically important to consider the additional question of whether creation of the ostomy is associated with better or worse outcomes than would be achieved with performing a primary repair or anastomosis and foregoing any ostomy creation. Although ostomy creation has historically been the norm for destructive colorectal injuries or emergent colon resections, the past several decades have demonstrated accumulating body of evidence supporting the safety and efficacy of primary anastomosis without an ostomy for most injuries or disease pathologies [6, 7, 9, 10, 12, 13]. In addition to further study regarding the practice of early or even same admission ostomy reversal, there must be continued analysis of the outcomes associated with primary repair/anastomosis as a definitive treatment even in the emergent setting, and a better characterization of which risk factors can reliably identify the small subgroup of patients who would be benefited by creation of an ileostomy or colostomy.

Recommendations Based on Data

1. Recovering trauma patients with temporary diverting loop colostomies can be considered for early, same admission colostomy closure after radiological confirmation of wound healing and no anatomic contraindication to reversal (Evidence quality moderate; moderate recommendation).
2. Earlier ostomy reversal (defined as 45–110 days from the index surgery) is associated with a shorter length of stay and 90-day readmission rate without an increased risk of anastomotic leak or other complications (Evidence quality moderate; moderate recommendation).

Personal View of Data

As academic and clinical surgeons, it is always good to identify and question our inherent biases or "surgical truths" that have been handed down based on anecdote rather than evidence. The management of colorectal trauma and emergency surgery for colorectal diseases is an area that has been particularly dominated by dogmatic approaches and practices, but where there also has been steady progress forward based on both accumulating experience and high-quality data analysis. We have moved from a position of mandatory ostomy or "wound exteriorization" for all traumatic colon injuries to the understanding that the majority can be treated with primary repair or resection and primary anastomosis without ostomy creation. Similarly, and thankfully, we are also slowly moving away from the Hartmann's procedure in favor of resection and anastomosis or anastomosis with proximal diverting loop ileostomy for perforated or complicated diverticulitis. It is our opinion that the Hartmann's procedure should be relegated to the least frequently utilized operation, reserved only for the dire straits of severe physiologic illness, extremes of age and comorbidities, or complex anatomic abnormalities that

preclude an anastomosis. In the authors' current practice the overall usage of a diverting colostomy has decreased significantly, the use of primary anastomosis continues to increase even for destructive colon injuries or Hinchey grade III/IV diverticulitis, and if a diverting ostomy is felt to be necessary then is most commonly a temporary loop ileostomy.

For the patient who did receive or require (which are two different things) an ostomy, we are then faced with the complex questions of whether to reverse it, when to reverse it, and how to safely make these decisions. Table 22.2 outlines some of the complex factors and decisions that we must make when dealing with colorectal injuries or emergency surgery, including the decision for attempting an early versus a standard (or late) reversal. Arguably the most important factors in this decision are patient stability, associated injuries or active medical problems, and the type/location of repair or anastomosis that is being protected. In terms of the type of ostomy, the most important factor in this consideration is whether a loop colostomy/ileostomy was created versus an end stoma. The former is much more amenable to early or even "same admission" reversal as they typically only require a local mobilization, anastomosis, and return to the abdominal cavity and not a repeat laparotomy or abdominal exploration. We believe that the majority of data strongly supports the safety and efficacy of early reversal (within 1–4 weeks) of loop ostomies providing that there are no other risk factors as outlined above and in Table 22.2. Although the data in the trauma population on this topic is much less robust compared to emergency and elective colorectal surgery, there is little reason to suspect that the outcomes would be markedly different provided that appropriate patient selection and preoperative evaluation protocols are utilized. For end colostomy or ileostomy, the risk:benefit calculus is significantly different as these will typically require a repeat laparotomy (although laparoscopy is being increasingly utilized) to take down the stoma and perform the anastomosis to re-establish intestinal continuity. These reversal procedures can be particularly difficult if it requires dissection back into an area that had significant inflammation and/or infection, such as reversing a Hartmann's procedure done for Hinchey III or IV diverticulitis. In these cases, we believe it is wiser to not attempt early or same admission stoma reversal, and to delay this procedure until at least 6–8 weeks later. However, for the majority of patients, we do not feel that additional and usually arbitrary time delays (3–6 months for example) offer any benefit unless the patient has additional active issues or contraindications that need time for treatment and resolution. Prior to ostomy reversal, and of particular importance when attempting any early reversal, is the preoperative evaluation of the existing anatomy and status of any repairs or anastomoses. This is usually best accomplished by a contrast study to evaluate for any leak or stricture, although endoscopy can be utilized in select scenarios. Another critical factor, and one that can result in devastating outcomes if overlooked, is assessing the anorectal complex, sphincter tone, and voluntary function to ensure that the patient will not have major fecal incontinence problems after restoring intestinal continuity.

Table 22.2 Key intraoperative and early postoperative management issues and decisions in colorectal trauma

Key decision	Factors to consider	Technical issues/pearls
Primary repair or resection?	Size of injury Shape of injury (linear, round/stellate) Single or multiple Tissue quality Mesentery status (rents, hematomas, devascularized)	Debride injured or burned tissue Connect close injuries rather than leaving "bridges" Evacuate large mesenteric hematomas Close mesenteric tears Resect segment with "bucket-handle" mesenteric defect
Damage control?	Patient stability Transfusion requirement Acid/base getting better or worse? Multiple injuries? Another reason for a "second-look" (i.e., bowel viability)	Make a decision early in case Proceed if patient improving, terminate if getting worse Vacuum-assisted temporary closure works best Usually no need for other drains
Anastomosis or ostomy?	Patient baseline status (age, comorbidities, meds) Physiologic status Quality of the tissues Other injuries and proximity to anastomosis Body habitus, ability to properly site an ostomy	Consider difficulty and risk of ostomy takedown Be wary of anastomosis with an associated pancreatic injury! Obesity increases difficulty and complications with ostomy Consider ostomy complication profile in risk:Benefit analysis
Anastomosis: Hand-sewn or stapled?	Operative time Other injuries to address Personal experience and comfort Tissue quality, edema Anatomic area and bowel alignment, available equipment	No difference in leak or complication rates in most series Hand-sewn potentially more secure with suboptimal tissue quality, bowel wall edema Laparoscopic staplers great for pelvis, hard-to-reach areas or sharp angles
Ostomy: Loop, end, other?	High-risk anastomosis that needs protection? Need access to distal bowel segment? Body habitus Mesentery—Shortened, edematous	Loop may reach skin easier with obesity or short mesentery May not get complete fecal diversion with a loop Remember the "end-loop" option (see text) Use an ostomy bar if any tension or obese patient
Leave a drain?	No indication for routine drainage of bowel anastomoses Widely drain any other adjacent injuries (pancreas, bladder, etc.) Other reasons: Associated abscess cavity, control ascites	Avoid direct contact of drain with anastomosis Larger sump drains usually not beneficial Make exit site remote from incision and any ostomy

(continued)

Table 22.2 (continued)

Key decision	Factors to consider	Technical issues/pearls
Early ostomy reversal?	Type and location of anastomoses or primary repairs Presence/severity of associated injuries vs. isolated injury Normalization of patient physiology Age, comorbidities, any impaired healing Current substance use/abuse, nutritional status Anorectal complex integrity, function, continence	Early or same admit loop ostomy reversal feasible in select low-risk patients based on these listed factors Preop contrast study demonstrating no leak, stricture, other abnormality End ostomy requiring laparotomy for reversal usually better to delay at least 2–3 months

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