Planned Re-laparotomy in a Non-Trauma Setting: A Single Center Experience

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ABSTRACT: **Background:** Damage control laparotomy (DCL) is the widely accepted procedure of choice in management of severely injured trauma patient. It has been implemented in non-trauma-related surgical pathology in the last decade.

Objectives: To evaluate our experience with planned re-laparotomy (PRL) in non-trauma patients and compare it to other reports.

Methods: Charts of all patients admitted to Assaf Harofeh Medical Center who underwent PRL for non-trauma-related abdominal pathology during a 6 year period were reviewed. Data regarding demographics, vital signs, laboratory tests, indications for surgery, length of hospital stay, and mortality were obtained from medical charts. Indications for surgery, risk factors, and mortality were analyzed.

Results: The study was comprised of 181 patients. Primary abdominal sepsis (50), postoperative sepsis (49), mesenteric event (32), and intestinal obstruction (28) were the most common indications for PRL. Mortality rate was 48.6%. Factors correlating with increased mortality were advanced age, hypotension, hypothermia, metabolic acidosis, and renal failure. Bowel resection was performed on 122 patients (67%) and primary intestinal anastomosis constructed in 46.7%. Mortality rate was lower in patients who underwent PRL with primary anastomosis compared to patients with postponed bowel anastomosis (33.3% vs. 55.4%, $P = 0.018$).

Conclusions: PRL in abdominal emergencies carries a high mortality rate. Primary anastomosis may be considered in non-trauma-related PRL.

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KEY WORDS: damage control laparotomy (DCL), planned re-laparotomy (PRL), septic abdomen

Metabolic failure manifested by metabolic acidosis, hypothermia, and coagulopathy have been recognized as causes of increased mortality in severely injured patients who undergo prolonged surgery. When metabolic failures are anticipated, the surgeon may consider abbreviated laparotomy and temporary abdominal closure followed by improvement of the physiological status before attempting definitive surgery. Damage control laparotomy (DCL) is a widely accepted procedure in management of critically ill patients with abdominal trauma [1,2].

Since its introduction in the treatment of trauma patients, the concept of DCL has been adopted in the management of non-trauma-related abdominal emergencies. Although the use of planned re-laparotomy (PRL) for non-trauma emergencies has been increasing, we were able to identify numerous publications. [3-14].

The decision to leave the abdomen open is based on different factors, such as the patient's general condition, technical inability to close the abdominal wall, or the need to re-evaluate the abdomen. Commonly used indications include severe intra-abdominal infection, bowel ischemia, and severe bowel edema.

The aim of this study was to evaluate our experience in performing PRL in non-trauma patients and compare this experience to other reports in the literature.

Special attention was given to the indications and outcome of PRL in this patient population.

PATIENTS AND METHODS

A retrospective observational case-control study was performed at Assaf Harofeh Medical Center. This study was approved by the center's institutional review board (No. 185/13).

Hospital charts of all patients who underwent explorative laparotomy for non-trauma-related abdominal pathology at least twice during the same hospitalization from 1 January 2007 to 31 December 2012 were reviewed. Patients who underwent re-laparotomy on demand were excluded.

Extracted data included patient demographics, indication for primary surgery, vital signs and laboratory data before the initial surgery, surgical findings, number and timing of surgical procedures, time to definitive abdominal closure, length of stay in the intensive care unit stay (LICU), length of hospital stay (LOS), and mortality.

Planned re-laparotomy was defined as laparotomy performed after urgent primary surgical intervention that left the abdominal wall open.

The abdomen was temporary closed using the Bogota bag alone or by sandwich techniques according to the operating

attending surgeon's preference. Re-laparotomy was planned to be performed 24 to 48 hours after the initial surgery and based on the patient's condition.

Heart rate > 100 beats/minute, systolic blood pressure < 100 mmHg, and body temperature < 35°C were considered as abnormal.

Laboratory data included arterial blood gases; white blood cell count (WBC); base excess; and levels of lactate, hemoglobin, and creatine.

STATISTICAL ANALYSIS

To compare quantitative (continuous) variables between the two independent groups, the two sample *t*-test was applied as well as the non-parametric Mann–Whitney test. The association between the two categorical variables was assessed using either the chi-square test or Fisher's exact test. All statistical tests applied were two-tailed. A *P* value < 0.05 was considered statistically significant. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 20 (SPSS, IBM Corp, Armonk, NY, USA).

RESULTS

Overall, 181 patients underwent PRL for non-trauma related indications during the study period. Indications for PRL are outlined in Table 1. The most common indications for surgery were primary abdominal sepsis, postoperative sepsis, and mesenteric events. The median age was 71 years (range 18–95 years). Ninety-eight (54.1%) were male and 83 (45.9%) were female. The median number of operations was three (range 1–8). Median ICU stay was 11 days (range 0–98 days) and median LOS was 19 days (range 0–176 days). No differences were found between the number of operations ($P = 0.2384$), ICU stay ($P = 0.5395$), or LOS ($P = 0.1508$) among the different indications for PRL. Eighty-eight (48.6%) patients died during the study period.

Table 2 describes possible risk factors for mortality in patients who underwent PRL. The patients who died were older and hypotensive; they presented with renal failure. Mortality increased with hypothermia and increasing base deficit. Bowel resection was required in 122 patients (67%) in the index procedure. Primary anastomosis was performed in 57 (46.7%). The mortality rate was 45% in patients who underwent bowel resection compared to 55% in cases in which bowel resection was not required ($P = 0.2$). The mortality rate was 33.3% in patients who underwent bowel resection with primary anastomosis compared to 55.4% in cases in which anastomosis was avoided and the bowel left closed on initial surgery ($P = 0.018$). LICU and LOS were 15 ± 12 and 32 ± 30 in the primary anastomosis group vs. 22 ± 16 and 40 ± 30 in the group with close bowel. Only surviving patients were included. An additional

Table 2. Risk factors for mortality

	Presence of risk factors in fatalities (%)	Presence of risk factors in survivors (%)	Odds ratio (95%CI)	*P* value
Age, years				
≥ 50	86 (97.7)	73 (78.5)	11.781 (2.66–52.12)	< 0.0001
≥ 60	74 (84.1)	55 (59.1)	3.652 (1.80–7.39)	0.0003
≥ 70	63 (71.6)	31 (33.3)	5.040 (2.68–9.49)	< 0.0001
≥ 80	39 (44.3)	9 (9.7)	7.429 (3.32–16.63)	< 0.0001
Vital signs				
SBP < 100 mmHg	16 (19.0)	5 (6.0)	3.718 (1.29–10.68)	0.0179
Hypothermia (< 36°C)	19 (26.0)	10 (12.3)	2.498 (1.07–5.81)	0.0389
Laboratory results				
Hemoglobin < 10g%*	26 (29.9)	20 (21.7)	1.534 (0.78–3.02)	0.2342
WBC > 10,000*	59 (67.8)	62 (67.4)	1.000 (0.55–1.91)	1.0
Creatin ≥ 1.5*	39 (44.8)	23 (25.3)	2.402 (1.27–4.53)	0.0075
Base deficit ≤ -4	44 (55.7)	28 (38.9)	1.976 (1.03–3.78)	0.0503
Base deficit ≤ -8	22 (27.8)	10 (13.9)	2.393 (1.04–5.49)	0.0461
Number of surgeries				
3 or more	41 (46.6)	54 (58.1)	0.630 (0.35–1.13)	0.1380
4 or more	15 (17.0)	22 (23.7)	0.6631 (0.32–1.38)	0.3567
5 or more	9 (10.2)	14 (15.1)	0.6429 (0.26–1.57)	0.3772
Types of surgeries				
Bowel resection**	55 (62.5)	67 (72.0)	0.6468 (0.35–1.21)	0.2050
Bowel resection and anastomosis**	19 (34.5)	38 (56.7)	0.4028 (0.19–0.84)	0.0181
Fatalities	51 (60.7)	51 (60.7)	1.000 (0.54–1.86)	1.0

*missing data (points.): pulse (13), systolic blood pressure (13), temperature (27), hemoglobin (2), WBC (2), creatine (3), base excess (30)

**Only patients who underwent bowel resection

95%CI = 95% confidence interval, SBP = systolic blood pressure, WBC = white blood cell count

Table 1. All patients who underwent non-trauma planned re-laparotomy

Indication	Patients, n	Median age (range)	Gender male: female	Median number of surgeries (range)	Median ICU stay, days (range)	Median LOS, days (range)	Mortality (%)
Primary abdominal sepsis	50	70 (27–90)	27:23	2 (1–8)	9.5 (0–50)	14 (0–134)	46
Postoperative sepsis	49	68 (18–86)	25:24	3 (1–6)	10 (1–61)	21 (1–176)	42.9
Mesenteric event	32	77 (26–94)	16:16	3 (1–6)	13.5 (0–55)	17 (0–89)	71.9
Intestinal obstruction with necrosis	28	63.5 (46–94)	16:12	2 (1–7)	9.5 (0–59)	17.5 (0–87)	42.4
Second look procedure	8	79 (22–95)	3:5	3 (2–5)	23.5 (2–38)	31.5 (2–72)	37.5
Ischemic event due to other causes	8	70 (50–77)	4:4	3 (2–4)	16 (4–50)	34 (11–126)	25
Compartment syndrome	3	77 (74–90)	1:2	2 (2–3)	17 (12–98)	17 (12–116)	66.7
Intra-abdominal hemorrhage	3	73 (39–74)	0:3	2 (2–2)	17 (7–40)	22 (19–59)	33.3

ICU = intensive care unit, LOS = length of hospital stay

bowel resection was required in 53.9% of patients with delayed primary anastomosis compared to 29.8% of patients in whom primary anastomosis was initially conducted ($P = 0.01$).

DISCUSSION

Following the introduction of DCL in trauma, this approach has gained acceptance as a valid form of treatment in patients undergoing emergency surgery for intra-abdominal emergencies. While widely used, current data on non-trauma PRL is insufficient.

The most common indications for DCL in this and other studies included severe abdominal infection and acute mesenteric ischemia [Table 3] [15]. The main goals of PRL for each of these indications may be different.

DCL in trauma is mainly aimed at limiting the operation to those components that are necessary to sustain life without exhausting the metabolic reserves of the injured patient. Non-trauma PRL in severe abdominal infection and acute mesenteric ischemia enables a repeated inspection of the abdominal cavity, improves control of sepsis, and avoids intra-abdominal hypertension.

Whether non-trauma PRL decreases mortality has not been examined thoroughly. To the best of our knowledge, there is only one study of 14 patients who underwent non-trauma PRL, mostly for abdominal sepsis [3]. Of these patients, only one (7.1%) died. Mortality rate in this study was much lower than the expected mortality rate of 64.5% and 49.6%, as predicted by the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) and the Portsmouth predictor equation (P-POSSUM), respectively [16].

Such a low mortality rate, as that reported by Finlay et al. [3] was not replicated in our study nor in most other studies. Furthermore, differences in mortality may indicate that the criteria to use non-trauma PRL might have been different between the various studies. For example, Kafka-Ritsch and colleagues [9] used PRL in all patients who underwent surgery for perforated diverticulitis Hinchey score III/IV. This was not true in our patient population. To further evaluate the value of this technique in reducing mortality in non-trauma patients, it is necessary to define precisely clinical criteria that will allow comparison between similar patient groups.

In our study, patients who died were older (almost 40% were older than 70 years of age) than those who survived presented with renal failure, and the majority died. Hypotension and hypothermia were also found to be risk factors of mortality. Nevertheless, only a few patients in this cohort suffered from either one of these two signs.

Patients who underwent bowel resection and primary anastomosis in our study did not suffer from increased mortality compare to those who underwent bowel resection and diversion. This observation highlights that major differences exist in the criteria leading to PRL in patients undergoing non-trauma-related surgery. Primary bowel anastomosis in trauma should be considered carefully. However, PRL non-trauma-related laparotomy is not always performed due to physiologic crush, so the possibility of primary anastomosis may not be ignored. The literature concerning primary anastomosis in these circumstances is limited. Emphasis is placed instead on the feasibility of delayed primary anastomosis following control of sepsis as an alternative to diversion [17]. It is of interest that 30% of patients with primary anastomosis required resection in the following surgery. This finding might be the result of progressing ischemia or inaccurate viability assessment.

A major limitation of our study is that it is based on a retrospective cohort in which the application of PRL did not follow a standard approach. The indications may have varied between the different surgeons. Although most other studies reported to date have a similar problem, there are some similarities between these studies that justify a surgeon's decision. The most common indications were abdominal sepsis and mesenteric ischemia. The number of relaparotomies is comparable. Still, precise clinical criteria should be defined to evaluate the efficacy of this surgical technique. In this study, we found that mortality in patients undergoing primary anastomosis was lower compared to those undergoing diversion. Due to the retrospective nature of this study, further research is needed to determine possible intervening factors that could have been involved in this study. Nevertheless, we cannot rule out performing primary anastomosis in selected cases of non-trauma PRL.

Table 3. Studies reporting planned re-laparotomy in non-trauma patients

Reference	Patients, n	Main indications	Mortality
Finlay [3]	14	Abdominal sepsis	7%
Stawicki [4]	16	Abdominal sepsis, hemorrhage, bowel ischemia	44%
Person [5]	31	Abdominal sepsis, bowel ischemia	55%
Kritayakirana [6]	35	Abdominal sepsis	31%
Gong [7]	15	Bowel ischemia	33%
Subramnian [8]	88	Abdominal emergencies	
Kafka-Ritsch [9]	51	Abdominal sepsis	10%
Khan [10]	42	Bowel ischemia, hemorrhage, abdominal sepsis	19%
Goussous [11]	181	Bowel ischemia, abdominal sepsis, loss of domain, hemorrhage	25%
Bruns [12]	96	Abdominal sepsis, bowel ischemia	
Becher [13]	53	Abdominal sepsis	45%
Present series	181	Abdominal sepsis, bowel ischemia, intestinal obstruction	49%

CONCLUSIONS

Abdominal sepsis and mesenteric ischemia were the most common indications for PRL. A major finding in this study was that in patients undergoing bowel resection, performing primary anastomosis did not lead to an increased mortality rate compared to delayed bowel reconstruction or a diversion procedure.

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Capsule

Impact of obesity and adiposity on inflammatory markers in patients with rheumatoid arthritis

The C-reactive protein (CRP) levels and erythrocyte sedimentation rates (ESR) are important disease activity biomarkers in rheumatoid arthritis (RA). **George** et al. aimed to determine to what extent obesity biases these biomarkers. Body mass index (BMI) associations with CRP level and ESR were assessed in two RA cohorts. Among women with RA and in the general population, greater BMI was associated with greater CRP levels, especially among women with severe obesity ($P < 0.001$ for BMI $\geq$ 35 kg/m^2 vs. 20–25 kg/m^2). This association remained after adjustment for joint counts and patient global health scores ($P < 0.001$ in the Body Composition cohort and $P < 0.01$ in Veterans Affairs Rheumatoid Arthritis registry), but was attenuated after adjustment for fat mass index ($P = 0.17$). Positive associations between BMI and ESR in women were more modest. In men with RA, lower BMI was associated with higher CRP levels and ESR, contrasting with positive associations among men in the general population.

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Capsule

A fluid transition into the field

Many point-of-care diagnostics rely on lateral flow assays or microfluidics; however, these methods generally cannot test multiple samples simultaneously. **Ng** et al. optimized inkjet-printed digital microfluidic cartridges and a portable control system to perform serological immunoassays in remote settings. Digital microfluidics use electrostatic forces to mix and separate reagents and samples in small droplets of fluids. The system measured immunoglobulin G (IgG) antibodies for measles and rubella in human blood samples obtained from adults and children on site in a refugee camp in Kenya. Four samples could be tested simultaneously, although digital microfluidic IgG detection was less sensitive and specific than laboratory-based ELISA (enzyme-linked immunosorbent assay) testing of matched serum samples. The emergence of this field-compatible technology brings with it tools for advancing global health.

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