Predictors of laparotomy and mortality in polytrauma patients with pelvic fractures

Jameel Ali, MD, MMedEd
Khaled Al Ahmadi, MBBS
Jack I. Williams, PhD

From the Department of Surgery, St. Michael's Hospital and the University of Toronto, Toronto, Ont.

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Correspondence to:
Dr. J. Ali
Department of Surgery
55 Queen St. E, Ste. 402
Toronto ON M5C 1R6
fax 416 864-6008
alij@smh.toronto.on.ca

Background: The decision to perform laparotomy in blunt trauma patients is often difficult owing to pelvic fractures; however, once the decision is made, delay or failure to perform laparotomy could affect morbidity and mortality. We sought to identify predictors of laparotomy and mortality in polytrauma patients with pelvic fractures.

Methods: We divided 390 blunt polytrauma patients (Injury Severity Score [ISS] ≥ 16) with pelvic fractures into laparotomy (n = 56) and nonlaparotomy (n = 334) groups. We assessed the role of the following variables in predicting laparotomy and mortality: age, sex, hypotension, fluid and blood transfusions, positive abdominal computed tomography (CT) scans or focused assessment with sonography for trauma (FAST) examination, pelvic fracture severity and ISS. We analyzed the data using Student t and χ^2 tests, followed by logistic regression analysis.

Results: Mortality was higher in the laparotomy group than the nonlaparotomy group (28.6% v. 12.9%; overall mortality 15.1%). The laparotomy group had higher mean ISS (36.9 v. 24.9), higher mean abbreviated injury scores (AIS) for the abdomen (2.6 v. 0.9) and chest (3.4 v. 1.6), lower mean initial hemoglobin levels (105.2 v. 127.0 g/L), higher mean crystalloid (4249 v. 3436 mL) and blood transfusion volumes over 4 hours (12.1 v. 3.9 units), more frequent hypotension (44.6 v. 18.0%) and a higher percentage of positive CT scans (67.9% v. 28.4%) and FAST examination results (42.9% v. 3.3%) than the nonlaparotomy group. Age (mean 53.7 v. 41.5 yr); ISS (mean 39.0 v. 24.4); AIS for the head (mean 3.2 v. 1.7), abdomen (mean 1.6 v. 1.1), chest (mean 2.7 v. 1.8) and pelvis (mean 3.1 v. 2.6); crystalloid (mean 5157.3 v. 3266.4 mL) and blood transfusion volumes over 4 hours (mean 13.1 v. 3.7) and initial hypotension (61% v. 14.8%) were all greater among patients who died than those who survived. Mean initial hemoglobin levels were lower among patients who died than among those who survived (111.1 v. 126.2 g/L). Age, the AIS for the head, initial hypotension and low initial hemoglobin levels were highly predictive of mortality, whereas low initial hemoglobin levels, a positive FAST examination and high AIS for the abdomen and chest were all highly predictive of laparotomy.

Conclusion: Among the polytrauma patients with pelvic fractures, 14.3% underwent laparotomy, and mortality was higher among these patients than among those who did not have the procedure. The predictors of laparotomy and mortality are similar to those anticipated in patients without pelvic fractures.

Contexte : La présence de fracture du bassin complique souvent la décision de recourir à la laparotomie chez les patients victimes de traumatismes fermés; une fois cette décision prise, toutefois, tout retard ou défaut de procéder à la laparotomie pourrait influer sur la morbidité et la mortalité. Nous avons voulu identifier les prédicteurs de la laparotomie et de la mortalité chez les polytraumatisés atteints de fracture du bassin.

Méthodes : Nous avons réparti 390 patients victimes d'un traumatisme fermé avec fracture du bassin (score ≥ 16 à l'échelle de gravité des traumatismes [*Injury Severity Score*, ISS]) entre 2 groupes, l'un soumis à la laparotomie (n = 56) et l'autre, non soumis à la laparotomie (n = 334). Nous avons évalué le rôle des facteurs suivants comme prédicteurs de la laparotomie et de la mortalité : âge, sexe, hypotension, perfusions de liquides et transfusions de sang, résultats positifs à la tomographie assistée par ordinateur abdominale ou à l'échographie ciblée (*Focused Assessment with Sonography for Trauma*, FAST), gravité et ISS de la fracture du bassin. Nous avons analysé les données au moyen des tests t de Student et du χ^2, suivis d'une analyse de régression logistique.

Résultats : Le groupe de laparotomie a enregistré un taux de mortalité plus élevé que le groupe non soumis à la laparotomie (28,6 % c. 12,9 %; mortalité globale 15,1 %). Comparativement au groupe non soumis à la laparotomie, le groupe de laparotomie a présenté un ISS moyen plus élevé (36,9 c. 24,9), ainsi qu'un score moyen plus élevé à l'échelle abrégée de gravité des traumatismes (*Abbreviated Injury Score*, AIS) pour l'abdomen (2,6 c. 0,9) et le thorax (3,4 c. 1,6), des taux moyens d'hémoglobine au départ plus bas (105,2 c. 127,0 g/L), des volumes moyens plus élevés de cristalloïdes (4249 mL c. 3436 mL) et de transfusions sanguines en 4 heures (12,1 c. 3,9 unités), une hypotension plus fréquente (44,6 % c. 18,0 %) et un pourcentage plus élevé de résultats positifs à la tomographie (67,9 % c. 28,4 %) et à l'échographie FAST (42,9 % c. 3,3 %). Par rapport aux patients ayant survécu, les patients décédés présentaient une élévation des paramètres suivants : âge (moyenne 53,7 c. 41.5 ans); ISS (moyenne 39,0 c. 24,4); AIS de la tête (moyenne 3,2 c. 1,7), de l'abdomen (moyenne 1,6 c. 1,1), du thorax (moyenne 2,7 c. 1,8) et du bassin (moyenne 3,1 c. 2.6); volumes de cristalloïdes (moyenne 5157,3 mL c. 3266,4 mL) et de transfusions sanguines en 4 heures (moyenne 13,1 c. 3,7); et hypotension initiale (61 % c. 14,8 %). Ils présentaient aussi des taux d'hémoglobine plus faibles au départ (moyenne 111,1 c. 126,2 g/L). L'âge, l'AIS de la tête, l'hypotension initiale et les taux faibles d'hémoglobine au départ se sont révélés être de puissants prédicteurs de la mortalité, tandis que les taux faibles d'hémoglobine au départ, un résultat positif à l'échographie ciblée, des scores AIS élevés pour l'abdomen et le thorax se sont révélé de puissants prédicteurs de la laparotomie.

Conclusion : Parmi les polytraumatisés atteints de fractures du bassin, 14,3 % ont subi une laparotomie et la mortalité a été plus grande chez ces patients que chez les patients non laparotomisés. Les prédicteurs de la laparotomie et de la mortalité ont été semblables à ceux auxquels ont pouvait s'attendre chez des patients polytraumatisés sans fracture du bassin.

The decision to perform laporotomy in blunt trauma patients is often difficult. One of the factors affecting this decision is the presence of associated pelvic fractures. Hypotension, low hemoglobin levels and abnormal physical examinations may all be present with or without important associated abdominal trauma requiring laparotomy. However, once laparotomy is required, failure to perform this procedure or delaying its performance could affect morbidity and mortality.[1–3] Tien and colleagues[4,5] reported that preventable deaths among polytrauma patients are largely due to delay in controlling hemorrhage. Furthermore, once hemorrhage is controlled, end points of resuscitation should be examined clinically with a view to restricting transfusion and minimizing the complications of aggressive transfusion. To guide the decision for laparotomy in patients with pelvic fractures and hopefully decrease mortality, we retrospectively assessed mortality in severely injured polytrauma patients with pelvic fractures who underwent laparotomy, and we compared their outcomes with those of patients who did not undergo laparotomy. We also reviewed and reported laparotomy findings.

Methods

St. Michael's Hospital is a tertiary level-1 trauma centre in Toronto, Ont., that admits about 550 polytrauma patients annually. These patients have Injury Severity Scores (ISS) of 16 or greater. Roughly 85% of injuries are due to blunt trauma and the other 15% are due to penetrating injury. Using the St. Michael's Hospital Trauma Registry, we conducted a retrospective review of all patients who sustained pelvic fractures and had an ISS of 16 or greater between March 1999 and February 2004. We excluded patients who underwent angiographic techniques for controlling pelvic fracture hemorrhage. For comparison purposes, we divided the included patients into 2 groups: those who had laparotomy and those who did not. The Research Ethics Board of St. Michael's Hospital approved out study protocol.

Statistical analysis

We used Student *t* and χ^2 tests to compare mortality (in-hospital deaths any time after admission for trauma); age; ISS; abbreviated injury scores (AIS) for the head, abdomen, chest and pelvis; initial hemoglobin levels; volume of crystalloid and blood transfused in the first 4 hours; the incidence of hypotension (blood pressure < 90 mm Hg within the first half-hour of arrival in the emergency department); positive computed tomography (CT) scan of the abdomen and positive focused assessment sonography for trauma (FAST) examination results between the 2 groups. We considered a CT scan to be positive if it showed extra pelvic fluid, bowel thickening, free air, evidence of solid organ laceration or hematoma. Our trauma team data analyst calculated the ISS and AIS for each region based on previously described guidelines.[6,7]

We also used Student *t* and χ^2 tests to compare the patients who survived with those who did not based on age; ISS; AIS for the head, abdomen, chest and pelvis; initial hemoglobin levels; crystalloid infusion; blood transfusion; hypotension; positive CT of the abdomen; and positive FAST results. Owing to the inter-relationships of these factors, we also performed a logistic regression analysis to determine the odds ratios for laparotomy and mortality.

RESULTS

There were 390 patients with an ISS of 16 or greater who had pelvic fractures. The overall mortality rate was 15.1% (59/390). The mortality rate in the laparotomy group was 28.6% (16/56), compared with 12.9% (43/334) in the nonlaparotomy group. The difference in mortality was statistically significant ($p = 0.002$, χ^2 test) (Table 1).

Demographic characteristics of the patients are summarized in Table 2. The mean age was similar between the 2 groups (43.2 v. 43.4 yr). The mean ISS (36.9 v. 24.9) and AIS for the chest (3.4 v. 1.6) and abdomen (2.6 v. 0.9) were significantly higher in the laparotomy group than the nonlaparotomy group, whereas the mean AIS for the pelvis (2.8 v. 2.6) and head (2.0 v. 1.9) did not differ significantly between the groups. The mean initial hemoglobin level of 105.2 g/L in the laparotomy group was lower than that in the nonlaparotomy group (127.0 g/L, $p < 0.001$). Crystalloid infusion in the first 4 hours (4249 v. 3436 mL, $p < 0.002$) and the number of blood transfusions (12.1 v. 3.9 units/first 4 hours, $p < 0.001$) was higher in the laparotomy group than in the nonlaparotomy group. The groups did not differ in sex, but there was a higher percentage of patients with hypotension (44.6% v. 18.0%, $p < 0.001$) in the laparotomy group than in the nonlaparotomy group. There was also a higher percentage of positive CT scans of the abdomen in the laparotomy group (38/56, 67.9%) compared with the non laparotomy group (95/334, 28.4%). Results of the FAST examination were more frequently positive in the laparotomy group (24/56, 42.9%) compared with the nonlaparotomy group (11/334, 3.3%).

We compare the demographic characteristics of survivors and nonsurvivors in Table 3. The mean age (53.7 v. 41.5 yr) was significantly higher among nonsurvivors than among survivors. In addition, the mean ISS (39.0 v. 24.4) and the mean AIS of the head (3.2 v. 1.7), abdomen (1.6 v. 1.1), chest (2.7 v. 1.8) and pelvis (3.1 v. 2.6) were all significantly higher among nonsurvivors than among survivors. There was also a lower initial hemoglobin level (111.1 v. 126.2 g/L) and higher blood (13.1 v. 3.7 units) and crystalloid infusion (5157.3 v. 3266.4 mL in 4 hours) volumes among nonsurvivors than among survivors. Although a higher percentage (67.8% v. 55.0%) of men than women died, this difference was not significant ($p = 0.07$). There was a higher incidence (61% v. 14.8%) of initial hypotension among nonsurvivors than among survivors ($p < 0.001$). We also observed a trend of more frequent positive results on FAST examinations among nonsurvivors than survivors (15.3% v. 7.9%, $p = 0.07$). There was no significant

Table 1. Mortality among polytrauma patients who underwent laparotomy versus those who did not

	Group; no. (%)		
Outcome*	Laparotomy *n* = 56	No laparotomy *n* = 334	Total, *n* = 390
Alive	40 (71.4)	291 (87.9)	331 (84.9)
Dead	16 (28.6)	43 (12.9)	59 (15.1)

*χ^2 = 9.204; p = 0.002.

Table 2. Demographic characteristics of 390 polytrauma patients admitted to St. Michael's Hospital between March 1999 and February 2004

	Group; mean (SD)*			
Characteristic	Laparotomy *n* = 56	No laparotomy *n* = 334	Test	*p* value
Age, yr	43.2 (17.7)	43.4 (19.6)	t = 0.074	0.94
Male sex, no. (%)	30 (53.6)	192 (57.5)	χ^2 = 0.300	0.58
ISS	36.9 (12.1)	24.9 (12.5)	t = 6.654	< 0.001
AIS				
Head	2.0 (0.8)	1.9 (1.9)	t = 0.249	0.80
Abdomen	2.6 (0.6)	0.9 (1.3)	t = 9.373	< 0.001
Chest	3.4 (1.2)	1.6 (1.8)	t = 7.151	< 0.001
Pelvis	2.8 (0.8)	2.6 (0.7)	t = 1.385	0.17
Initial hemoglobin level	105.2 (17.7)	127.0 (12.7)	t = 11.197	< 0.001
Hypotension, no. (%)	25 (44.6)	60 (18.0)	χ^2 = 20.027	< 0.001
Crystalloid	4249 (2791)	3436 (1723)	t = 3.139	0.002
Blood transfusion	12.1 (10.1)	3.9 (10.0)	t = 5.638	< 0.001
Positive abdominal CT scan, no. (%)	38 (67.9)	95 (28.4)	χ^2 = 33.153	< 0.001
Positive result on FAST, no. (%)	24 (42.9)	11 (3.3)	χ^2 = 91.896	< 0.001

AIS = Abbreviated Injury Score; CT = computed tomography; FAST = focused assessment with sonography for trauma; ISS = Injury Severity Score; SD = standard deviation.
*Unless indicated otherwise.

Table 3. Comparison of demographic characteristics of survivors and nonsurvivors among 390 polytrauma patients admitted to St. Michael's Hospital between March 1999 and February 2004

	Outcome; mean (SD)*			
Characteristic	Dead, *n* = 56	Alive, *n* = 334	Test	*p* value
Age, yr	53.7 (21.7)	41.5 (18.4)	t = 4.542	< 0.001
Men, no. (%)	40 (67.8)	182 (55.0)	χ^2 = 3.35	0.07
Women, no. (%)	19 (32.2)	149 (45.0)		
ISS	39.0 (11.6)	24.4 (12.1)	t = 8.542	< 0.001
AIS				
Head	3.2 (1.8)	1.7 (1.7)	t = 6.545	< 0.001
Abdomen	1.6 (1.4)	1.1 (1.3)	t = 2.664	0.008
Chest	2.7 (1.8)	1.8 (1.8)	t = 3.597	< 0.001
Pelvis	3.1 (1.0)	2.6 (0.6)	t = 4.724	< 0.001
Initial hemoglobin	111.1 (25.9)	126.2 (11.4)	t = 7.377	< 0.001
Crystalloid	5157.3 (2151.7)	3266.4 (1589.5)	t = 7.939	< 0.001
Blood transfusion	13.1 (20.9)	3.7 (6.2)	t = 6.682	< 0.001
Hypotension, no. (%)	36 (61.0)	49 (14.8)	χ^2 = 62.74	< 0.001
Positive abdominal CT scan, no. (%)	20 (33.9)	113 (34.1)	χ^2 = 0.001	0.97
Positive result on FAST, no. (%)	9 (15.3)	26 (7.9)	χ^2 = 3.35	0.07

AIS = Abbreviated Injury Score; CT = computed tomography; FAST = focused assessment with sonography for trauma; ISS = Injury Severity Score; SD = standard deviation.
*Unless otherwise indicated.

difference in the incidence of positive abdominal CT scans between the groups (33.9% v. 34.1%, $p = 0.97$).

Logistic regression analysis

We started by comparing laparotomy/nonlaparotomy and nonsurvivors/laparotomy patients on predictor demographic, clinical and scored data. We used logistic regression to estimate the predictive power of individual variables after controlling for the effects of the other independent variables in the model. We used the forward selection method for building the model. For the variables to be brought into the model, they had to be significant at the $p = 0.1$ level. We then generated tables in terms of descending level of significance of the odds ratios (Table 4 and Table 5).

We looked at the relation among the predictor variables by putting them into a correlation matrix. The correlations were low to moderately high, with a number of the coefficients being statistically significant. Table 4, which summarizes the odds ratios predicting laparotomy, and Table 5, which summarizes the logistic regression analysis for determining the odds ratio of mortality, show the independent effects of the predictors once the covariance with other variables was taken into account. A negative initial hemoglobin level, positive result on FAST examination and elevated AIS for the abdomen and chest were the strongest independent predictors of laparotomy. Crystalloids and AIS for the head and pelvis entered the model, but they were of lesser importance. Crystalloid, AIS of the head and AIS of the pelvis were not predictive of laparotomy in the multiple regression analysis model, as indicated by the calculated odds ratios for these parameters (Table 4). Older patients were more likely to die, and death was more likely in patients with high AIS of the head, hypotensive patients and patients with low initial hemoglobin levels. Crystalloid, sex and high ISS were all marginally related to mortality in this logistic regression model (Table 5).

Table 6 summarizes the clinical findings at laparotomy. As demonstrated, many of these patients had multiple organ involvement with the spleen being the most frequently involved organ (55.4%). All but 1 of the 56 patients who underwent laparotomy had positive findings; we identified no intra-abdominal source of shock in this patient, who was taken to the operating room with a severe head injury and hypotension and who died as a result of these injuries. Of the patients who did not undergo laparotomy, 37 had splenic injuries, 32 had liver injuries and 22 had kidney injuries.

Table 4. Logistic regression analysis of factors predicting laparotomy*

Laparotomy	OR	SE	*Z*	Prob *Z*†	95% CI
Initial hemoglobin‡	0.89	0.02	–5.95	0.000	0.85–0.92
Positive FAST†	13.51	7.72	4.56	0.000	4.41–41.40
AIS					
Abdomen†	2.40	0.47	4.47	0.000	1.64–3.52
Chest†	1.75	0.28	3.47	0.001	1.28–2.39
Head	0.64	0.11	–2.63	0.009	0.45–0.89
Pelvis	0.48	0.15	–2.33	0.020	0.26–0.90
Crystalloid	0.99	0.00	–2.73	0.006	0.99–1.00

AIS = Abbreviated Injury Score; CI = confidence interval; FAST = focused assessment with sonography for trauma; LR = logistic regression; OR = odds ratio; SE = standard error.
*$n = 390$, LR $\chi^2 = 183.85$, probability < 0.001, pseudo $R^2 = 0.537$
†Prob *Z* refers to the statistical significance of the *Z* value (Wald Test Statistic).
‡Low initial hemoglobin, positive FAST, high AIS abdomen and chest were highly predictive of laparotomy.

Table 5. Logistic regression analysis of factors predicting mortality*

Death	OR	SE	*Z*	Prob *Z*	95% CI
Age‡	1.05	0.01	4.68	0.000	1.00–1.07
AIS of the head‡	1.86	0.27	4.24	0.000	1.40–2.47
Hypotension‡	4.80	2.07	3.64	0.000	2.06–11.17
Initial hemoglobin‡	0.96	0.96	–3.06	0.002	0.94–0.99
Crystalloid	1.00	0.00	2.37	0.018	1.00–1.00
Sex	2.66	1.13	2.31	0.021	1.16–6.11
ISS	1.04	0.02	2.13	0.034	1.00–1.08

AIS = Abbreviated Injury Score; CI = confidence interval; ISS = Injury Severity Score; LR = logistic regression; OR = odds ratio; SE = standard error.
*$n = 390$, LR $\chi^2 = 152.07$, probability < 0.001, pseudo $R^2 = 0.459$
†Prob *Z* refers to the statistical significance of the *Z* value (Wald Test Statistic).
‡Age, AIS of the head, hypotension, and low hemoglobin were strong predictors of mortality.

DISCUSSION

The presence of pelvic fractures in polytrauma patients poses challenges because the signs and symptoms of intra-abdominal injuries may be masked by the findings associated with the pelvic fractures. Such findings include hypotension from the fracture itself, abdominal pain and clinical findings that are difficult to differentiate from those of peritonitis. These findings would ordinarily be a clear indication for laparotomy in the trauma patient. The trend toward nonoperative management of solid intra-abdominal organ injury increases the likelihood that clinically important intra-abdominal injuries may go unnoticed, and this could be further compounded by the

Table 6. Laparotomy findings for 56 polytrauma patients admitted to St. Michael's Hospital between March 1999 and February 2004

Site of injury	No. (%)
Diaphragm	11 (19.6)
Spleen	31 (55.4)
Liver	23 (41.1)
Duodenum	3 (5.4)
Small bowel	11 (19.6)
Large bowel	10 (17.9)
Pancreas	6 (10.7)
Kidney	6 (10.7)
Bladder	6 (10.7)
Vascular	3 (5.4)

presence of pelvic fractures. Generally, bleeding from pelvic fractures does not warrant an open surgical approach;[8,9] however, the bleeding from the pelvic fractures could result in hypotension, which may be indistinguishable from hypotension due to associated intra-abdominal injuries. Based on experience in pelvic fracture management in Europe,[10–12] a trial of preperitoneal pelvic packing for hemodynamically unstable patients with pelvic fractures has been reported.[13] This approach, however, remains controversial.

Although preliminary AIS and ISS are assigned in the trauma room by the trauma team leader, the final AIS and ISS are determined usually after discharge, when the entire chart is reviewed in detail by the data analyst. We did not compare the ISSs assigned in the trauma room with the final scores to determine whether there was a substantial or clinically important difference. Conceivably, in our study, the final ISS may have been higher in the laparotomy group because more detailed information about the intra-abominal injuries following the laparotomy was available for these patients. This would result in the laparotomy group having higher ISSs and increase the likelihood of injury severity as a strong predictor of laparotomy. This suggests that clinical decisions (e.g., whether or not to perform laparotomy) frequently need to be made without complete and detailed information, adding to the challenge of managing the multiply injured blunt trauma patient. This difficulty is potentially offset by the high accuracy of our imaging techniques, particularly CT scans of the abdomen.

In our study, laparotomy was performed in 14.3% of polytrauma patients with pelvic fractures. In the literature, the frequency of laparotomy in polytrauma patients with pelvic fractures varies from 15% to 35%,[8–13] but the databases are not exactly comparable. The incidence of 14.3% from our data is, therefore, similar to that reported elsewhere. However, polytrauma patients with pelvic fractures who require laparotomy have a higher mortality than patients who do not need the procedure. One possible interpretation of the data, therefore, is that laparotomy kills patients. This assumption is, of course, absurd because the injury prompting the laparotomy is responsible for the mortality and not the laparotomy itself. We anticipated that the severity of pelvic fracture may correlate positively with mortality and the need for laparotomy. Initial Student *t* tests suggested that an increased AIS of the pelvis was a predictor of mortality, but this was not confirmed by logistic regression analysis. Our data did not identify AIS of the pelvis as a predictor of laparotomy. Conceivably, the use of a pelvic fracture classification based on mechanism and stability[13–15] may have shown a correlation between the type and/or severity of pelvic fracture and mortality as well as the need for laparotomy. Pelvic fractures in our trauma database are not consistently categorized using these classifications; however, AIS of the pelvis was uniformly assigned in the database, which was our reason for using severity of pelvic fracture based on the AIS categorization. The type and/or severity of pelvic fractures has not been uniformly reported to be a predictor of laparotomy or outcome. Associated injury[2,15–17] has been reported to be more predictive of outcome than the type of pelvic fracture. Other authors, however, have reported that fracture pattern is a predictor of mortality.[3] The role of the pelvic fracture therefore remains uncertain both as an indicator for laparotomy and a predictor of mortality among polytrauma patients. Our data suggest that other factors are more predictive of the need for laparotomy and of mortality in patients with pelvic fractures undergoing laparotomy.

The presence of a pelvic fracture per se does not seem to predict laparotomy or mortality in the severely polytraumatized patient. The identified predictors (hypotension, head injury, low hemoglobin levels) appear to be equally predictive of laparotomy and mortality, regardless of whether a pelvic fracture is present or not.

It is noteworthy that severity of head injury did not predict laparotomy but was associated with higher mortality. High AIS of the abdomen was, however, a very strong predictor of laparotomy, as expected. These observations suggest that patients with severe head injuries are less likely to have severe abdominal injuries requiring laparotomy. This may be because patients with severe head injuries experienced blunt force directed primarily toward the head with less energy transfer to the abdomen. However, when a severe head injury is associated with an intra-abdominal injury warranting laparotomy, this is likely to be associated with high mortality.

Laparotomy findings among patients in our study who underwent the procedure raise the possibility that some patients may have had substantial intra-abdominal injuries for which laparotomy was not performed. Our database did not allow us to clarify this issue. Routine post-mortem examinations of patients who did not undergo laparotomy and died may have allowed insight into this issue, but our numbers in this category were too low to allow any meaningful assessment of this question. It should be noted that some of the injuries (e.g., liver, spleen, bladder) found at laparotomy may not have required surgical correction.

Strong predictors of laparotomy were increased severity of abdominal and thoracic injury, whereas strong predictors of mortality by logistic regression were increased severity of head injury, hypotension and low initial hemoglobin levels. From our review, it appears that the decision to perform a laparotomy in polytrauma patients with pelvic fractures is still difficult and, although the frequency is relatively low (14.3%), mortality is very high. This finding appears to be related more to the associated intra-abdominal and head injuries than to the severity of the pelvic fracture. We anticipated that the severity of pelvic fractures would be a strong predictor of mortality; however, this was not supported by our data.

Polytrauma patients with pelvic fractures who have initial low hemoglobin levels and positive results on FAST examination are prime candidates for laparotomy. In such patients, many factors are important in predicting laparotomy and outcome, and the trauma surgeon must be aware of all the identified predictors. Our study supports the notion that predictors of laparotomy and mortality in polytrauma patients with pelvic fractures are essentially the same as those expected in patients without pelvic fractures.

Competing interests: None declared.

Contributors: Drs. Ali and Williams designed the study. Drs. Ali and Al Ahmadi acquired the data, which all authors analyzed. Drs. Ali and Williams wrote the article, which all authors reviewed and approved for publication.

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