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Cumulative incidence and management of enterocutaneous fistulas owing to laparotomy for penetrating abdominal trauma: a single centre experience

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Background: Enterocutaneous fistula (ECF) owing to laparotomy for penetrating abdominal trauma (PAT) is rarely reported. The quoted incidence in two recent publications is 1.9% and 1.5%, in 2224 and 2373 patients, respectively. Advances in trauma surgery including damage control surgery and the use of open abdomen techniques, have led to concerns of increasing fistula rates in trauma patients. The purpose of this study was to determine the incidence and outcomes of patients with ECF resulting from penetrating abdominal trauma.
Methods: A retrospective study including patients who underwent laparotomies for PAT between 01 January 2015 and 31 August 2018 (44 months) was performed. The Groote Schuur Hospital (GSH) Trauma Centre RedCap, GSH Intestinal Failure Unit and the Stoma Therapy department databases were scrutinised by folder review.
Results: Of a total of 965 patients with PAT, 597 underwent laparotomies and 586 had hollow viscus injury (HVI). Twenty-six patients (4.4%) developed an ECF or an anastomotic leak. Thirteen (50%) patients underwent damage control laparotomy. Fistulas and leaks occurred in small bowel 13 (50%), large bowel 7 (26.9%), and duodenum 6 (23.1%). Five patients with ECF spontaneously resolved with medical treatment. Six patients (42.9%) with ECF were managed in the intestinal failure unit and required surgical intervention. Five anastomotic leaks were addressed at early relook laparotomy, with a mortality rate of 58.3%.
Conclusion: The anastomotic leak/ECF rate in PAT in our centre is 4.4% and is associated with a high mortality of 30.8%.
Keywords: enterocutaneous fistula, penetrating trauma, abdominal trauma, anastomotic leaks, trauma surgery

Introduction

Enterocutaneous fistula (ECF) following laparotomy is a common and serious complication that has been widely reported following abdominal surgery, however, for penetrating abdominal trauma (PAT) it is rarely reported on. The most recent incidence of 1.9% and 1.5% of patients undergoing laparotomy for abdominal trauma was reported in 2009 and 2008, respectively.[1,2] Advances in trauma surgery, including damage control resuscitation and abbreviated laparotomy, together with the increasing utilisation of temporary abdominal closure, have led to the perception of increasing fistula rates, therefore updated incidence rates are essential.[3]

Prior to establishment of mature fistulas, anastomotic leaks (ALs) from bowel repairs are usually identified as septic foci, detected either radiologically and/or at relook laparotomy.[4] ALs and ECFs secondary to PAT present sequentially. However, their respective time-to-development varies, with ALs tending to be detected early, while ECFs tend to develop over a longer time.

To categorise these two similar complications, this study introduces the umbrella classification of "suture-line catastrophes" (SLCs) to differentiate and allow for standardised reporting. SLCs pose significant morbidity risks for patients, have adverse effects on quality of life, and may lead to additional complications including death.

The purpose of this study was to determine the incidence and outcomes of patients with ALs and ECFs resulting from PAT in a single tertiary institution.

Methods

A retrospective folder review was performed on all patients who underwent their index laparotomy for PAT at Groote Schuur Hospital (GSH), an academic level one trauma centre in Cape Town, South Africa. All records from 01 January 2015 to 31 August 2018 were included equating to a total of 44 months. Inclusion criteria for the study were all PAT undergoing laparotomy, whereas patients with blunt trauma and those referred post-laparotomy from other hospitals were excluded. Patients with extraperitoneal rectal injuries that were not explored and repaired, and managed with proximal diversion only, as per the unit protocol, were also excluded.

All patients who developed a SLC post initial trauma laparotomy were identified from the Trauma Centre PAT Redcap database and cross-referenced with the Intestinal Failure Excel database from the Colorectal Unit, and the

Table I: Data extracted from participants files

Demographics	Date of birth, age, sex
Mechanism of injury	Stab, gunshot
Admission physiology	Blood pressure, pulse rate, respiratory rate, arterial blood gas parameters
Injury severity scores	PATI – penetrating abdominal trauma index, ISS – injury severity score, RTS – revised trauma score
Intra-abdominal injuries and AAST Injury Organ Grading	Gastric, duodenum, small bowel, colon
Damage control surgery	Yes or No
Laparostomy	Fascial closure within 7 days
Hospital and ICU stays	Length of stay in days
Mortality	

Stomatherapy Unit database (manual record). Table I lists the data extracted for analysis.

The presence of an AL or ECF was documented. AL was diagnosed based on a combination of clinical deterioration (including sepsis, enteric output from drains or wounds), radiological findings where available, and intraoperative confirmation at relook laparotomy.

In this trauma cohort, the primary indication for relook laparotomy was clinical deterioration suggestive of intraabdominal sepsis rather than routine imaging. The following data were recorded regarding ECFs: anatomic definition, management and outcome was determined. Fistula anatomy (stomach, duodenum, small bowel, colon, rectum) and if a damage control laparotomy (DCL) was performed was identified. The length of hospital and ICU stay was determined as well as the overall outcome of each patient. Data was entered onto a password-protected Microsoft Excel spreadsheet. Values are reported as mean, interquartile range and raw percentages.

The study received ethical approval from the University of Cape Town's Human Research Ethics Committee (HREC reference: 637/2018).

Results

Sample selection

During the 44-month study period, 965 patients with penetrating abdominal trauma in the form of either a stab or gunshot wound met the inclusion criteria for the study. All the patients were male with a mean age of 32.53 (IQR 17) years. Of the 965 patients, 597 (61.9%) underwent laparotomies with 586 (60.7%) patients identified with hollow viscus injuries. SLCs were noted in 26 (4.4%) patients. Gunshot injuries occurred in 25 (96.2%) of the patients and one patient sustained an abdominal stab (3.8%). Of the 26 patients with SLC post-bowel-repair, 12 (46.2%) were identified as an AL at relook laparotomy and 14 (53.8%) developed an established ECF (Figure 1). Patients with ALs and ECFs were analysed separately.

Anastomotic leaks (n = 12)

Seven (58.3%) patients underwent DCL, and all patients sustained an abdominal gunshot wound. The mean age of patients was 32.8 (IQR13).

ALs occurred mostly in the duodenum (5), large bowel (4), small bowel (2) and ileo-colic region (1). One patient's small bowel leak was subsequently excised and repaired at the relook laparotomy. One patient with a large bowel leak had a Hartmann's procedure performed. Three patients with large bowel suture-line breakdown were exteriorised as loop colostomies, which were reversed without complications. One patient leaked from his ileocolic anastomosis post-right-hemicolectomy. This was exteriorised as a double barrel stoma. Patients spent on average 42.5 (IQR 53.5) days in hospital with 19.5 (IQR 11) days in ICU. Seven (58.3%) patients died of severe sepsis with multi-organ failure. The anatomical location of injury of the seven patients who died were as follows: 5 duodenal, 1 gastric and 1 large bowel. All these patients underwent DCL.

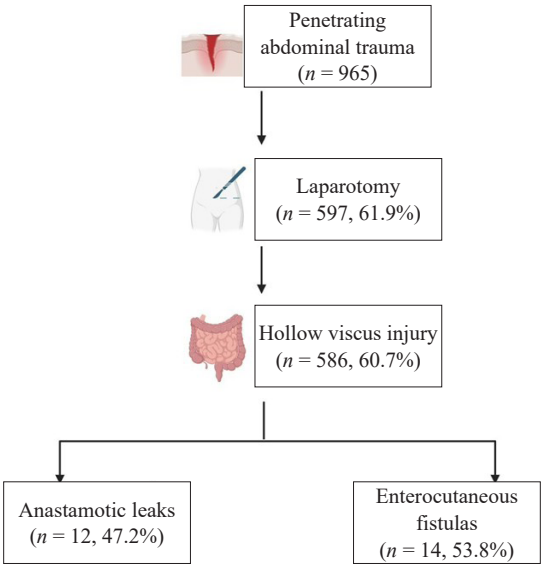

Figure 1: Population meeting inclusion criteria, management and relevant complication

Enterocutaneous fistulae (n = 14)

Six (42.9%) patients underwent DCL. One of the 14 patients sustained a stab wound, and the rest all sustained a gunshot wound to the abdomen. The mean age of patients was 30.8 (IQR 18). Eleven patients developed ECFs from a small bowel injury, and two injuries sustained to the colon developed into an ECF. Five (35.7%) patients' fistulas spontaneously resolved with a mean time to closure of 71.6 days (IQR 114.5) with standard fistula management in the trauma centre. Six patients were managed by the Intestinal Failure Unit and had an elective closure of their ECFs with a mean time to closure of 210 days (IQR 180). One (7.1%) patient with a small bowel ECF died of severe sepsis, one patient with a large bowel ECF was lost to follow-up

Table II: Comparison of patients with anastomotic leaks and enterocutaneous fistulae

	Anastomotic Leak (*n* = 12)	Enterocutaneous Fistula (*n* = 14)
Gender		
Male	12	14
Female	0	0
Mean age (years)	32.8 (R 23–51) (IQR 13)	30.8 (R 19–59) (IQR 18)
Mechanism of injury		
GSW	12	13
SW	0	1
Severity scores (mean)		
RTS	7.65 (R 7–8) (IQR 0.27)	7.66 (R 6–8) (IQR 0.04)
PATI	39.2 (R 22–77) (IQR 29)	27.4 (R 9–47) (IQR 8)
ISS	22.4 (R 9–43) (IQR 8.5)	20.6 (R 4–75) (IQR 13)
Damage control surgery	7 (58.3%)	6 (42.9%)
Anatomy		
Duodenum	5	1
Large bowel	4	2
Small bowel	2	11
Ileo-colic	1	0
Management (Mean time to intervention)	Resection and anastomosis (1) (48 hours)	Definitive closure (6) 7.3 (R 4–14) months
	Leak exteriorised (4) (48–120 hours)	Conservative management (5) 71.6 (17–210) (IQR114.5) days
Total hospital stay (days)	42.5 (R 2–144) (IQR 53.5)	106.8 (R 11–258) (IQR 132)
Total ICU stay (days)	19.5 (R 11–41) (IQR 11)	16.4 (R 3–54) (IQR 35)
Mortality	7 (58.3%)	1 (7.1%)
	Duodenum (4)	Small bowel (1)
	Duodenum & LB & SB (1)	
	Stomach (1)	
	Large bowel (1)	

RTS – Revised trauma score, PATI – Penetrating abdominal trauma index, ISS – Injury severity score, GSW – Gunshot wound, SW – Stab wound

and one patient with a large bowel ECF refused medical treatment and was subsequently lost to follow-up. The mean duration of hospital stay was 106.8 days (IQR 132) with a mean of 16.4 days (IQR 35) in ICU. Table II compares the two groups.

Patients with AL had a significantly higher mortality compared to those who developed ECF (58.3% vs 7.1%, Fisher's exact test, $p \approx 0.01$). No statistically significant differences were observed between the two groups with respect to damage control surgery (DCS) or mechanism of injury. ISSs were numerically higher in the AL group; however, formal comparative analysis was not performed due to small sample size.

Discussion

This study intended to focus on the presence of ECFs following PAT, due to a paucity of available large-scale data. ECFs cannot be discussed in isolation given the spectrum that ALs and ECFs exist upon, with the latter developing because of the former. The umbrella classification of "suture-line catastrophes" was utilised to better reflect this spectrum. Traditional classifications of AL and ECF largely arise from elective colorectal surgery and may not adequately capture the spectrum, complexity, and physiological impact of failures following emergency trauma laparotomy.

In the trauma setting, tissue oedema, contamination, DCS, delayed anastomosis, and ongoing sepsis often result in a continuum of pathology rather than discrete entities. The term "suture-line catastrophe" was therefore employed to describe clinically significant breakdown of gastrointestinal repair or anastomosis resulting in enteric leakage with systemic consequences, irrespective of formal fistula classification. This terminology facilitates more pragmatic reporting in trauma cohorts and aligns better with clinical decision-making focused on sepsis control and nutritional salvage rather than strict anatomical definitions.

The incidence of SLCs in this study of 4.4% is to our understanding, the first to be reported in South Africa. This is almost twice the previously reported incidence and therefore, highlights the challenges in managing these complications in trauma. Key observations include the high mortality associated with AL (58.3%) compared to the relatively low mortality rate of ECF (7.1%). These outcomes reflect the severity of early septic complications in AL versus the protracted course and multidisciplinary management required for ECF.[5]

Although formal multivariable analysis was not feasible due to the limited number of mortality events, deaths occurred predominantly in patients with AL involving the duodenum or multiple bowel segments, and in those with higher PATI scores. These findings suggest anatomical

location and injury burden as important contributors to mortality but should be interpreted with caution.

The findings align with the hypothesis that ALs and ECFs represent different points in the continuum of suture-line failure, with ALs typically occurring earlier and ECFs developing over a longer period. This study noted that ALs, with their early and often dramatic clinical presentation, are frequently accompanied by sepsis and organ dysfunction, explaining the higher mortality in our study and that is supported by literature.[5-8] Conversely, ECFs, though debilitating, allow for extended timeframes to stabilise patients before definitive surgical management. The term "suture-line catastrophes" may assist in standardising reporting and facilitating comparative analysis in future research. This is a valuable contribution considering the sequential nature of ALs and ECFs. It recognises that all ECFs were initially ALs, and therefore reporting of both is essential to treat and minimise morbidity and mortality rates.

The mechanism of injury plays a critical role in predisposing patients to ALs, particularly in the context of traumatic bowel injuries. High-velocity or penetrating trauma is often associated with extensive tissue damage, devascularisation, and contamination, all of which compromise the local environment necessary for optimal anastomotic healing. The extent and nature of tissue trauma can directly impact the integrity of the anastomosis by affecting perfusion, increasing local inflammation, and reducing the viability of the bowel ends. Furthermore, injuries involving multiple organ systems or associated with haemodynamic instability often necessitate damage control surgery and delayed primary anastomosis, further complicating the healing process. Therefore, understanding the mechanism of injury is essential when assessing the risk of anastomotic failure and in guiding intraoperative decision-making regarding the appropriateness and timing of an anastomosis.

DCLs emerged as a significant factor in the development of both AL and ECF, with over half of the patients in both groups undergoing DCLs. This finding is consistent with previous studies suggesting that the open abdomen, delayed definitive repair and prolonged inflammation increase the risk of suture -line failure.[4-7] This also suggests that the initial physiological derangement in these patients may predispose them to early suture-line failure. Severity scores (RTS, ISS, and PATI) were slightly higher in AL patients, correlating with more extensive injuries and worse outcomes and higher mortality. Early identification and management are pivotal, as evidenced by interventions such as leak exteriorisation and resection, though the overall prognosis remains guarded.[4,6,7,9,10]

Interestingly, the anatomical distribution of leaks and fistulas also varied, with duodenal injuries being more prevalent among AL cases. The duodenum's retroperitoneal location, complex blood supply, and proximity to vital structures likely contribute to poorer outcomes. Small bowel injuries dominated in ECF cases. This aligns with the small bowel's propensity for trauma-induced perforations and subsequent complications. This distinction has implications for both surgical technique and postoperative monitoring.[8,11,12]

The prolonged hospital and ICU stays for patients with SLCs highlight the burden on healthcare systems, particularly in resource-limited settings. The mean hospital stay for ECF patients (106.8 days) was significantly longer than for AL patients (45.5 days), displaying the extended period required for conservative management and delayed definitive surgical interventions. The protracted course of care underscores the importance of multidisciplinary management, including nutritional support, wound care, and infection control, in achieving favourable outcomes for ECF patients.[1-3,12] Despite these challenges, the study reported successful closure of fistulas in the majority of ECF cases, with spontaneous closure occurring in 35.7% of patients and elective surgical closure in 42.9%. This emphasises the potential for favourable outcomes with appropriate management, even in complex cases. However, this requires early identification of AL and the involvement of a multi-disciplinary team from the start. Due to being a resource limited setting this does not always occur resulting in associated complications of some fistulas. This remains a significant concern, requiring careful patient selection and timing for surgical interventions.[9,11,12]

When comparing the findings to previous studies, the study's lower mortality rate for ECF patients may reflect improved multidisciplinary care and early identification of risk factors.[7] However, the high mortality rate for AL patients underscores the need for targeted strategies to prevent leaks and improve early detection and intervention.[10]

Conclusion

This study has contributed to the available data on SLCs in patients with penetrating abdominal trauma. It provides valuable insights into the incidence, management, and outcomes of SLCs and underscores the significant morbidity and mortality associated with these complications. The findings emphasise the pivotal role of multidisciplinary care in managing both ALs and ECFs. The novel introduction of the "suture-line catastrophes" classification offers a valuable conceptual step in the context and framework for standardised reporting of ALs and ECFs. Efforts to optimise surgical techniques, improve early detection of leaks, and enhance conservative management strategies for fistulas are essential to reducing the burden of SLCs. Future research should focus on identifying predictors of SLC development, refining surgical protocols, and exploring innovations in wound care and nutritional support to improve outcomes for this challenging patient population. The study also emphasises the need for accurate record-keeping, resource allocation and training to manage these complex cases effectively, particularly in resource-constrained settings.[9]

Study limitations

Human error that may naturally occur during manual folder review was minimised by two junior researchers doing the initial folder review, with a subsequent check by a senior clinician. Statistical power may have been a key limitation given the sample size. While exploratory univariate analysis was performed, the number of mortality events was too small to support reliable multivariable modelling without significant risk of overfitting. We have highlighted potential predictors based on observed trends, acknowledging that these findings should be interpreted with caution. Poor documentation on the part of the treating teams left several useful variables pertaining to the patients' ECFs missing upon folder review. Namely, ECF output, accurate anatomical locations, physiological parameters at

presentation or throughout the course of stay and, critically, the events leading up to the demise of the patient's included. Absent note-keeping regarding decisions for referral to the Intestinal Failure Unit would have added a useful layer of clinical understanding to each patient that regrettably was not available.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

The study received ethical approval from the University of Cape Town's Human Research Ethics Committee (HREC reference: 637/2018).

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