

## Original Research Article

# Abdominal and pelvic vascular trauma in Queensland, Australia: institutional experience at a level one trauma centre

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### ABSTRACT

**Background:** Abdominal and pelvic vascular injuries are amongst the most lethal injuries sustained by trauma patients. Unlike internationally, the epidemiology is not well documented in Australia. Gold Coast University Hospital (GCUH) is a level one trauma centre in Queensland, Australia. This study aims to identify the epidemiological patterns of abdominal and pelvic vascular traumatic injuries, their interventions and outcomes, and compare these with national and international data.

**Methods:** All individuals who presented to GCUH between January 2014 and December 2019 with abdominal or pelvic vascular injuries were retrieved from the GCUH prospective trauma database. A descriptive analysis was undertaken on this cohort.

**Results:** The study reviewed 5452 trauma admissions to GCUH, of which 68 patients sustained abdominal or pelvic vascular injuries. The number of blunt and penetrating trauma cases were 53 (77.9%) and 15 (22.1%) respectively, and 51 (75%) of the patients were male. Interventions were required in 57 patients (83.8%). Of these interventions, 28 were open (41.2%), 27 were endovascular (39.7%) and 2 required both open and endovascular interventions (2.9%). The most commonly injured vessels were the visceral arteries (51.9%) and iliac arteries (22.7%). The mortality rate was 8.8% which were all as a result of blunt trauma.

**Conclusions:** Abdominal and pelvic vascular trauma causes significant injuries with a higher mortality than general trauma. Given the majority of cases occurred secondary to road accidents, motor vehicle safety interventions and prevention programmes are likely to have the greatest effect on reducing the abdominal and pelvic vascular injury rate in Australia.

**Keywords:** Abdominal, Pelvic, Vascular injury, Trauma, Australia

### INTRODUCTION

On a global scale, trauma as a cause of mortality and morbidity is growing with figures from 2000 showing injuries accounted for 11% of global mortality and 13% of all disability-adjusted life-years.<sup>1</sup> It represents a significant and burgeoning public health issue and in view of the magnitude of this problem, trauma clinicians play a pivotal role and require an understanding of its epidemiology, mechanisms of injury, and a structured approach to trauma management.<sup>1</sup>

Abdominal and pelvic vascular trauma, although rare, comprises among the most lethal injuries encountered by trauma surgeons with mortality rates ranging from 20% to 60%.<sup>2</sup> They present a major challenge for clinicians due to severe acute blood loss, large number of associated injuries and difficulty gaining rapid control of the bleeding vessel.<sup>3,4</sup> Abdominal and pelvic vascular injuries can be resultant from either blunt and penetrating trauma, and the vast majority of these patients present to hospital in profound hemorrhagic shock.<sup>2,4,5</sup> Early mortality occurs secondary to exsanguination and late mortality

occurs due to the lethal cycle involving secondary hypothermia, acidosis and coagulopathy leading to multi-system organ failure.<sup>2,4,5</sup> Management of abdominal and pelvic vascular injuries is fraught with difficulties presenting numerous challenges to trauma surgeons.<sup>4</sup> Factors which contribute to this complexity include difficulty obtaining adequate exposure and immediate proximal control, repairing injuries in the face of contamination, concurrent need to treat often critical associated injuries, and need to manage the consequences of ischaemia to critical end organs.<sup>4,6</sup>

Considerable variation in the epidemiology of vascular trauma exists throughout the world with Australian and Thailand studies reporting blunt injuries as the most common aetiology whereas in places such as America penetrating trauma contributes the greatest percentage.<sup>3,7,8-11</sup>

Internationally almost all studies report a greater incidence of vascular trauma in the male population.<sup>3,7,8-13</sup> Men are also more likely to experience a penetrating vascular injury than woman.<sup>13</sup> Patients with penetrating injuries are often reported to be at higher risk of dying from their injuries than those with blunt injuries, as are patients with higher ISS scores.<sup>11,13</sup>

Other factors associated with mortality include the presence of shock on arrival and associated injuries.<sup>11</sup> The most commonly injured abdominal or pelvic vessels include the iliac arteries, visceral arteries or veins, aorta and inferior vena cava.<sup>2,7,8-11</sup>

Mortality rate figures for abdominal and pelvic vascular trauma vary between countries and publications with various American studies reporting mortality figures of 25%, 45%, and 54%, whilst an Australian and a Thailand study reported mortality of 35.6% and 36% respectively.<sup>3,8,11,13</sup> When compared with mortality rates for general abdominal trauma these are significantly higher which various articles reporting figures between 5-13.2%.<sup>14-16</sup>

Lack of current data regarding abdominal and pelvic vascular trauma exists despite the significant morbidity and mortality associated with it. No Australian studies have been performed specifically investigating traumatic abdominal and pelvic vascular injuries.

The aim of this study was to describe the epidemiology and outcomes of abdominal and pelvic vascular trauma in a Level One Trauma Centre, the Gold Coast University Hospital (GCUH) in Queensland, Australia and review how it compares with national and international literature. An improved understanding of this can empower clinicians of all levels of experience to contribute to strengthening the trauma system they work in.

## METHODS

This study was approved by the GCUH Human Research and Ethics Committee, reference number 61769. Patients who presented to GCUH with an abdominal or pelvic vascular injury between the dates of January 2014 and December 2019 were identified and selected from the Gold Coast University prospective trauma database. Information required for the study was either obtained from the trauma database or the patients electronic medical records. Patients were excluded from the study if they were under the age of fourteen and therefore deemed to be a paediatric patient, did not sustain any abdominal or pelvic vascular injuries, or died pre-hospital either at the scene or in-transit to the Emergency Department. Patients injuries were classified using the Abbreviated Injury Score (AIS 2008 prior to 2015 and AIS 2015 for the subsequent years). The demographic information which was collected from the database or the patient's medical records included their age, gender, mechanism of injury, rural/inter-hospital transfer, injury severity score (ISS), use of drugs or alcohol within 12 hours of injury, length of hospital stay and length of intensive care admission. The main outcomes were the type of intervention required (none, endovascular or surgical), in addition to mortality, which was defined by whether death occurred within 30 days of the injury during the same hospital admission. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) program.

## RESULTS

The study reviewed 5452 trauma admissions to GCUH, of which 213 sustained vascular injuries. There were 68 patients who presented with abdominal or pelvic vascular injuries, which accounts for 31.9% of the total vascular trauma patients seen over this time period. The number of abdominal vascular injuries totalled 79. The number of blunt and penetrating trauma cases were 53 (77.9%) and 15 (22.1%) respectively, and 51 (75%) of the patients were male. The mean age of this cohort was 45.8 years (median 44.0), with a range from 14 to 90 years. Alcohol was a contributing factor in 14 patients (20.6%), while drugs were a factor in only 9 (13.2%). The mortality rate for abdominal vascular injuries was 8.8% (n=6) which were all as a result of blunt abdominal trauma. 12 patients (17.6%) were interhospital transfers.

Interventions were required in 57 patients (83.8%). Of these interventions, 28 were open (41.2%), 27 were endovascular (39.7%) and 2 required both open and endovascular interventions (2.9%). Of the interventions for the 53 blunt injuries, 15 were open (28.3%), 25 were endovascular (47.1), 2 required both open and endovascular (3.8%) and 11 required no intervention (20.8%). All of the 15 penetrating injuries required interventions, with 13 open procedures (86.7%) and 2 endovascular procedures (13.3%) performed (Table 1).

**Table 1: Types of intervention required for blunt and penetrating injuries.**

Type of intervention	Blunt	Penetrating
None	11 (20.8%)	0 (0%)
Open	15 (28.3%)	13 (86.7%)
Endovascular	25 (47.1%)	2 (13.3%)
Open + endovascular	2 (3.8%)	0 (0%)

**Table 2: ISS, ICU length of stay (LOS) and hospital length of stay (LOS) for both blunt and penetrating injuries.**

Category	Blunt	Penetrating
ISS	Mean= 26.4	Mean=13.5
	Range= 2-75	Range=2-21
ICU LOS (days)	Mean=2.3	Mean=3.7
	Range 0-14	Range=0-28
Hospital LOS (days)	Mean=14.3	Mean=10.5
	Range =1-74	Range=3-38

The ISS had a mean of 23.6 (median 21.5), with a range from 2 to 75. Blunt injuries had a higher mean ISS as compared with penetrating injuries (26.4 vs 13.5 respectively). The average ISS was higher for the patients who died of their injuries (37.2) as compared with those who did not (22.2).

The ICU length of stay (LOS) had a mean of 2.54 days (median 1.00), with a range from 0-28 days. Penetrating injuries had a higher mean ICU LOS as compared with blunt injuries (3.7 vs 2.3 respectively). The average hospital LOS was 13.5 days (median 8.0), ranging from 1-74 days. Blunt injuries had higher mean hospital LOS

as compared with penetrating injuries (14.3 vs 10.5 respectively) (Table 2).

The most commonly injured vessels include the iliac artery (22.7%), hepatic artery (15.1%), renal artery (13.9%), superior mesenteric artery (11.4%), aorta (10.1%) and splenic artery 6.3% (Table 3). The most common mechanism of injuries was motor vehicle accident (23.5%), motorbike accident (22.1%), blade or knife (17.6%), fall (14.7%) and pedestrian vs car (5.9%) (Table 4).

**Table 3: Type and number of abdominal and pelvic vascular injuries.**

Vessel injured	Number of injuries
Aorta	8
Portal vein	1
Renal/ hepatic/ splenic artery	28
Renal/ hepatic/ splenic vein	1
Coeliac artery	1
Superior mesenteric artery	9
Superior mesenteric vein	1
Inferior mesenteric artery	3
Inferior mesenteric vein	2
Iliac artery	18
Iliac vein	1
Other	6

Abdominal and pelvic vascular trauma admissions remained relatively stable over the six-year period with admission numbers ranging from 7 to 15 per year and representing between 23.3% and 35.7% of the total vascular trauma admissions (Table 5).

**Table 4: Mechanisms of injury.**

Mechanism of injury	Number of patients	%
Motor vehicle accident	16	23.5
Motorbike accident	15	22.1
Blade or knife	12	17.6
Fall	10	14.7
Pedestrian vs car	4	5.9
Assault	3	4.4
Animal	3	4.4
Other	3	4.4
Bicycle	1	1.5
Gunshot	1	1.5

**Table 5: Number of abdominal and pelvic vascular trauma admissions per year.**

Outcome measure	Period					
	2014	2015	2016	2017	2018	2019
Abdominal & pelvic vascular trauma admissions (patient total)	15	9	12	7	15	10
Abdominal & pelvic vascular trauma admissions as a percentage of total vascular trauma admissions	35.7%	27.3%	30.8%	23.3%	35.7%	34.5%

## DISCUSSION

Trauma is a leading cause of morbidity and mortality worldwide and remains a major public health problem among all countries.<sup>16,17</sup> It was estimated by the year 2020, 8.1 million people would die yearly as a result of injuries and by the year 2030, road traffic injuries are expected to become the fifth leading cause of death and third leading cause of disability worldwide, with approximately 90% of this burden occurring in low and middle income countries, costing US \$518 billion globally.<sup>1,17</sup> Abdomen is the third most frequently injured body region, with 25% of all abdominal trauma requiring abdominal exploration and around 7-10% of all trauma related deaths occurring due to these injuries.<sup>16</sup> This study is the first to specifically characterise the epidemiology of abdominal and pelvic vascular trauma at an Australian level one trauma centre.

The mechanisms for abdominal and pelvic vascular injuries vary significant on an international level. The principal mechanism seen within this study was blunt trauma which constituted 77.9%. This is consistent with other Japan, United Kingdom (UK) and Australian studies such as one performed in New South Wales and another in Western Australia which revealed blunt trauma to be the cause in 64.4% and 83.8% of cases respectively.<sup>8,9,12,18</sup> Various studies in America however reported a greater incidence of penetrating injuries such as one performed in Las Angeles over a 5 year period which saw 88% of patients presenting with penetrating injuries.<sup>10</sup> 83% of these were secondary to gunshot wounds.<sup>10</sup> Another study performed in Detroit reported 89% of abdominal vascular injuries occurred secondary to penetrating trauma.<sup>3</sup> The lower incidence of penetrating injuries in regions such as Australia, the UK and Japan is likely secondary to the stringent firearm-control registration and policies.

The main mechanisms of injury seen within the study were motor vehicle accidents (23.5%), motorbike accidents (22.1%) and stabbing (17.6%) which is alike to other Australian studies including a vascular trauma study performed in Western Australia over a 10-year period which revealed that the most common causes of abdominal or pelvic vascular injury were also due to motor vehicle accidents (36%), motorbike accidents (23.4%) and stabbing (15.3%).<sup>8</sup>

This study demonstrates a male predominance (75%) for patients suffering from abdominal vascular injuries. This is consistent with studies on vascular injuries in all anatomical regions including both Australian (89%) and international studies in the UK (66%), New Zealand (68%), Japan (66.3%) and America (91%).<sup>1,7,8,10,18</sup>

The mean age of this cohort was 45.8 years (median 44.0), with a range from 14 to 90 years. This is higher than various other studies including nationally (median age 36 and 32) or internationally (US mean age of 32).<sup>3,7</sup>

The most commonly injured vessels included the iliac artery (22.7%), hepatic artery (15.1%), renal artery (13.9%), superior mesenteric artery (11.4%), aorta (10.1%) and splenic artery (6.3%). This is consistent with other Australian studies such as one conducted in Liverpool Hospital New South Wales which showed the most common injured vessels were the visceral arteries (35.6%), visceral veins (24.4%) and iliac arteries (15.6%) (8) and one conducted in the Royal Perth Hospital Western Australia where the most common injured vessels were also the visceral arteries (49.3%), iliac arteries (22.4%), and visceral veins (11.9%).<sup>7,8</sup>

The mortality rate for abdominal and pelvic vascular injuries in this study was 8.8% which were all as a result of blunt abdominal trauma. In comparison, this is lower than other Australia studies which reported mortality rates of 35.6% (NSW) and 15.3% (WA).<sup>7,8</sup> This is also lower as compared with various American articles which reported mortality figures of 25%, 45%, and 54%, or a publication from Thailand which reported mortality of 36%.<sup>1,3,11,13</sup> Mortality rates vary depending on the type and number of injured vessels, presence of associated injuries, and presence of shock on arrival.<sup>1,6</sup> Abdominal aortic injury is associated with a high mortality rate in the literature, with one mortality amongst the 8 patients who sustained aortic injury in this study.<sup>2,9,10</sup>

Literature varies internationally regarding whether penetrating or blunt trauma is associated with a higher mortality rate. Various American studies report that patients with penetrating injuries were 1.72 times more likely to die from their injuries than those with blunt traumas.<sup>13</sup> In Thailand blunt injuries were reported to account for a higher percentage of mortalities as are studies from Australia.<sup>8,11</sup> All mortalities which occurred in this study were secondary to blunt trauma. Other factors such as presence of associated injuries, patient age and low percentage of penetrating trauma within the study however were not taken into consideration may skew this data.

As seen in previous national and international studies, patients with higher ISS scores were more likely to die from their injuries than patients with lower ISS scores.<sup>3,7</sup> Alcohol was a contributing factor in 20.6% of the cases, while drugs were a factor 13.2%. This is slightly lower than other Australian studies which showed 34% of patients had consumed alcohol in the past 12 hours and 6% of patients had used illicit drugs.<sup>9</sup>

There are several limitations to this study with one of the most apparent of these due to the fact the study is retrospective in nature. The size of our cohort was also relatively small, however given all patients who were admitted to GCUH during the time period and were suitable for the study were included, the cohort size could not be increased. The likelihood of information bias from the trauma database is minimised given a dedicated data collection team who prospectively collected the patient

data was used, however this cannot be guaranteed to be correct. There was generally greater inconsistency with the data collected from the electronic medical record, with the documentation for alcohol and drug use particularly poor. As such our data for alcohol and drug use are likely underestimated. Data collection and analysis of associated injuries and complications was not undertaken for this study. The importance of associated injuries in length of hospital or ICU stay, type of interventions required, and mortality rates has been well established in other studies and should be included in further research.

## CONCLUSION

Despite its limitations, this study contributes to the paucity of current Australian articles on this topic and provides insights into the epidemiology and outcomes for abdominal and pelvic vascular injuries at a level one trauma centre on the Gold Coast, Australia. Given the majority of injuries occurred as a result of road accidents, it suggests that motor vehicle and motor bike safety interventions and prevention programmes could be important factors in decreasing the presentation of these injuries.

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