The Safety of Primary Repair in Penetrating Colorectal Injuries During Current Yemeni War

Abstract:

Background: The study evaluated the surgical outcomes of a 4-year experience with war-related penetrating colorectal injuries (PCIs) at a field hospital in Taiz city during the current Yemeni Civilian War. Where the management policy had favored primary repair (PR) of colorectal injuries. **Patients and methods:** The purpose of this retrospective study was to evaluate septic colon related-complications and death in a series of 56 consecutive PCI patients exclusively managed with PR at the field hospital of Taiz, Yemen. Patients' records and files were reviewed for the duration from April 2015 to January 2020 of the current Yemeni Civilian war. **Results:** As 8 patients had multiple-PCIs, the whole 56 patients inflicted a total of 64 colon injures were managed by PR within 24 hours (42 cases underwent PR by primary suture/s and 14 cases required at least resection and anastomosis [PA] for their PR). All cases were secondary to ballistic mechanism of injury (MOI), most commonly from gunshot wound (GSW), with no one stab wound (SW). Nineteen patients (33.9%) developed 30 colon-related infectious complications. No one death was related to colon injury PR. The most common complications were incisional surgical site infection (SSI) that occurred in 17.9% of cases (10 of 56), followed by missile-track wound infection in 16.1 % (9 of 56). Relatively less common complications were enterocutaneous fistula in 10.7% (6 of 56), in addition to a rate of 5.4% (3 of 56) for intra-abdominal abscess and 3.6% (2 of 56) for fascial dehiscence. Remarkably, no one patient suffered from suture-line failure and peritonitis. Only 7 patients were re-operated: 3 enterocutaneous fistula cases required diversion stoma, 2 cases required debridement for wound infection, 2 cases required the closure of abdominal wall after fascial dehiscence. **Conclusion:** The one-stage PR procedure is safe and effective management for PCIs in the limited resource setting of battlefields.

Keywords: Colorectal injury; penetrating trauma; complications; primary repair; war

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Introduction:

Penetrating colorectal injuries (PCIs), are more commonly observed in military trauma (5-10%) than civilian trauma practice (1-3%).[1,2] Mortality of colorectal injuries has changed dramatically over the last two centuries; from the high rates of 60% in World War I and 40% in World War II to a lower rate of 3% in the last two decades. Coincidently, a little change in morbidity occurred, studies show septic complications in the range from 16% to 33%.[3–6] These changes are thought to go along with the advancement in the field of trauma surgery, colon injury operative techniques, perioperative care, and antibiotic prescription.[7,8]

Management of traumatic colorectal injuries has undergone a dramatic change over time. This has evolved from conservative management during the Civil War to selective primary repair (PR) amidst the World War I era.[9] At the outbreak of World War II, the management of colorectal trauma remain debated and inconsistent. In 1943, Sir W.H. Ogilvie, a British surgeon who served in both World Wars, famously concluded in his book "Forward Surgery in Modern War" that for all war colorectal injuries mandate proximal diversion to treat.[10] That same year, the Surgeon General of USA Thomas Parran, Jr. mandated proximal diversion for all PCIs sustained in combats.[11]

As the war ended, trauma-trained surgeons enrolled in civilian surgery practice. Nevertheless, mandatory colostomy became the unchallenged gold standard of care for PCIs, until the late 1970s. With the concomitant advancement of perioperative care and early definitive management; civilian surgeons started to advocate PR in selected cases of PCIs.[12,13] This was supported by Woodhall and Ochsner's study that enrolled 50 patients with civilian PCIs, they found that 2 of the 24 patients treated by PR died, compared to 9 of the 26 patients treated with diversion stoma. Concluding that diversion stoma creation is not essential for a good outcome in many civilian encountered PCIs.[12] The practice of PR in civilian-related PCIs was subsequently validated by more evidences, including five multiple randomized controlled trials[14–18] and two meta-analyses[19,20].

Nowadays, the trend of PR for PCIs has gained widespread acceptance among both military and civilian surgeons, with a limited role for diversion stoma,. Although there is still some skepticism by many surgeons, especially in the presence of certain risk factors such as destructive colon injuries, severe contamination, multiple injuries and delay in treatment.[21–23]

Given the ongoing debate of PCIs management and paucity in studies addressing the safety of one-stage PR during wars, particularly for patients managed in the austere environment of low-to-middle-income countries (LMICs) setting such as Yemen. It was the primary aim of this study to

explore what are the surgical outcomes of our 4-year local experience in PR for PCI, performed in the urgent/emergent setting (within 24 hours of sustaining injury). Focusing on cases managed at the Field Hospital of Al Rawdha, Taiz city during the current Yemeni Civilian War from April 2015 to January 2020.

Patients and Methods:

This was a retrospective, observational study, conducted at the Field Hospital of Al Rawdha in Taiz city during the period between April 2015 to January 2020, of the current Yemeni Civilian War. After approval by Taiz Faculty of Medicine's Review Board, we reviewed the retrospectively collected database for all adult patients who were admitted and managed for penetrating abdominal trauma that proved intra-operatively to have devascularization or full-thickness colorectal injury, in whom primary operative repair was performed in the urgent/emergent setting (less than 24 hours from the time of injury to operation).

We excluded patients younger than 14 years old, PCI secondary to blunt mechanism of injury (MOI), patients who underwent laparotomy and PR after a delay of 24 hours or more since injury's onset, or patients whose management included any form of diversion stoma proximal to the PR.

Information was obtained from patients' files, discharge notes, and electronic hospital databases. The recorded data included age, gender, MOI, comorbid conditions, shock at initial operation, number of blood bags transfused at day of admission, site and severity of colon injury (destructive or non-destructive), type of PR performed, associated intra-abdominal injuries and use of antibiotics. Postoperative course was analyzed for in-hospital complications or need for reoperation. Colon-related complications superficial/deep SSI, missile wound infection, intra-abdominal abscess, fascial dehiscence, enterocutaneous fistula, major suture line leak/peritonitis. Colon-related mortality was defined as in-hospital death secondary to colon-related complications.

PR was defined as: 1) debridement with primary closure, or 2) primary resection and anastomosis (PA) ; without diverting stoma. At the time of this study, there was no strict protocol in place for the management of PCIs. and the decision to proceed with PR or diversion was left to the discretion of the attending surgeon. As such, all management decisions were made on a case-by-case basis by the attending surgeon. However, a general policy of PR was favored over diversion for PCIs, whenever feasible.

A nondestructive colon wound is an injury to the colon that can be repaired with limited debridement and primary suture repair**. Destructive colon injuries** are those injuries that need segmental colon resection as colonic integrity is lost (indicated by the involvement of more than 50 % of colon circumference, complete colon transection, or significant tissue loss), or segmental devascularization occurred from mesenteric injury (or both).

Although there is no distinct definition or classification for colorectal suture line leak.[24] After Bruce et al. and Chambers et al. we classified leaks into major clinical leak that present as diffuse postoperative peritonitis, and minor clinical leaks that present as postoperative enterocutaneous fistulas or intra-abdominal abscess.[25,26]

Major clinical leaks: These leaks present as diffuse postoperative peritonitis can be defined as peritonitis that persists or recurs following the apparently adequate surgical source control by PR during initial exploratory laparotomy, and proper antibiotic therapy. This is defined by the presence of associated compatible clinical illness with diffuse intraoperative or radiologically confirmed spillage of luminal contents due severe disruption of the PR suture line (whether primary suture closure or PA). These leaks are potentially life threatening and require reintervention (usually reoperation).[24–31]

Minor clinical leaks/postoperative enterocutaneous fistulas were defined as aberrant communications between any portion of the gastrointestinal tract and the skin/wound. Initial diagnosis was made by the clinical observation of local inflammation, e.g. fever (temperature >38C^{o}), leucocytosis (white cell count >10,000/liter), and enteric or colon contents leakage through the abdominal wall wounds or operatively placed drainage catheters. This leak may appear on imaging studies, and/or intraoperatively.[25,26,32] Minor clinical leaks that cause intra-abdominal collection was considered separately.

Statistical analysis was performed using the 24th version of SPSS (Statistical Package for the Social Sciences) software. Each enrolled patients' ID number was represented on an SPSS datasheet's rows. Each element in the questionnaire was represented in an SPSS datasheet's column and each categorical variable question's answers were given a code. Coding was saved in an external cross-reference sheet. Descriptive statistics were calculated for categorical and continuous variables. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as mean, median, interquartile range (IQR) or standard deviation. Graphical displays and tables were used to clarify some variables. Statistical analysis was

performed by using the unpaired Students t-test or Mann-Whitney rank-sum test for continuous variables, and chi-squared or Fisher's exact for categorical variables where appropriate. Statistical significance was set at a *p*-value < 0.05.

Results:

Demographic data and patient characteristics:

During this study, we included 56 consecutive patients with PCI who were admitted and managed by PR at Al Rawdha Hospital in Taiz city over the period from April 2015 to January 2020 of the current Yemeni Civilian War. All patients were brought to the operating room within less than 24 hours of injury. See table (1).

Most of the patients were young healthy men having a median age of 25 (range, 14–60) years; with 55 male and only single female patients. Only 5 patients had pre-existing comorbidity. The most common MOI were gunshot wounds (GSWs) that occurred in 35 patients (62.5%), followed by shrapnel penetrating injury secondary to blast explosion that occurred in 12 patients (21.4%), unspecified projectile-related injury whether GSW or blast MOI in 9 patients (16.1%). Surprisingly, no one patient with a stab wound (SW) was observed.

In the study, eight patients have sustained multiple-segment PCIs making a percentage of 14.3%. All of them get two-segment injuries, giving rise to a total of 64 colorectal wounds in our 56 patients. The 64 colorectal wounds were distributed as follow: 15 PCIs in cecum involving 26.8% of the patients, 5 PCIs in ascending colon involving 8.9% of the patients, 22 PCIs in transverse involving 39.3% of the patients, 9 PCIs in descending involving 16.1% of the patients, 9 PCIs in sigmoid involving 16.1% of the patients, and 2 PCIs in intra-peritoneal rectum involving 3.6% of the patients. Additionally, 2 PCIs occurred in unknown colon segments in 3.6% of the patients (see **خطأ! لم يتم العثور على مصدر المرجع.**. For purposes of localization, we divided the intra-peritoneal large bowel into right and left colon, based on the embryologic origin (see **خطأ! لم يتم العثور على مصدر المرجع.**. The right colon includes the cecum, ascending colon, hepatic flexure, and proximal two-thirds of the transverse colon; while the left colon includes the distal third of the transverse colon, descending colon, splenic flexures, sigmoid colon, and intra-peritoneal rectum.[33] Overall, 20 patients have at least one left-colon injury constituting 35.7% of the study population.

Table 1. Demographics of patients undergoing laparotomy for penetrating colorectal injury.

Variable	n=56
Age in years; median (IQR)	25 (22-34)
Sex (%)	
Male	98.2% (55)
Female	1.8% (1)
Presence of comorbidity (%)	8.9% (5)
MOI (%)	
GSW	62.5% (35)
Blast related	21.4% (12)
Unknown	16.1% (9)
SW	0% (0)
Shock at initial operation (%)	42.9% (42)
Site of PCI (%)	
Right-sided PCI	28.9% (33)
Left-sided PCI	32.1% (18)
Both left and right sides PCI	5.4% (3)
Unknown site	3.6% (2)
Multiple-segment PCI (%)	14.3% (8)
Severity of PCI (%)	
Non-destructive	75% (42)
Destructive	25% (14)
Associated intra-abdominal injuries (%)	71.4% (40)
Number of associated intra-abdominal injury (%)	
None	28.6% (16)
Single associated organ injury	35.7% (20)
≥ 2 organs injury	35.7% (20)
Median 24-hour of transfused blood (IQR)	3 (1-5) units
Blood transfusion (%)	
≥ 2 units	66.1% (37)
< 2 units	33.9% (19)
Median of hospital length of stay (IQR)	10 (7–16.5) days
Median for ICU length of stay (IQR)	1 (0–4) days
Required ICU admission	29 (51.8%)
Complications (%)	
Colon-related	33.% (19)
Non-colon-related	26.8% (15)
Mortality (%)	0% (0)

GSW; gunshot wounds, ICU; intensive care unit, IQR; interquartile range, MOI; mechanism of injury, n; number, PCI; penetrating colon injury, SD; Standard Deviation, SW; stab wound

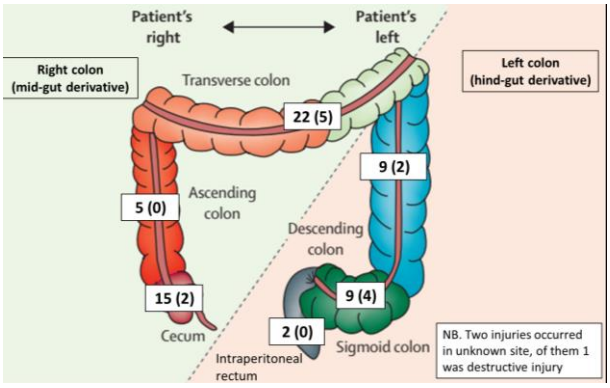

Figure.1 Frequency distribution of 64 penetrating colorectal injuries by colon segment, destructive injuries are shown in parentheses

Only 16 patients (28.6%) sustained isolated PCI. The remaining 40 patients (71.4%) have acquired associated injuries to a total of 73 extra-colic intra-abdominal organs. Twenty patients (35.7%) have acquired single associated intra-abdominal injury, 12 patients (21.4%) have two organs injuries, 6 patients (10.7%) have three organs

injuries, and 2 patients (3.6%) have five organs injuries.

The distribution of the 73 intra-abdominal organs that were co-injured with the large bowel is depicted in Figure.2 The most commonly associated intra-abdominal injury was to the small bowel that occurred in about 46.4% of the patients (26 of 56). followed by abdominal vascular injury in 14.3% (8 of 56), pelvic fracture in 10.7% (6 of 56), kidney injury in 10.7% (6 of 56), liver laceration in 8.9% (5 of 56), retroperitoneal hematoma in 7.1% (4 of 56). Relatively less common associated injuries involved the stomach, duodenum, stomach and spinal cord that constituted 5.4%, each (3 of 56). Diaphragm injuries occurred at a rate of 3.6% (2 of 56). While, the least concomitant intra-abdominal organs co-injured were the spleen, ureter and pancreas at a rate of 1.8%, each (1 of 56). Additionally, other organs injuries as gall bladder or adrenal gland injuries occurred in 7.1% (4 of 56).

Systolic blood pressure less than 90 mmHg during initial operation defining intraoperative shock, occurred in 24 patients (42.9%), while the remaining 32 (57.1%) patients maintained a stable hemodynamic status during initial operation.[34] See figure (3). In our study, patients with shock had a significantly higher rate of associated abdominal vascular injury in comparison to normotensive patients (29.2% vs. 3.1%, p = 0.016). Additionally, patients with shock received a median of 5 (IQR, 3-8.5) blood units which is significantly higher than the median of 2 (IQR, 1-3) blood units among normotensive patients, (p = 0.000).

Of the 56 patients, 47 patients (83.9%) received a total of 195 units of whole blood during their initial operation, having a median of 3 (IQR,1-5) blood units**,** with a median of 2.5 (IQR, 1-4) units after non-destructive PCI and 4 (IQR, 1-5) units after destructive PCI; (p = 0.504). While only 9 patients (16.1%) didn't receive any blood transfusion (6 patients with non-destructive and 3 with destructive PCIs, [p= 0.676]). Amid the 56 cases in our study, 37 patients (66.1%) received two or more blood units (64.3% of those with non-destructive injuries and 71.4% of those with destructive injuries, [p = 0.751]); as depicted in figure (3).

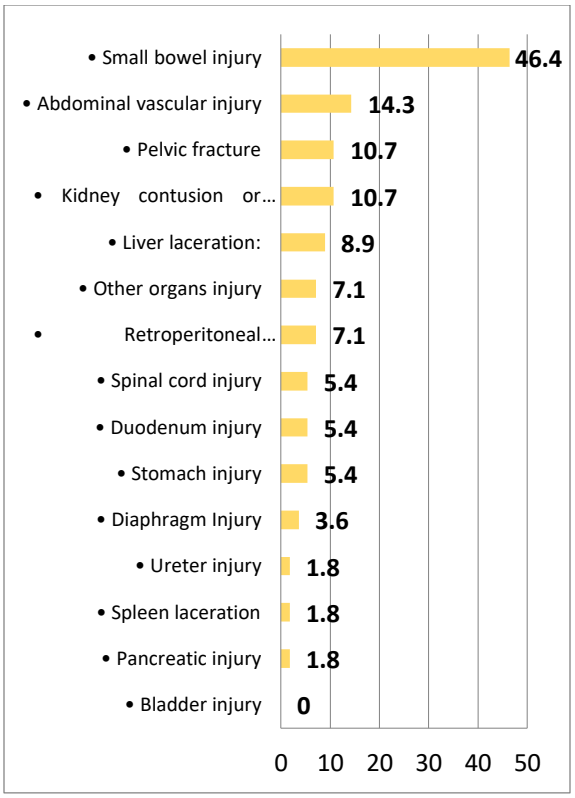

Figure.2 Percent distribution of associated intra-abdominal organs injuries (n=73) in the study 56 patients

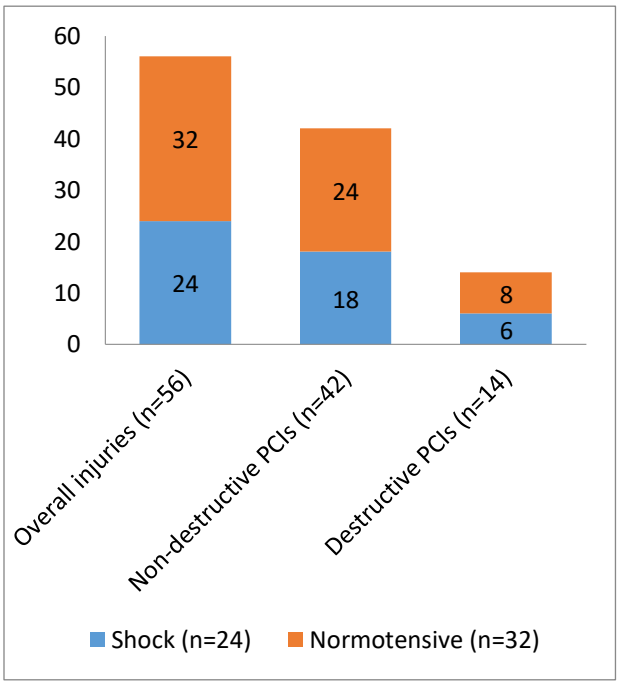

Figure.3 frequency distribution of shock among patients with penetrating colorectal injury as a whole and according to severity of injury

Regarding the management of 64 PCIs that were found in the study, 52 (81.2 %) colon wounds were non-destructive that were managed with primary suturing (of them, 15 patients have at least primary suturing for left-PCI). While only 14 (21.1%) colorectal injuries were destructive that required PA (with 6 patients underwent at least PA for left-PCI). Thus among the 56 patients in this study, 25% (14 of 56) have sustained at least one destructive PCI that required PA (8 performed for right colon injuries and 6 performed for left colon injuries). This association between the side and severity of PCI was insignificant on univariate analysis ($p = 0.552$).
Additionally, we found no significant association between the mechanism and severity of injury ($p = 0.310$). Figure (1) depicts the distribution of 64 colon wounds by site and severity. Among the 14 patients with PA, the site of these anastomoses was colo-colic in seven patients, colo-rectal in four, ileo-colic in two patients, in addition to one anastomosis in an unknown site.

Overall, our study group consisted of 56 PCI patients, with 64 intra-operatively confirmed PCIs that was primarily repaired with; simple suturing only in 42 patient (75%), PA only in 11 patient (19.6%), while 3 patients (5.4%) required both primary suturing and PA.

Mortality

No one death resulted from colon-related septic complications in this study.

Morbidity:

Overall, about half of the patients (29 of 56) had one or more complications (whether colon-related or general). Complications were only colon-related infections in 19 patients (33.9%), while other complications occurred in 15 patients (26.8%). The 19 patients with colon-related infectious complications have acquired a total of 30 complications. The most common complications were superficial/deep SSI that occurred in 17.9% of cases (10 of 56), followed by missile-track wound infection in 16.1 % (9 of 56). Relatively less common complications were enterocutaneous fistula with a rate of 10.7% (6 of 56). In addition to rates of 5.4% (3 of 56) for intra-abdominal abscess and 3.6% (2 of 56) for burst abdomen (fascial dehiscence). Remarkably, no one patient suffered from major suture-line failure with peritonitis. Non-infectious complications of colon repair occurred in two patients (3.6%) who suffered from early postoperative intestinal obstruction secondary to intestinal adhesions. The distribution of surgical outcomes recorded for the study population, as a whole, and according to the severity and hence type of PR, is illustrated in In the group of patients with colon-related infectious complications, only seven patients (12.5%) were re-operated: three enterocutaneous fistula cases required diversion stoma, two cases required debridement for wound infection, and two cases required the closure of abdominal wall after burst abdomen. Finally, two cases required adhesiolysis for early postoperative intestinal obstruction. Two patients required percutaneous aspiration of intra-abdominal abscess. Antibiotic management was modified in 17 patients due to colon-related septic complications, and four cases for non-colon-related infections.

Table.2 (2). These variables did not differ significantly by severity and type of PR performed, or in other word there was no difference between patients with non-destructive PCIs who underwent primary suturing and those with destructive injuries managed by PA.

In the group of patients with colon-related infectious complications, only seven patients (12.5%) were re-operated: three enterocutaneous fistula cases required diversion stoma, two cases required debridement for wound infection, and two cases required the closure of abdominal wall after burst abdomen. Finally, two cases required adhesiolysis for early postoperative intestinal obstruction. Two patients required percutaneous aspiration of intra-abdominal abscess. Antibiotic management was modified in 17 patients due to colon-related septic complications, and four cases for non-colon-related infections.

Table.2 Miscellaneous complications in 56 patient after primary repair of penetrating colon injury according to severity and surgical technique

Complications	Overall PR (n=56)		Non-destructive PCI (n=42)		Destructive PCI (n=14)		*P**
	N	%	N	%	N	%	
Overall[$]	29	51.8	22	52.4	7	50.0	0.877
General non-colon related	15	26.8	12	28.6	3	21.4	0.736
Colon related septic	19	33.9	14	33.3	5	35.7	0.871
Superficial/deep SSI	10	17.9	6	14.3	4	28.6	0.247
Missile-track wound infection	9	16.1	6	14.3	3	21.4	0.676

Intra-abdominal abscess	3	5.4	2	4.8	1	7.1	1.000
Fascial dehiscence	2	3.6	1	2.4	1	7.1	0.441
Minor suture line leak/ Enterocutaneous fistula	6	10.7	3	7.1	3	21.4	0.158
Major suture line leak/peritonitis	0	0.0	0	0.0	0	0.0	-

$ Presence of one complication or more

*The p values were derived from two-tailed Fisher's exact test or x2 test for categorical variables and Mann-Whitney test for continuous variables, n; number, PR; primary repair, PA; resection and anastomosis, SSI; surgical-site infection

Discussion:

PCIs can be managed by either PR or diversion stoma. During World War II, the standard procedure to repair these injuries was diversion: since then, diversion with stoma creation dominated the treatment of both military and civilian colonic injuries.[35] Over the past three decades, PR gained popularity and has become more accepted at least for non-destructive PCIs inflicted in the civilian setting.[19,20] This was not the case for war injuries, as surgeons began to appreciate the difference between the military and civilian injuries and noted that civilian low-velocity gunshot wounds and stabbings were of a different nature than the high velocity devitalizing military wounds.[19,20] Additionally, war injuries differs from their civilian counterpart by involving a different spectrum of injuries, happening in austere environments, and dealing with mass casualties. Thus, civilian trauma practices may be unsuitable in certain combat settings.[36] Published papers reporting outcomes in war-related colon injuries are inconsistent, but most of them support at least a limited role for PR of colon injuries.[37–39] The goal of the present study was not meant to compare the outcomes of PR vs. fecal diversion, as many other studies have shown equivalent or improved outcomes.[37–39] Rather, this study aimed to evaluate the current management and outcome of patients with PCIs on the modern-day battlefield in the context of increasing willingness to perform PR.

Mortality

In our study, no one death was related to the PR of PCI. This is similar to George et al.[40] who found no death related to PCI among 95 patients whom PCIs were repaired primarily. And compare well to other studies that recorded a mortality rate approaching 0%.[41,42]

Morbidities

It has been well established that colon injuries result in more complications than do injuries to most of the other abdominal organs. This indeed reflects the septic morbidities from fecal soiling and the associated colonization with a large number of various aerobic and anaerobic microorganisms. In the absence of gastrointestinal injury, the rate of septic complications in patients with penetrating abdominal injuries is basically the same as in elective procedures.[40]

In the present series of 56 cases exclusively managed by PR, we found a 33.9% rate (19 of 56) colon-related septic morbidity (33.3% [14 of 42] after primary suture and 35.7% [5 of 14] after PA, p=1.00) which is relatively higher than those rates reported in civilian settings: 18% reported by Gonzalez et al.[17], 14.3% reported by Chappuis et al.[15], 2.3% reported by Sasaki et al.[38], 22.5% reported by Kamwendo[43], and 24% of Demetriades et al.[42]. However, it approaches the 29.5% rate after PR reported by George et al.[40] among civilian PCIs in the USA (26% for the primary suture group and 50% for the PA group), and the 29% reported by Vertrees et al.[38] that studied patients from the Iraqi war. Other military-based studies reported also high rates of colon-related complications, for example, Duncan et al.[44] reported a complication rate of 48%, Hudolin et al.[37] reported 27%, Stankovic et al.[45] reported 39.6%, and Strada et al.[46] reported a rate of 15%.

Indeed, comparisons between morbidity and mortality of this study and other series are difficult; not only because this study was conducted in a war setting while most of the literature included civilian studies. But also because exclusions and inclusions criteria are different and not always clearly defined. For instance, when patients who sustained a seromuscular injury with no full-thickness PCI are included, the morbidity and mortality rates will be lower. Another distinction is the MOI, most of such studies were conducted in a civilian setting with a relatively larger proportion of simple PCI resulting from SWs[40,47]. Furthermore, many authors either perform diversion or exclude patients with comorbid condition[48], shock[49], with multiple concomitant intra-abdominal injuries[49], those with higher amount of blood transfusion[48,49], destructive PCIs[49,50], and the presence of significant peritoneal soiling by feces[49,50]; producing an artificially low morbidity and mortality rates. Additionally, warfighters are frequently young men, whereas the civilian population is more heterogeneous. Finally, resource limitations

associated with the treatment of war victims could affect their management and outcomes.

Keep in mind that most of the mentioned rates are derived from studies that targeted civilian trauma patients. The high morbidity rate related to PCI in our study can be partly interpreted by the military nature of our PCI patients, that our complications rate of 33.9% approaches the those reported in military studies.[37,45,46] Despite the younger age, war-related PCIs have a different MOI including the higher velocity weapons used in warfare and different tactics of militias war that include the use of snipers and landmines. Not to forget the deterioration of security situation, that lead to weapons spread including those causing high-velocity injuries among the community. Consequently, our patients had more destructive patterns of PCI requiring PA that was performed for 25% of our patients. In contrast to our war-based study, in the civilian work of George et al., only 12 (12.6%) PAs were performed from an overall of 95 PRs.[40] Also, Gonzales et al.[17] performed only 5 PA of the 89 PR in his civilian trauma patients.[17] Thus our PR success rate of 66.1% is more comparable with recent military series that quote success rate from PR as 11 to 72 percent[1,37]

Another possible explanation for our higher rates of colon septic complications; is that incisional SSI and missile-track wound infection contributed significantly to the colon septic complications noted in this study, both of these wound infectious outcomes formed 19 of the 30 overall colon-related complications found in the 19 complicated cases. As incisional SSI was present in 50.6% (10 of 19) of patients with complications (p=0.000), and missile wound infections were found in 47.4% (9 of 19) of patients with complications (p=0.000). The most likely exposition for the high rates of incisional SSI (17.9%), is that almost all the cases underwent primary closure of laparotomy wounds during the initial surgery even in the presence of gross fecal peritoneal contamination. Although we have also found relatively high rate of missile wound infection (16.1%), we lacked substantial data regarding the exact management of missile-related wounds, which limited our proper assessment of this adverse outcome. Unlike our study findings, there were no superficial wound infections of the operative wound sites in the study of Neill et al.[51], the author claimed that because all skin wounds were left open after operation to heal by secondary intention. Velmahos et al.[52] also observed that primary laparotomy wound closure to double the risk of wound infection. Interestingly, if we excluded the ten patients whom PRs were complicated only by wounds infection; whether only incisional SSI (4 of 10), only missile-related wound infection (4 of 9) or both types of wounds infection alone (2 of 10); our colon related septic complication will be almost halved from the 33.9% (19 of 56) to 16.1% (9 of 56).

This study is inherently limited by the retrospective observational study design. The record was insufficiently documented. For example, the database captured neither the exact injury to repair delay, duration of operation, Penetrating Abdominal Trauma Index (PATI) and severity of contamination.

Conclusions:

War-related PCIs endure a challenging clinical entity associated with significant morbidity. However, civilian studies showed that this was not related to management techniques whether stoma diversion or PR. In conclusion, our war surgery experience suggests that even in a field hospital with an austere environment and limited resources a definitive one-stage PR for PCI can be performed safely and satisfactorily avoiding all the disadvantages of diversion stoma with the need for multiple procedures. In our opinion, the routine use of diversion stoma in war-related PCIs seems no longer to be justified. Further studies are required to find the optimal management techniques including damage control surgery for war-related PCIs in the presence of high-risk factors or in critically ill patients.

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