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Impact of Advanced Age on Outcomes Following Damage Control Interventions for Trauma

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Abstract

Background Damage control (DC) strategy has significantly contributed to mortality reduction in massively bleeding and critically injured trauma victims. However, there is a lack of literature validating the effectiveness of this approach in the elderly population.

Methods The trauma registry of a Level I trauma center was utilized to identify all severely injured patients [Injury Severity Score (ISS) ≥16] from January 1996 to December 2007 who underwent initial DC procedures. Patients with a head Abbreviated Injury Scale (AIS) ≥3 were excluded from the analysis. Demographics, clinical and physiological parameters, and in-hospital outcome measures were compared between elderly (≥55 years) and younger (<55 years) patient cohorts subjected to DC procedures.

Results Overall, 158 patients met the inclusion criteria. Among them, 34 patients (21.5%) were aged ≥55 years (range 55–85 years) and 124 patients (78.5%) were <55 years old (range 16–54 years). The overall in-hospital mortality rate was 10.1% ($n = 16$) with a significantly higher mortality rate for elderly patients than for younger patients: 29.4% vs. 4.8%; adjusted $P = 0.001$; adjusted odds ratio (OR) with 95% confidence interval (CI) 7.09 (2.30–21.74). When stratified by DC subgroups, the case-fatality rate was significantly higher for the elderly patients who underwent extremity DC procedures [19.2% vs. 3.2%; adjusted $P = 0.032$; adjusted OR with 95% CI 5.95 (1.16–30.30)] and DC laparotomy [55.6% vs. 7.1%; $P = 0.005$; OR and 95% CI 16.25 (2.32–114.06)]. Both cohorts required massive transfusion during the initial 24 h of admission (18.9 ± 2.9 vs. 15.1 ± 1.6 units of packed red blood cells; $P = 0.290$). Nevertheless, there were no statistically significant differences between the two groups regarding hospital and surgical intensive care unit lengths of stay or major in-hospital complications.

Conclusions The mortality rate for elderly trauma patients undergoing DC is excessive at 29%. Despite the significant burden of injury and the massive transfusion requirement, most of the elderly patients subjected to DC survived and experienced in-hospital morbidity measures comparable to those of the younger patients. Our results provide further support for damage control intervention in severely injured elderly patients.

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Introduction

Damage control (DC) procedures for critically injured patients with major torso and extremity trauma have proven to be a significant factor in decreasing morbidity and mortality [1, 2]. Although multiple studies during the recent decade confirmed improved outcomes by applying the DC concept to trauma patients in general [3–7], there is a lack of literature validating the effectiveness of this approach in the elderly trauma cohort. This age segment, in particular, is increasing in size as our population ages [8]. Furthermore, elderly trauma patients are characterized by experiencing worse outcomes than their younger counterparts [9–14]. Functional changes with age, preexisting comorbidities, and preinjury medications—all of which result in limited physiological reserves and decreased ability to mount an adequate response to stress—are thought to account for worsened outcomes [15, 16]. The purpose of this study was to compare outcomes between severely injured elderly and younger trauma patients undergoing DC procedures.

Patients and methods

Study details

The study setting was the University Hospital of Zurich, which admits on average 100 to 150 severely injured trauma patients annually. The hospital's trauma alert activates a multidisciplinary trauma team consisting of an attending trauma surgeon, a senior postgraduate year surgical resident, an attending anesthesiologist, an anesthesiologist in training, an attending radiologist, and registered and highly specialized trauma care nurses. The trauma area comprises two resuscitation bays with a 64-slice multidetector computed tomography (CT) scanner and a dedicated trauma operating room. The multidisciplinary in-hospital trauma system includes all the emergency medical subspecialties on request. Physicians caring for trauma patients work in accordance to advanced trauma life support (ATLS) principles.

The institutional review board approved the study. The trauma registry of the Division of Trauma Surgery, University Hospital of Zurich, a verified Level I trauma center, was reviewed to identify all severely injured patients [Injury Severity Score (ISS) $\geq$16] from January 1, 1996 to December 31, 2007 who underwent initial DC procedures. DC management was defined as limited operations to control hemorrhage and/or the temporary fixation of severe extremity and pelvic injuries in patients presenting in physiological extremis (hemodynamic compromise, coagulopathy, hypothermia <35°C, and/or severe metabolic acidosis). This included management of solid organ injuries by packing, limited resection of hollow viscus injuries without primary reanastomosis, the use of temporary closure techniques at a site of surgical exploration, and temporary stabilization of extremity and pelvic fractures. Data pertinent to DC procedures were obtained from the electronic operative records and were further validated by a third-party reviewer to ensure data quality.

The demographic and clinical information collected included age, sex, mechanism of injury (blunt vs. penetrating), systolic blood pressure (SBP), glasgow coma scale (GCS) score upon admission, ISS, and the abbreviated injury scale (AIS) for each body area (head, chest, abdomen, extremity, pelvis). The number of packed red blood cells (PRBC), fresh frozen plasma (FFP) and platelet (PLT) units transfused was abstracted. Laboratory parameters including hemoglobin, serum lactate, and base deficit levels at hospital admission, surgical intensive care unit (SICU) admission, and 24 h after admission were also recorded. For the analysis, continuous variables were dichotomized using clinically relevant cutoff points: GCS on admission ($\leq$8 vs. >8), SBP on admission (<90 mmHg vs. $\geq$90 mmHg), and ISS ($\geq$25 vs. <25). To minimize the impact of a severe head injury on the outcomes, patients with a head AIS $\geq$3 were excluded from the analysis.

Massive transfusion protocol was activated if >4 units of PRBC were transfused during the first hour or the expected transfusion requirement was in excess of 10 units within 12 h after admission. Upon activation of the massive transfusion protocol, a set of 6 units of PRBC, 6 units of FFP, and one apheresis pack of platelets was sent to the patient's bedside.

Systemic inflammatory response syndrome (SIRS) and sepsis were defined according to the guidelines of the American college of chest physicians/society of critical care medicine consensus conference [17] but were modified in that these criteria had to be fulfilled for at least three continuous days to confirm the presence of SIRS or sepsis. SIRS was subdivided into three grades (zero and one positive SIRS criterion, no SIRS; two positive SIRS criteria, SIRS 2; three and four positive SIRS criteria; SIRS 3/4). Sepsis was diagnosed if all criteria of SIRS (SIRS 4) were present for at least 3 days in combination with a proven infectious focus or positive blood cultures. Acute respiratory distress syndrome (ARDS) was diagnosed in cases of acute onset, PaO_2:FiO_2 $\leq$200 mmHg and bilateral infiltrates on chest radiography. Pneumonia was diagnosed by the presence of a new or changing infiltrate on chest radiography plus clinical (two or more SIRS criteria) and laboratory findings. Wounds were considered infected in the presence of purulent exudates requiring surgical wound care. Multiple organ failure (MOF) was considered present when the Goris score was $\geq$6 points [18].

The primary outcome measure tested was mortality. Secondary endpoints included major in-hospital complications, ventilator days, and SICU and hospital lengths of stay (LOS).

Statistical analysis

The demographic and clinical characteristics of elderly patients (≥55 years) were compared with those of younger patients (16–54 years) using a bivariate analysis. The P values for categoric variables were derived from the χ^2 test or two-sided Fisher's exact test; and continuous variables were evaluated by Student's t-test, the Mann-Whitney test, or the Median test. To obtain adjusted differences in the outcomes, logistic regression was performed to control for factors that were significantly different ($P < 0.05$) between the compared groups. For continuous outcomes, analysis of covariance was used to adjust for confounders that were significant at $P < 0.05$.

The values are reported as the mean ± standard error of the mean (SEM) for continuous variables and as percentages for categoric variables. All analyses were performed using the Statistical Package for Social Sciences (SPSS Mac), version 16.0 (SPSS, Chicago, IL, USA).

Results

During the 12-year study period, 1625 patients with an ISS ≥16 were admitted. Among them, 281 patients (17.3%) underwent initial DC procedures. After excluding 123 patients with severe head injury (head AIS ≥3), a total of 158 patients were available for analysis. Of these patients, 34 (21.5%) were ≥55 years of age (range 55–85 years) and 124 (78.5%) were <55 years (range 16–54 years). The mean overall age was 40.9 ± 1.3 years, 69.6% were male, and the mean ISS was 29.9 ± 1.0. Blunt trauma was responsible for most of the injuries ($n = 146$, 92.4%) (Table 1).

The mean time from trauma to hospital admission was 78 ± 5 min (median 75 min; range 45–135 min) for elderly patients and 74 ± 3 min (median 75 min; range 25–135 min) for younger patients (Student's t-test, $P = 0.468$; Median test, $P = 0.865$). The mean time from hospital admission to initial DC surgery was 92 ± 4 min (median 90 min; range 30–170 min) and 93 ± 7 min (median 90 min; range 10–175 min) for young and elderly patients, respectively (Student's t-test, $P = 0.881$; Median test, $P = 0.814$).

The injury patterns and DC procedures performed are depicted in Table 2. No statistically significant differences in AIS scores or specific injuries sustained were noted between the elderly and younger patients. Damage control procedures were most commonly performed on the upper and/or lower extremities (73.5%), followed by DC laparotomies (23.4%), DC procedures to stabilize pelvic fractures temporarily (17.1%), and DC surgery of the chest (3.2%).

Laboratory parameters, including hemoglobin, serum lactate, and base deficit levels at hospital admission, SICU admission, and 24 h after hospital admission are shown in Fig. 1. Elderly patients demonstrated significantly lower hemoglobin values and higher base deficits and serum lactate levels on hospital admission. Following DC procedures and volume resuscitation, these values were similar for the two age groups upon SICU admission and 24 h after hospital admission.

The blood components transfused within 24 h and the blood component ratios at 24 h after admission are shown in Table 3. Both of the patient cohorts received massive blood component transfusions; in addition, elderly patients received significantly more fibrinogen and showed a trend toward increased transfusion of PRBC and PLT units during the first 24 h of hospitalization compared to the young patient cohort.

No statistically significant differences were found in the two cohorts regarding the hospital LOS, SICU LOS, major in-hospital complications, or SIRS/sepsis (Table 4). Likewise, there were no statistically significant differences in the length of stay or in-hospital morbidity measures when comparing elderly and young patients in the DC subgroups (extremity, pelvis, abdomen).

The overall in-hospital mortality rate was 10.1% ($n = 16$), with a significantly higher rate for elderly patients compared to younger patients [29.4% vs. 4.8%; adjusted $P = 0.001$, adjusted odds ratio (OR) and 95% confidence interval (CI) 7.09 (2.30–21.74)] (Table 5).

Table 1 Demographic and admission characteristics of trauma patients undergoing damage control (DC) procedures

Characteristic	Total ($n = 158$)	≥55 years ($n = 34$)	<55 years ($n = 124$)	P
Age (years), mean ± SEM	40.9 ± 1.3	64.7 ± 1.5	34.3 ± 1.0	<0.001
Male	69.6% (110)	70.6% (24)	69.4% (86)	0.890
Penetrating MOI	7.6% (12)	0% (0)	9.7% (12)	0.071
SBP <90 mmHg	7.0% (11)	11.8% (4)	5.6% (7)	0.252
ISS, mean ± SEM	29.9 ± 1.0	32.3 ± 2.0	29.2 ± 1.1	0.195
ISS ≥25	64.6% (102)	73.5% (25)	62.1% (77)	0.217

MOI mechanism of injury; *SBP* systolic blood pressure; *ISS* injury severity score

Table 2 Injury pattern and DC procedures performed among trauma patients

Injury pattern/procedure	Total ($n = 158$)	≥55 years ($n = 34$)	<55 years ($n = 124$)	*P*
AIS: chest ≥3	53.2% (84)	55.9% (19)	52.4% (65)	0.720
AIS: extremity ≥3	76.6% (121)	73.5% (25)	77.4% (96)	0.635
Femoral shaft fracture	39.9% (63)	32.4% (11)	41.9% (52)	0.312
Tibial shaft fracture	51.3% (81)	52.9% (18)	50.8% (63)	0.825
Humeral shaft fracture	10.8% (17)	17.6% (6)	8.9% (11)	0.207
Open fracture	50.6% (80)	50.0% (17)	50.8% (63)	0.934
AIS: pelvis ≥3	29.7% (47)	38.2% (13)	27.4% (34)	0.222
PFT: open book	4.4% (7)	2.9% (1)	4.8% (6)	1.000
PFT: lateral compression	5.7% (9)	8.8% (3)	4.8% (6)	0.406
PFT: vertical shear instability	19.6% (31)	26.5% (9)	17.7% (22)	0.256
AIS: abdomen ≥3	48.1% (76)	50.0% (17)	47.6% (59)	0.802
Liver injury	13.3% (21)	11.8% (4)	13.7% (17)	1.000
Splenic injury	8.9% (14)	5.9% (2)	9.7% (12)	0.736
Hollow viscus injury	7.6% (12)	8.8% (3)	7.3% (9)	0.722
Kidney injury	8.2% (13)	5.9% (2)	8.9% (11)	0.736
DC: chest	3.2% (5)	0% (0)	4.0% (5)	0.586
DC: extremity	75.3% (119)	76.5% (26)	75.0% (93)	0.860
External fixator upper extremity	12.0% (19)	14.7% (5)	11.3% (14)	0.561
External fixator lower extremity	54.4% (86)	35.3% (12)	59.7% (74)	0.011
DC: pelvis	17.1% (27)	23.5% (8)	15.3% (19)	0.260
Pelvic C-clamp	13.9% (22)	20.6% (7)	12.1% (15)	0.261
Anterior external fixator pelvis	5.7% (9)	5.9% (2)	5.6% (7)	1.000
DC: laparotomy	23.4% (37)	26.5% (9)	22.6% (28)	0.635
Hollow viscus resection without primary anastomosis	7.0% (11)	5.9% (2)	7.3% (9)	1.000

AIS abbreviated injury scale; *PFT* pelvic fracture type

When stratified by DC subgroups, the elderly patient cohort who underwent extremity DC procedures and DC laparotomy demonstrated significantly higher case-fatality rates compared to their younger counterparts. The mean times to death were 11.6 ± 4.3 days (median 3 days, range 2 h to 41 days) and 5.0 ± 3.6 days (median 16 h, range 6 h to 22 days) for elderly and younger patients, respectively (Mann–Whitney test, $P = 0.147$; median test, $P = 0.119$) (Table 4). Causes of death included hemorrhagic shock in 6 cases (3 vs. 3, elderly vs. younger patients) and MOF in 10 cases (7 vs. 3, elderly vs. younger patients).

Discussion

The elderly segment of the population is currently the fastest growing age group in modern societies, and traumatic insults in this age segment accounts for a significant proportion of admissions to trauma centers [8]. Multiple studies in trauma patients in general have documented significantly worsened short- and long-term outcomes in elderly patients compared to their younger counterparts [9–14]. Reduced physiological reserves and a higher prevalence of preexisting co-morbidities coupled with significant injuries, as observed by the current investigation, are contributing to these poor outcomes in elderly trauma victims [15, 16]. In the study by Kuhne et al. [9], the incidence of MOF and overall in-hospital mortality significantly increased after the age of 56 years, independent of injury severity. Likewise, in a study that exclusively analyzed penetrating trauma victims, mortality progressively increased with age to exceed 50% in the age group >75 years [10].

Damage control procedures have become well established over the past few decades as a surgical strategy of choice for treating critically injured patients [1, 2]. Stone and coauthors [19] noted a significant reduction in the mortality rate due to penetrating abdominal trauma by applying the technique of initial truncation of laparotomy, establishing intraabdominal pack tamponade, and completing the surgical therapy once coagulation abnormalities were corrected in an intensive care setting. Many subsequent studies observed that the DC concept for abdominal, thoracic, and orthopedic injuries improved the outcomes after both blunt and penetrating trauma [3–7]. Johnson et al. [3] demonstrated that the continued application of DC principles has led to improved survival in patients with penetrating abdominal injury by comparing a

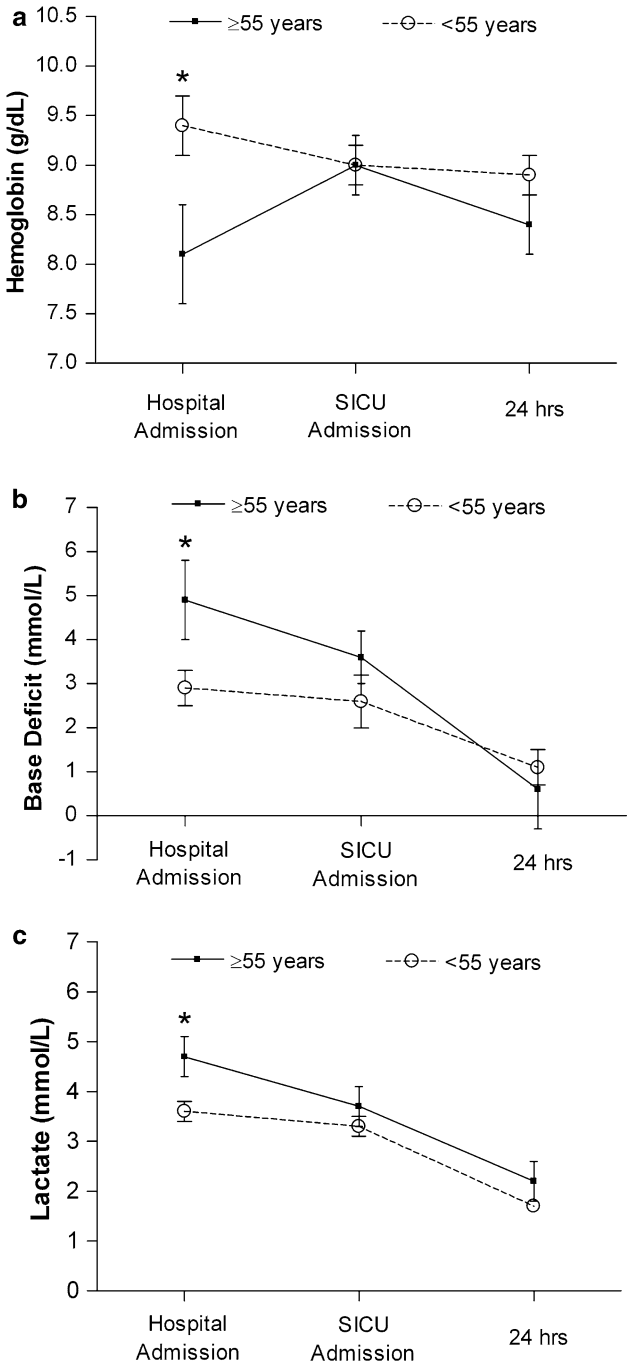

Fig. 1 Laboratory parameters in elderly and young patients undergoing DC surgery. Hemoglobin (**a**), base deficit (**b**), and lactate (**c**) values at the time of hospital admission, surgical intensive care unit (*SICU*) admission, and 24 h after admission (24 h). Values are given as the mean ± SEM. *$P < 0.005$

historical cohort with a current study population. In their study, overall survival improved from 58 to 90% ($P = 0.02$) with equivalent injury severity. These authors concluded that the early treatment of hypothermia and coagulopathy and increased experience in managing the open abdomen significantly contributed to improved survival. For patients with multiple injuries and concomitant orthopedic trauma, it has been demonstrated that DC surgery significantly reduces the incidence of general systemic complications such as ARDS and MOF [6]. In summary, the DC strategy has been shown to be a strong predictor and contributor to improved outcomes following severe traumatic insult during recent decades. Only a few studies—all on patients who required DC procedures for abdominal injuries—have specifically investigated the impact of advancing age on outcomes in patients undergoing DC surgery [20, 21]. Newell and colleagues [20] evaluated 62 patients who were subjected to DC laparotomy and noted a significantly increased mortality rate in the elderly patient cohort (≥55 years) compared to their younger counterparts (42.9% vs. 12.5%; $P = 0.02$). Similarly, in a study from South Africa that determined the predictors of mortality in patients who underwent DC laparotomy, age was the most significant independent preoperative risk factor for mortality. In that investigation, none of the patients who were >58 years of age survived DC laparotomy [21].

The results of the present study are in agreement with those previously published. The overall fatality rate in elderly patients was significantly higher than that in younger patients (29.4% vs. 4.8%; adj. $P = 0.001$). When stratifying the patients according to the DC procedures performed, the patients who required DC laparotomy had the highest in-hospital mortality (18.9%), with elderly patients being 16-fold more likely to die than their younger counterparts. Similar results were observed in the subgroup of patients who underwent DC orthopedic surgery. In the DC extremities and DC pelvis cohorts, the crude mortality rate was higher in patients who were ≥55 years; however, statistical significance was reached only in the subgroup of patients who required temporary stabilization of extremity fractures. The number of patients in the pelvic DC management subgroup might have been too low for an adequately powered analysis to detect outcome differences.

Although the mortality rate was significantly higher in the elderly DC population, the remaining outcome measures were not significantly different from those of the younger cohort of patients subjected to DC surgery. Both groups were characterized by having prolonged hospital LOS (>40 days) and prolonged SICU LOS (>12 days) among the survivors. For the nonsurvivors, a trend toward a longer time to death was observed in the elderly patients (11.6 ± 4.3 vs. 5.0 ± 3.6 days; $P = 0.147$). Not surprisingly, and as observed in previous studies [22–24], the incidences of severe SIRS (SIRS 3/4; 32.9%), sepsis (25.9%), and the overall incidence of infection (47.5%) and MOF (37.3%) were high in this severely injured patient collective. However, other than a trend toward a higher incidence of MOF in the elderly, there were no age-related differences regarding in-hospital complications.

Table 3 Blood component summary for the first 24 h stratified by age

Blood component	Total ($n = 158$)	≥55 years ($n = 34$)	<55 years ($n = 124$)	P
PRBC 24 h (units)	15.8 ± 1.4	18.9 ± 2.9	15.1 ± 1.6	0.290
PLT 24 h (units)	10.3 ± 1.4	12.9 ± 2.8	9.7 ± 1.6	0.368
FFP 24 h (units)	14.0 ± 1.5	15.7 ± 2.9	13.5 ± 1.7	0.551
FFP: PRBC at 24 h	0.80 ± 0.04	0.84 ± 0.09	0.79 ± 0.04	0.599
PLT: PRBC at 24 h	0.54 ± 0.06	0.66 ± 0.14	0.50 ± 0.06	0.266
Fibrinogen 24 h (g)	1.7 ± 0.2	2.6 ± 0.5	1.5 ± 0.2	0.043

PRBC packed red blood cells; *PLT* platelets; *FFP* fresh frozen plasma

Results are given as the mean ± SEM

Table 4 Clinical outcomes for elderly and young trauma patients undergoing DC procedures

Clinical outcome	Total ($n = 158$)	≥55 years ($n = 34$)	<55 years ($n = 124$)	P
Ventilator days (survivors), mean ± SEM	7.0 ± 0.6	7.3 ± 1.7	6.9 ± 0.7	0.735
SICU LOS (survivors) (days), mean ± SEM	12.9 ± 1.0	14.7 ± 2.9	12.6 ± 1.0	0.402
Hospital LOS (days), mean ± SEM				
Survivors	40.6 ± 2.2	41.2 ± 4.5	40.4 ± 2.5	0.409
Nonsurvivors	9.1 ± 3.0	11.6 ± 4.3	5.0 ± 3.6	0.147
SIRS				
0	13.9% (22)	11.8% (4)	14.5% (18)	0.787
2	27.2% (43)	26.5% (9)	27.4% (34)	0.912
3/4	32.9% (52)	38.2% (13)	31.5% (39)	0.456
Sepsis	25.9% (41)	23.5% (8)	26.6% (33)	0.716
Overall infection	47.5% (75)	52.9% (18)	46.0% (57)	0.471
Pneumonia	23.4% (37)	26.5% (9)	22.6% (28)	0.635
Wound infection	25.9% (41)	20.6% (7)	27.4% (34)	0.421
Intraabdominal abscess	7.0% (11)	5.9% (2)	7.3% (9)	1.000
Acute renal failure	3.2% (5)	5.9% (2)	2.4% (3)	0.293
Deep venous thrombosis	5.1% (8)	5.9% (2)	4.8% (6)	0.682
ARDS	1.9% (3)	0% (0)	2.4% (3)	1.000
MOF (Goris ≥6)	37.3% (59)	47.1% (16)	34.7% (43)	0.186

SICU surgical intensive care unit; *LOS* length of stay; *SIRS* systemic inflammatory response syndrome; *ARDS* acute respiratory distress syndrome; *MOF* multiple organ failure

Table 5 Overall mortality and mortality in DC subgroups

Groups	Total	≥55 years	<55 years	P	OR (95% CI)	Adj. P	Adj. OR (95% CI)
Overall	10.1% (16/158)	29.4% (10/34)	4.8% (6/124)	< 0.001	8.19 (2.72 – 24.70)	0.001[a]	7.09 (2.30–21.74)[a]
Damage control							
Extremity	6.7% (8/119)	19.2% (5/26)	3.2% (3/93)	0.012	7.14 (1.58–32.27)	0.032[b]	5.95 (1.16–30.30)[b]
Pelvis	18.5% (5/27)	25.0% (2/8)	15.8% (3/19)	0.616	1.78 (0.24–13.41)	–[c]	–[c]
Laparotomy	18.9% (7/37)	55.6% (5/9)	7.1% (2/28)	0.005	16.25 (2.32–114.06)	–[c]	–[c]

OR odds ratio; *CI* confidence interval; *Adj.* adjusted

[a] Adjusted for external fixator lower extremity, fibrinogen 24 h

[b] Adjusted for external fixator lower extremity, systolic blood pressure <90 mmHg

[c] No statistically significant confounders between the compared groups

The laboratory variables (e.g., hemoglobin, base deficit, serum lactate levels) were significantly deranged in elderly patients upon hospital admission. However, following aggressive blood component resuscitation and the application of surgical DC strategies, these parameters were similar between the two age groups upon SICU admission and at 24 h after hospital admission. The elderly patients demonstrated a trend toward increased requirement of blood product transfusions and received more fibrinogen than their younger counterparts. This may be explained by multiple factors observed in the current analysis, including the trends toward a higher rate of admission hypotension and more serious injuries. However, combining these findings with the previously discussed results of the similar rates of major in-hospital morbidities between both DC age cohorts and the fact that most of the seriously injured elderly patients (>70%) survived to hospital discharge, the current study provides support for the recommendations made by previous authors for early aggressive monitoring and intervention in elderly trauma victims [25–27].

To the best of our knowledge, this is one of the largest and first studies examining the impact of age on the outcome among patients undergoing various DC procedures. Nevertheless, there are several limitations, the most important being the retrospective nature of the data collection and analysis. The definition utilized to characterize elderly and younger trauma victims was based on the patient's chronologic age (≥55 years vs. <55 years) but did not account for the patient's physiologic age, such as the nature and the extent of preexisting medical conditions. Unfortunately, preexisting co-morbidities and medications, which have previously been shown to have an impact on outcome [16], were not available for analysis. Therefore, these variables are of critical value in future investigations of outcomes in elderly DC cohorts.

The study cohort consisted of patients with a wide variety of injury patterns. To minimize the impact of head injuries, patients with a head AIS ≥3 were excluded. Care was also taken to include severely traumatized patients only by setting an ISS threshold of 16 points. In fact, the mean ISS was 30, with most of the patients (65%) having an ISS ≥25 (i.e., defined as critically injured). Therefore, despite the heterogeneous study population, we strongly believe that our results are applicable in these clinical settings.

As in any long-term study spanning a 12-year inclusion period, advances in transfusion practices and critical care medicine may have influenced subsequent outcomes. Also, the age of the PRBCs transfused, which has recently been shown to significantly affect outcome [28–30], was not available for analysis. Finally, our relatively small sample size of 158 patients, with 34 patients ≥55 years of age, may not have provided adequate statistical power to observe specific outcome differences when comparing the elderly and younger DC patients.

Conclusions

The mortality rate for the elderly trauma patients who underwent DC surgery was significantly high at 29%. Despite the significant burden of injury and the massive transfusion requirement, however, most of the elderly patients survived and experienced in-hospital morbidity measures comparable to those of the younger patients. Our results provide further support for DC intervention in severely injured elderly patients.

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