Abdominopelvic Vascular Injuries

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Abstract

The clinical records of 25 patients with 32 abdominopelvic vascular injuries were reviewed. Sixty per cent of patients sustained blunt trauma and 40 per cent sustained penetrating trauma. Nineteen patients (76%) were in shock on arrival, 2 of them underwent ER thoracotomy when they first arrived in the emergency room. Nine patients (36%) had signs of lower extremity ischemia. The Injury Severity Score (ISS) ranged from 16 - 50, mean 29 ± 10.0. Nineteen patients (76%) had 35 associated injuries. Of the 32 injured vessels; 8 were external iliac artery, 5 were renal vein, 4 were abdominal aorta, 3 were common iliac artery, common iliac vein, external iliac vein and inferior vena cava, and 1 was superior mesenteric artery, superior mesenteric vein and median sacral artery. Treatments included: 13 lateral repair, 4 prosthetic grafting, 4 nephrectomy, 3 ligation, 3 reversed saphenous vein grafting, 2 end to end anastomosis, 1 internal iliac artery grafting, 1 intravascular shunt and packing and 1 perihepatic packing. Nine patients (36%) died. High mortality was observed in injuries to the abdominal aorta (75%), inferior vena cava (66.7%), common iliac vein (66.7%) and associated major pelvic fractures (50%). Factors significantly associated with mortality were the presence of shock on arrival, associated injuries and high Injury Severity Score. The author concludes that short prehospital time, effective resuscitation and proper surgical decision making are important for survival in these critically injured patients.

Key word : Abdominopelvic Vascular Injuries

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Injury to abdominal and pelvic vessels following an abdominopelvic trauma carries a high mortality rate[1,2]. Exsanguinating hemorrhage and ischemia of the lower extremity are important clinical features. Frequently, situations are compounded by associated injuries to the intra and extraabdominal organs making management of the entire entity a surgical challenge. In some circumstances, diagnosis of abdominopelvic vascular injuries may be missed during exploratory laparo-

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tomy owing to the retroperitoneal location of these vessels leading to significant morbidity and mortality[3,4]. With improvement in the trauma system, prehospital care and resuscitation, more patients with these complex problems reach the operating room alive[5].

The purpose of this study is to examine our experience and results of treatment of patients with abdominopelvic vascular injuries at Chulalongkorn Hospital, Bangkok, Thailand.

MATERIAL AND METHOD

The clinical records of patients who had major vascular injuries following abdominopelvic trauma at Chulalongkorn Hospital, Bangkok, Thailand from July 1991 to January 1998 were reviewed. Diagnoses of major vascular injuries were confirmed during the operations in all cases. Data collection included: age, sex, mechanisms of injury, clinical presentations, associated injuries, Injury Severity Score, management and results of treatment. Shock in this study was defined as a systolic blood pressure of $\leq$ 90 mmHg.

During the study period, our initial assessment and resuscitation of the trauma patient were similar to the protocol of Advanced Trauma Life Support guidelines suggested by the Committee on Trauma, the American College of Surgeons[6]. Airway maintenance, ventilatory support and fluid resuscitation with crystalloid, colloid and blood were started in the emergency room as indicated. Indications for exploratory laparotomy were one or more of the following: 1. all penetrating and blunt abdominal trauma with unstable hemodynamics or generalized peritonitis, 2. all gunshot wounds through the abdomen, 3. stab wound of the abdomen with visceral evisceration, 4. abdominal trauma with positive diagnostic peritoneal lavage or CT scan. In patients who presented with lower extremity ischemia, angiography was performed only if hemodynamically stable and with good limb viability. Emergency room thoracotomy (ER thoracotomy) was performed in 2 patients with penetrating abdominal trauma who arrived in the emergency room in extremis.

Univariate analyses of factors associated with mortality were performed by using Mann-Whitney U Test and Fisher's Exact Test. The P value of < 0.05 was considered significant.

Table 1. General characteristics.

	Number of patients	%
Patients entering the study	25	100
Male	21	84
Female	4	16
Causes of injuries		
Blunt trauma	15	60
Motorcycle accident	12	48
Motor vehicle accident	2	8
Automobile - pedestrian accident	1	4
Penetrating trauma	10	40
Stab wound (SW)	8	32
Gunshot wound (GSW)	2	8
Shock	19	76
ER thoracotomy (1 SW, 1 GSW)	2	8
Associated injuries	19	76
Lower extremity ischemia	9	36
Death	9	36

RESULTS

During the study period, 25 patients with 32 injuries to major abdominal and pelvic vessels were operated upon. Twenty one (84%) were males and 4 (16%) were females. The age ranged from 15 to 46 years, mean 28.7 ± 9.4 years. Fifteen patients (60%) suffered from blunt trauma and 10 (40%) were victims of penetrating injuries (Table 1). Nineteen patients (76%) were in shock on arrival. Two patients, 1 stab wound and 1 gunshot wound of the abdominal aorta, were in extremis and underwent ER thoracotomy when they first arrived in the emergency room. Nine patients (36%) also had evidence of lower extremity ischemia. Nineteen patients (76%) had 35 associated injuries (Table 2). The Injury Severity Score (ISS)[7] ranged from 16 to 50, mean 29.6 ± 10.0. In blunt abdominal trauma patients the ISS ranged from 16 to 50, mean 32.7 ± 11.9, median 34. In penetrating abdominal trauma patients, the ISS ranged from 20 to 29, mean 24.9 ± 2.1, median 25. The difference of the ISS between blunt and penetrating trauma patients was not statistically significant (P = 0.08) (Mann-Whitney U Test) (Table 6).

Details of the injured vessels are as follows : external iliac artery 8 (25%), renal vein 5 (15.6%), abdominal aorta 4 (12.5%), common iliac artery 3 (9.4%) inferior vena cava 3 (9.4%) (1 retrohepatic vena cava), common iliac vein 3 (9.4%), superior mesenteric artery 1 (3.1%), superior mesenteric vein 1 (3.1%) and median sacral artery 1 (3.1%)

Table 2. Associated injuries.

Associated injuries	Blunt trauma	Penetrating trauma	Total
Small bowel	2	5	7
Pelvic fractures	6	-	6
Colon	1	5	6
Long bone fractures	3	-	3
Chest wall and lungs	3	-	3
Duodenum	1	2	3
Spleen	2	-	2
Head injuries	2	-	2
Liver	1	-	1
Stomach	1	-	1
Urinary bladder	1	-	1
			35

Table 3. Details of the injured vessels.

Injured vessels	Blunt trauma	Penetrating trauma	Total (%)	Death (%)
External iliac artery	7	1	8 (25)	1 (12.5)
Renal vein	4	1	5 (15.6)	2 (40)
Abdominal aorta	1	3	4 (12.5)	3 (75)
Common iliac artery	1	2	3 (9.4)	1 (33.3)
Common iliac vein	2	1	3 (9.4)	2 (66.7)
External iliac vein	3	-	3 (9.4)	-
Inferior vena cava	1	2	3 (9.4)	2 (66.7)
Superior mesenteric artery	1	-	1 (3.1)	-
Superior mesenteric vein	1	-	1 (3.1)	-
Median sacral artery	1	-	1 (3.1)	-
Total	22	10	32	

Table 4. Treatments of abdominopelvic vascular injuries.

Injured vessels	Lateral repair	Pros. graft	Ligation	Ligation and nephrectomy	RSVG	End to end anas.	IIA graft	Intravasc. shunt and packing	Packing only	Total	
										no	%
Abd. aorta	3	1	-	-	-	-	-	-	-	4	75
CIA	2	-	-	-	-	-	-	1	-	3	33.3
EIA	-	3	-	-	2	2	1	-	-	8	12.5
SMA	1	-	-	-	-	-	-	-	-	1	0
SMV	-	-	-	-	1	-	-	-	-	1	0
RV	1	-	-	4	-	-	-	-	-	5	40
CIV	2	-	1	-	-	-	-	-	-	3	66.7
EIV	2	-	1	-	-	-	-	-	-	3	0
MSA	-	-	1	-	-	-	-	-	-	1	0
IVC	2	-	-	-	-	-	-	-	1	3	66.7
Total	13	4	3	4	3	2	1	1	1	32	
(%)	(40.6)	(12.5)	(9.4)	(12.5)	(9.4)	(6.3)	(3.1)	(3.1)	(3.1)	(100)	

NB Abd. aorta = abdominal aorta, CIA = common iliac artery, EIA = external iliac artery, IIA = internal iliac artery, SMA = superior mesenteric artery, SMV = superior mesenteric vein, RV = renal vein, CIV = common iliac vein, MSA = median sacral artery, IVC = inferior vena cava, RSVG = reversed saphenous vein graft, Pros. graft = prosthetic graft, Intravasc. shunt = intravascular shunt

Table 5. Details of nonsurvivors.

Case No.	Age	Sex	ISS	Causes of injury	Shock	ER thoracotomy	Assoc. injury	Injured vessels	Treatments	Causes of death
1	23	M	25	SW	yes	yes	small bowel	abd. aorta RV	repair aorta, nephrec.	exsang.
2	20	F	41	MCA	yes	no	pelvic Fx	EIA	RSVG	sepsis, MSOF
3	25	M	25	SW	yes	no	duoden., small bowel	IVC	repair	sepsis, MSOF
4	46	M	43	MCA	yes	no	liver	IVC	packing	exsang.
5	35	M	50	MCA	yes	no	pelvic Fx	CIA	intravasc. shunt, packing	exasng.
6	33	F	50	MCA	yes	no	pelvic Fx	CIV	ligation	sepsis, MSOF
7	15	M	43	MCA	yes	no	stomach, spleen, chest, Fx femur	RV	repair then nephrec.	sepsis, MSOF
8	45	M	25	MVA	yes	no	colon	abd. aorta	Prosthetic grafting	sepsis, MSOF
9	18	M	25	GSW	yes	yes	duoden., colon.	abd. aorta	repair	exsang.

NB. Abd. aorta = abdominal aorta, RV = renal vein, CIA = common iliac artery, CIV = common iliac vein, EIA = external iliac artery, IVC = inferior vena cava, nephrec. = nephrectomy, duoden. = duodenum, Fx = fracture, exsang. = exsanguination, MOSF = multisystem organ failure

Table 6. Factors associated with mortality.

Factors	Number of patients	Range	Mean	Median	P value
Injury Severity Score (ISS)					
All patients	25	16-50	29.6±10.0		
Penetrating trauma	10	20-29	24.9±2.1	25	
					0.08
Blunt trauma	15	16-50	32.7±11.9	34	
Survivors	16	16-41	25.9±7.3	25	
					0.03
Nonsurvivors	9	25- 50	36.3±11.2	41	
Associated injuries					
No. of death with associated injuries		9/19			
					0.045
No. of death without associated injuries		0/6			
Shock					
No. of death in patients with shock		9/19			
					0.045
No. of death in patients without shock		0/6			

(Table 3). Surgical treatment included: simple or lateral repair 13 (40.6%), prosthetic graft 4 (12.5%), nephrectomy 4 (12.5%), reversed saphenous vein graft 3 (9.4%), ligation 3 (9.4%), end to end anastomosis 2 (6.3%), internal iliac artery interposition graft 1 (3.1%), intravascular shunt and packing 1 (3.1%) and perihepatic packing only 1 (3.1%) (Table 4).

Nine patients died, the mortality rate was 36 per cent (Table 5). The ISS of nonsurvivors ranged from 25 to 50, mean 36.3 ± 11.2, median 41 while the ISS of those who survived ranged from 16 to 41, mean 25.9 ± 7.3, median 25. The difference was statistically significant (P = 0.03) (Mann-Whitney U Test). No mortality was observed in patients without associated injuries (n = 6) while 47.4 per

cent mortality was noted in patients with associated injuries (n = 19). The difference was statistically significant (0.045) (Fisher's Exact Test). Regarding the presence of shock on arrival, no mortality was observed in patients without shock (n = 6) while 47.4 per cent mortality was noted in patients with shock on arrival (n=19). The difference was also statistically significant (P = 0.045) (Fisher's Exact Test) (Table 6). Among 6 patients who had associated pelvic fractures, 3 (50%) of them died. Causes of death of patients in the current study were exsanguination in 4 cases (44.4%) and sepsis and multisystem organ failure (MSOF) in 5 cases (55.6%).

DISCUSSION

Abdominopelvic vascular injuries commonly resulted from penetrating trauma[1,2,5]. In our study, we have more blunt trauma than penetrating trauma patients. This is probably due to the fact that a certain number of patients with penetrating abdominopelvic vascular injuries did not reach the operating room alive and were not entered into the study. The majority of patients with abdominopelvic vascular injuries in our study arrived in the emergency room with signs and symptoms of blood loss and were immediately sent to the operating room after a short period of aggressive resuscitation. Some patients arrived in the emergency room in extremis and underwent ER thoracotomy as part of resuscitation. Although ER thoracotomy offers a very low yield in these moribund trauma patients [8-12], it seems to be the only way to keep the patients alive long enough to reach the operating room. On the other hand, when patients arrive in the emergency room with a stable hemodynamic status, mortality is relatively low. Most patients in this group have an occlusive lesion rather than a bleeding lesion which usually resulted from blunt trauma[13-17]. Death in these patients is mainly due to associated injuries not massive hemorrhage.

Associated injuries are common in patients with abdominopelvic vascular injuries[1,5,8,9,11, 13]. Higher morbidity and mortality are observed in patients with associated injuries[1,8,9,11,13,18]. In the current study, all patients who died had at least 1 associated injury while no mortality was observed in patients without associated injuries. The difference is statistically significant.

In the operating room, rapid control of bleeding from the injured vessels is crucial. In our study, a significantly high mortality was observed in patients with injuries to the abdominal aorta, inferior vena cava and common iliac vein. Uncontrollable hemorrhage was the main cause of death in these patients. Surgeons encountering such situations should be ready for prompt and effective bleeding control. Direct pressure or digital control of the bleeding site should be the first maneuver, followed by precise proximal and distal control. Knowledge of surgical approach of the entire abdominopelvic vascular system is important. Approaches to the abdominal and pelvic vascular system have been described by several investigators[14,19,20,21]. Direct suture repair is the most frequent procedure employed in injuries to the abdominal aorta and inferior vena cava[1,9,18,22]. For iliac artery injuries, end to end anastomosis and lateral arteriorrhaphy are the procedures of choice[5,20,23]. Iliac venous injuries should be treated by lateral venorrhaphy or ligation if suture repair is difficult or patients are in an unstable condition[12,20,23]. Yelon and Scalea[24] in a study of 74 patients with 79 venous injuries recommended that ligation is a safe alternative to repair in patients with venous injuries to the lower extremities and pelvis.

In certain situations when primary suture repair or end to end anastomosis of the injured aorta or iliac arteries are not feasible or cannot be safely performed, vascular reconstruction with prosthetic grafts is an excellent alternative[1,13,15-17,20,25]. In our study, we used prosthetic grafts for vascular reconstruction in 4 patients. Although 1 patient who had an aortic graft died from sepsis and MSOF, all grafts worked well without evidence of graft infection.

Management of renal vein injuries depends on patients status and severity of the damaged renal vein. Isolated renal vein injury may be safely repaired by lateral venorrhaphy or end to end anastomosis[12,14,21]. When the patient is in an unstable condition, ligation with or without concomitant nephrectomy may be an appropriate treatment. Of the 5 patients in our study who had renal vein injuries, 4 underwent nephrectomy at initial operation, 1 of them died. The remaining patient underwent suture repair of the injured renal vein but subsequently required nephrectomy. He eventually died from sepsis and MSOF. Renal vein injuries are frequently associated with a high mortality rate[11, 12]. Proper management at the initial operation may be an important factor to determine the outcome.

A 50 per cent mortality of patients who had major pelvic fractures associated with iliac vessel injuries in our study signifies the seriousness of the situation. During the operation, surgeons have to face not only the difficulties in dealing with the injured iliac vessels but also the potentially fatal hemorrhage from the pelvic venous plexus and fracture sites when the pelvic peritoneum is opened. Management varies according to the patient's condition. The injured iliac veins should be ligated or quickly repaired with running sutures. Immediate reconstruction of the injured common or external iliac artery should be avoided in unstable patients. In such situations, ligation with subsequent extra-anatomic bypass when the patient's condition improves has been recommended[21]. In some extreme situations, with the combination of devastating lower extremity, pelvic and vascular injuries, emergency hemipelvectomy may be necessary[26, 27].

One patient in our study who had major pelvic fractures underwent insertion of a temporary intravascular shunt for common iliac artery injury concomitant with pelvic packing to control bleeding from the pelvic venous plexus. The other one who had retrohepatic vena cava injury associated with severe liver injury underwent perihepatic packing. Although both of them died, they represented the most severe forms of abdominopelvic vascular injuries. With an extreme physiologic exhaustion resulted from massive blood loss and aggressive resuscitation, the vicious cycle of hypothermia, acidosis and coagulopathy develops[28,29]. The triad is preterminal if not effectively corrected. The concept of damage control which involves abbreviated laparotomy and planned reoperation or staged injury repair has been advocated in order to improve survival of these seriously injured patients[30-32]. Insertion of a temporary intravascular shunt for iliac artery injuries and abdominal packing has been successfully performed by some investigators as a life-saving procedure[26].

In conclusion, abdominopelvic vascular injuries are highly lethal conditions, especially in patients with associated injuries. Effective prehospital care and resuscitation are of the utmost importance. Proper management at the emergency and the operating room by an experienced trauma team is crucial. During the operation, rapid control of hemorrhage and appropriate decision making for vascular repair or ligation or using a temporary intravascular shunt as part of the damage control in unstable patients are important for survival in these critically injured patients.

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การบาดเจ็บต่อหลอดเลือดในช่องท้องและอุ้งเชิงกราน

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ได้รายงานผู้ป่วย 25 ราย ที่ได้รับบาดเจ็บต่อหลอดเลือดในช่องท้องและอุ้งเชิงกรานจำนวน 32 แห่ง ที่มารับการรักษาที่โรงพยาบาลจุฬาลงกรณ์ ในช่วงระยะเวลา 6 ปี 7 เดือน ผู้ป่วยร้อยละ 60 ได้รับบาดเจ็บจากอุบัติเหตุรถจักรยานยนต์และรถยนต์ ผู้ป่วยร้อยละ 40 ได้รับบาดเจ็บจากถูกยิงหรือถูกแทง ผู้ป่วย 19 ราย (ร้อยละ 76) อยู่ในภาวะช็อคเมื่อแรกรับ ในจำนวนนี้ 2 ราย ได้รับการทำ ER thoracotomy ผู้ป่วย 9 ราย (ร้อยละ 36) มีอาการของการขาดเลือดไปเลี้ยงขา ผู้ป่วย 19 ราย (ร้อยละ 76) มีการบาดเจ็บร่วมต่ออวัยวะอื่นนอกจากการบาดเจ็บต่อหลอดเลือด ค่า Injury Severity Score ของผู้ป่วยในรายงานนี้อยู่ระหว่าง 16-50 ค่าเฉลี่ย 29 ± 10.0 การบาดเจ็บต่อหลอดเลือดทั้ง 32 แห่ง แบ่งออกได้เป็น 8 external iliac artery, 5 renal vein, 4 abdominal aorta, 3 common iliac artery, common iliac vein, external iliac vein และ inferior vena cava และ 1 superior mesenteric artery, superior mesenteric vein และ median sacral artery การรักษาประกอบด้วยการเย็บซ่อมแซมโดยตรง (13), ใส่ prosthetic graft (4), ผูก (3), reversed saphenous vein graft (3), end to end anastomosis (2), internal iliac artery graft (1), ใส่ intravascular shunt ร่วมกับ packing (1) และทำ perihepatic packing เพียงอย่างเดียว (1) มีผู้ป่วยเสียชีวิต 9 ราย (ร้อยละ 36) การบาดเจ็บที่มีอัตราตายสูงได้แก่ การบาดเจ็บต่อ abdominal aorta (อัตราตายร้อยละ 75), การบาดเจ็บต่อ inferior vena cava (อัตราตายร้อยละ 66.7), การบาดเจ็บต่อ common iliac vein (อัตราตายร้อยละ 66.7) และการบาดเจ็บต่อหลอดเลือดที่เกิดร่วมกับมีกระดูกเชิงกรานหักรุนแรง (อัตราตายร้อยละ 50) ปัจจัยเสี่ยงที่พบในกลุ่มผู้ป่วยที่เสียชีวิตที่มีความแตกต่างจากกลุ่มที่รอดชีวิตอย่างมีนัยสำคัญทางสถิติ ได้แก่ การมีการบาดเจ็บร่วม (P = 0.045), การมีภาวะช็อคเมื่อแรกรับ (P = 0.045) และคะแนนความรุนแรงของการบาดเจ็บ (Injury Severity Score) ที่สูง (P = 0.03) ผู้รายงานมีความเห็นว่า การส่งผู้ป่วยมาถึงโรงพยาบาลอย่างรวดเร็ว, การ resuscitation อย่างมีประสิทธิภาพ และการผ่าตัดที่เหมาะสมมีความสำคัญที่จะช่วยให้ผู้ป่วยหนักเหล่านี้มีโอกาสรอดชีวิตได้

คำสำคัญ : การบาดเจ็บต่อหลอดเลือดในช่องท้องและอุ้งเชิงกราน

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