European Journal of Vascular and Endovascular Surgery 44 (2012) 199–202

Contents lists available at SciVerse ScienceDirect

European Journal of Vascular and Endovascular Surgery

journal homepage: www.ejves.com

A Ten Year Review of Civilian Iliac Vessel Injuries from a Single Trauma Centre

J.C. Oliver, W. Bekker, S. Edu, A.J. Nicol, P.H. Navsaria*

Trauma Centre, Groote Schuur Hospital, Faculty of Health Sciences, University of Cape Town, Cape Town 7925, South Africa

WHAT THIS PAPER ADDS

- Patients with either iliac artery or iliac vein injuries can be haemodynamically unstable and require prompt management decisions, frequently requiring damage control surgery.
- Ligation of venous and internal iliac artery injuries is safe with good medium term outcomes.
- A temporary intravascular shunt can be used in a haemodynamically unstable patient with these arterial injuries to maintain distal perfusion and improve limb salvage.

ARTICLE INFO

Article history:
Received 18 August 2011
Accepted 14 May 2012
Available online 2 June 2012

Keywords:
Iliac vessels
Vascular trauma
Penetrating trauma

ABSTRACT

Objective: To report the surgical management and outcome of iliac vessel (IV) injuries in a civilian trauma centre with a high incidence of penetrating trauma.
Design, patients and methods: A retrospective record review of patients with IV injuries treated between January 2000 and December 2009.
Results: Sixty nine patients, 59 with gunshot wounds, sustained 108 iliac vessel injuries. Mean revised trauma and injury severity scores was 7.06 and 28.4, respectively. Twenty nine patients required damage control laparotomy. Common or external iliac arteries were repaired by primary repair (10), temporary shunt with delayed graft (6), interposition graft (5) or ligation if limb non-viable (3). Forty-seven patients had injuries to the common or external iliac vein, 42 were ligated. Mortality was 25% and 6 survivors required amputation.
Conclusions: In a stable patient a primary arterial repair is preferred but a temporary shunt can be a life and limb saving option in the unstable patient. Ligating the common or external iliac veins is associated with a low incidence of prolonged leg swelling.

Introduction

Injury to the iliac vessels is associated with a mortality between 30 and 50%.[1,2] This high mortality is related to large volume blood loss caused by difficult vascular control both preoperatively, as the bleeding is non compressible and intraoperatively as the iliac vessels are retroperitoneal and especially when combined with a large haematoma, can be difficult to isolate and control.[3] Also due to their position buried deep in the pelvis, injuries to the iliac vessels are often associated with other genitourinary and gastro-intestinal injuries which add to the overall morbidity. Data demonstrating the optimum treatment of these injuries is scarce due to their infrequent occurrence. The primary aim of this study was to review the surgical management and outcome of patients with iliac vessel injuries treated in an urban centre with a high incidence of penetrating trauma.

Materials and Methods

We performed a retrospective case notes analysis. Patients were identified by reviewing the operation records of all patients that underwent surgery at the Trauma Center, Groote Schuur Hospital, during the 10 year period from January 2000 to December 2009, and selecting all patients with documented injuries to either the common, external or internal iliac artery or vein. Patients who did not undergo open surgery were not included in the study. Data regarding patient demographics, mechanism of injury, admission observations and blood transfusion requirements were retrieved from patient records. Operation notes documented the vessels injured, the method of repair, and associated intra-abdominal

* Corresponding author. Tel.: +27 404 4114; fax: +27 404 4115.
E-mail address: Pradeep.Navsaria@uct.ac.za (P.H. Navsaria).

1078-5884/$ – see front matter © 2012 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ejvs.2012.05.012

injuries. Admission to the intensive care unit (ICU), duration of ICU and hospital stays, and complications were noted. Injury severity was categorized using the revised trauma (RTS) and injury severity (ISS) scores.

Initial management and resuscitation were along standard Advanced Trauma Life Support (ATLS) guidelines. All patients underwent plain x-ray imaging of the chest and pelvis. Those with suspected renal tract injury underwent single shot intravenous pyelogram in the emergency department. Patients with peritonism (diffuse abdominal tenderness, rebound tenderness, guarding and rigidity) or persistent shock underwent emergency laparotomy without any further preoperative imaging. Haemodynamically stable patients without definite indication for a laparotomy underwent helical computed tomography. Haemodynamic stable patients with a viable limb with signs of an iliac vascular injury (diminished or absent peripheral pulses, bruit/thrill, large groin haematoma) underwent formal digital subtraction angiography. Unfortunately access to emergency endovascular intervention is limited in our centre and therefore this was not performed in this series, although it may be an option in a stable patient.

Immediate damage-control surgery was performed for the haemodynamically unstable (systolic blood pressure persistently less than 90 mmHG without inotropes, despite initial fluid resuscitation), acidotic (arterial pH <7.25 or Base excess <-5, hypothermic (core temperature less than 35.5)) patient. This involved a laparotomy of maximum 1 h duration. Procedures performed included control of bleeding by ligation or shunting of injured vessels, packing of bleeding solid organs and control of contamination by ligating or stapling injured hollow organs such as bowel or ureter. Patients were then transferred to the intensive care unit for transfusion of packed red cells fresh, frozen plasma and platelets and active warming. Definitive surgery was performed when this had been achieved.

Operative approach: Iliac vessel injuries, like other abdominal vascular trauma presents either as free intraperitoneal haemorrhage, retroperitoneal haematoma, or a combination of both. The source of bleeding or location of the haematoma in these patients are pelvic in location. Prior to exploration of the haematoma, proximal control must be achieved by clamping either the aorta or the common iliac artery and vein on the injured side, then on the left the sigmoid colon is mobilized. Distal control is achieved either by compression with a finger or a 'swab-on-a-stick' deep in the pelvis by an assistant. If this does not achieve adequate control, the ipsilateral internal iliac artery must be controlled in a similar way. A combination of blunt and sharp dissection is used to open the pelvic peritoneum and reach the injured vessel/s. The proximal vascular clamp is then progressively adjusted to reach the injured segment/s. The internal iliac artery is isolated, using angled vascular clamps ensuring visualization and preservation of the ureter at this level. Bleeding from the confluence of the common iliac veins can be difficult. The overlying right common iliac artery may be transected to gain venous control. The injured artery can be repaired or shunted, depending on the patient's physiological status. Iliac veins are best ligated. Shunting (artery) and ligation (vein) are the damage control options for iliac vessel injuries.

The data was analysed using Statistical Package for the Social Sciences version 11.5 (SPSS, Chicago, IL) using the Kruskal Wallis and Chi-squared tests. A level of $P < 0.05$ was considered statistically significant. This retrospective analysis was intended to be primarily descriptive.

Results

Sixty nine patients with a total of 108 iliac vessel injuries were identified. The majority (56%) of patients had only one iliac vessel injured, but 7 patients had sustained injury to three or four vessels. Over 90% of these patients were male, and over 90% had sustained a penetrating injury, most commonly a gunshot wound. The mean age was only 26 years with a mean RTS and ISS of 7.09 and 28.04, respectively. The patient's initial observations were similar regardless of the type of vessel injured as illustrated in Table 1. Fifty patients presented with or became shocked during the initial assessment prior to surgery. Only one patient underwent CT imaging of the abdomen, in this patient the major venous injury was identified. Only one haemodynamically stable patient underwent formal angiography; an external iliac arterio-venous fistula was identified, which required surgical repair.

Table 1
Physiological parameters of the patients by type of vessel injured.

Physiological parameters mean (SD)	Artery only	Vein & Artery	Vein only	*p*
N	16	25	28	
Systolic blood pressure (mmHg)	97 (27.7)	96.9 (26.7)	90.2 (27.8)	0.47
Heart rate	115 (26.6)	108 (22.3)	108 (26.5)	0.65
Revised trauma score	7.35 (0.72)	7.13 (1.2)	6.88 (1.3)	0.59
Injury severity score	28.3 (6.8)	27.9 (7.0)	28.9 (8.3)	0.86
pH on admission	7.24 (0.12)	7.21 (0.14)	7.21 (0.17)	0.73
Haemoglobin concentration (G %)	9.6 (2.6)	9.4 (2.2)	9.4 (3.1)	0.92
Temperature	36.2 (1.22)	35.0 (1.8)	35.3 (1.5)	0.07
Blood transfusion in first 24 hrs	8.1 (4.9)	12.3 (8.4)	12.5 (7.4)	0.15
Damage control surgery *N* (%)	4 (25)	14 (56)	11 (39)	0.14

Overall there were 17 deaths giving an overall mortality of 25%. Ten of these were within the first 24 h due to ongoing bleeding from irrecoverable shock and coagulopathy. Eleven patients required major amputation, of these only six patients survived to discharge. Overall, as is displayed in Table 2, the patients with an injury to both the common or external iliac artery or vein had a higher rate of fasciotomy, total amputation, survival with amputation and mortality than any other group.

Eleven patients sustained isolated vascular injuries, while the remaining fifty-eight sustained associated injuries, most commonly to the small bowel and colon as shown in Table 3. None of the patients underwent emergency thoracotomy with cross clamping of the aorta prior to transfer to the operating theatre.

Twenty-nine patients required a damage control procedure, and a further 9 patients required packs to be left in the abdomen at the conclusion of the initial laparotomy for haemorrhage control. Fifty-six underwent a midline laparotomy incision only, a further 9

Table 2
Outcome related to type of vessel injured.

Vessel injured	*N*	Fasciotomy	Amputation	Survive with Amputation	Deaths
Artery only					
Common/external	12	3	3	2	1
Internal	5	0	0	0	1
Vein & artery					
Common/external artery & vein	17	6	7	4	7
Internal artery & common/external v	6	0	0	0	0
Common/external a & internal vein	1	1	0	0	0
Internal artery & vein	1	0	0	0	1
Vein only					
Common/external	25	1	1	0	7
Internal	3	0	0	0	0
Total	69	11	11	6	17

Table 3
Associated injuries found in 58 patients.

Injury	Number
Small bowel	43
Colon	29
Stomach/duodenum	3
Diaphragm	1
Liver	1
Kidney	2
Ureter	6
Bladder	6
External genitalia	1
Inferior vena cava	3
Pelvis fracture	4
Other fractures	9
Head Injury	3
Total	111

patients required an extension of the incision into the groin. Four patients received only a groin incision, these were patients who were hemodynamically stable on presentation, with an isolated iliac artery injury that was identified either clinically or after formal angiography.

Patients with injuries to a common or external iliac artery fell into three groups. Those requiring a damage control procedure, those who were stable enough to undergo definitive surgery during the initial procedure and those with 'bruising' to the vessel identified clinically. A summary of the surgical management of patients in each of these groups is illustrated in Table 4. Three patients underwent ligation of the injured vessel; each of these had a non-viable limb prior to the procedure and required a primary amputation. Among the patients undergoing damage control surgery, a temporary shunt was employed in six patients. Of the six patients managed with a temporary shunt, two died before definitive surgery due to refractory shock and ongoing coagulopathic bleeding. The remaining four had repair with interposition grafting within 48 h of the initial laparotomy. One of these patients required an amputation which was due to a delay in performing a fasciotomy. No formal anticoagulation was administered to these patients. Four patients with 'bruising' to the iliac vessels were identified at laparotomy; three had sustained a GSW, the fourth sustained blunt trauma. Two of the 'bruised' vessels were explored and intimal injuries identified, excised and grafted with no further vascular complications. One of these patients died from other injuries within hours of surgery. One patient whose injury was not explored at the initial laparotomy developed an acutely ischaemic leg relating to iliac thrombosis within 24 h of the initial surgery which required above knee amputation.

Forty seven patients sustained an injury to the common or external iliac veins. The mortality was higher than overall at 30% among these patients. One patient with a common iliac vein injury required a fasciotomy, this patient subsequently underwent above knee amputation, but passed away from multiorgan failure. Four patients with an associated arterial injury required an amputation. The majority, 42 of the venous injuries were ligated, with a high prevalence of leg swelling after the procedure. However, subjectively this swelling resolved in the majority of patients and only 3 were still complaining of swelling at the follow up appointment. Five patients, whose vein was not completely transected, had a repair procedure to the vessel. (Table 5)

Twenty-five patients sustained injuries to an internal iliac vessel. These were all ligated with no vascular complications; however there were no cases of bilateral injuries. There was only one death among the 9 patients with an injury to the internal iliac vessels and this was related to an associated severe head injury.

Table 4
Surgical techniques and outcome of common and external iliac artery injuries.

Type of Surgery	*N*	Death	Amputation
Damage control procedure	14	5	2
Temporary shunt	6	2	1
Primary repair	5	1	0
Ligation	1	0	1[a]
Death on operating table	2	2	0
Primary definitive surgery	12	1	5
Primary repair	5	0	2
Interposition graft	5	1	1
Vein graft	*2*	*0*	*0*
Synthetic graft	*2*	*0*	*0*
Arterial graft	*1*	*0*	*1*
Ligation	2	0	2[a]
Arterial bruising	4	1	1
Explored: intimal flap identified:	2	0	0
Unexplored	2	1	1[b]

[a] Limb non-viable before ligation of the iliac artery.
[b] Limb loss due to peripheral embolisation within 24-hours of initial surgery.

Discussion

The mortality of patients with iliac vessel injuries in this series was 25%; this compares favourably to previously published series in which the mortality ranges from 22% to 49%.[1,4,6] None of the patients in this series had undergone an emergency front room thoracotomy with cross clamping of the aorta prior to laparotomy. It is not standard treatment in our institution as it has been suggested that this is a futile procedure. However in the three published series of iliac artery injuries 47 patients underwent this manoeuvre of whom 12 survived.[1–3] None of our patients underwent endovascular management of their injuries due to limited access at our institution, however there is growing evidence that in the stable patient this type of treatment can be effective with reduced blood loss and complications related to opening the retroperitoneal haematoma.[5]

The temporary intravascular shunts (TIVS) were created with a piece of plastic tubing, most commonly from a high flow line, or nasogastric tube, cut to the size of the defect in an artery with an overlap of one-cm at each end, and secured in the vessel with a silk tie. This procedure was first described in 1919, however its use as a damage control procedure has only recently become commonplace, with most of the published literature from military hospitals during the Gulf conflicts.[6] In the 3 largest recent series of iliac vessel trauma there were no TIVSs used.[1–3] In our series six patients underwent this surgical procedure. A recent study compared the outcome of patients with a TIVS used in the common or external iliac artery with historical controls that underwent ligation of the common or external iliac artery as a damage control procedure.[7] They identified a 47% amputation rate after common or external iliac ligation, compared to 0% after TIVS. They also comment that the fasciotomy rate among patients with temporary shunts was

Table 5
Causes of amputation and death.

Amputation	
Associated limb injury	3
Iliac artery thrombosis	1
Non-viable limb prior to surgery	4
Delayed fasciotomy	2
Occluded TIVS	1
Death	
Multi-organ failure	4
Uncontrolable bleeding	10
Other non-surgical causes	3

only 43% and the mortality was also significantly reduced among these very unstable patients. In our unit during the time of the study, the policy was only to ligate the iliac vessels if the limb was not viable prior to surgery therefore the amputation rate was 100% among the 3 patients who underwent ligation. Among our unstable patients who had a TIVS placed, mortality was two of six, 33% this similar to the three of seven (43%) in the published series.[7]

In the stable patient the management of the arterial injury depends on the nature of the injury. Where possible, a repair or primary anastamosis was performed to the injured vessel. In our series a repair or primary anastamosis was only possible in 10 of 23 patients with arterial injuries, fewer than other published series. An explanation for this may be that following a TIVS, the ends of the vessel are damaged and therefore a graft is necessary.

Injury to the intima of the external or common iliac artery is a rare but well described injury after blunt abdominal trauma.[8] This injury is commonly associated with normal initial haemodynamic status and vascular examination findings progressing to embolic phenomena and limb loss. A high index of clinical suspicion is vital as prompt treatment can be limb saving. Our series has demonstrated that iliac arterial intimal injuries are not only related to blunt trauma as we identified three cases caused by GSWs. While there is some evidence to suggest that clinically occult vascular injuries in penetrating extremity trauma can be managed non-operatively, the optimum treatment of an intimal injury in the iliac arteries has not been formally evaluated. In a series of patients with confirmed intimal injuries in limb vessels caused by penetrating trauma managed non-operatively, the incidence of acute limb threatening ischaemia was 85% within a five year retrospective study period suggesting that it is critical to repair these injuries.[9] Whether we can extrapolate the results of this study to common and external iliac arteries which are abdominal retroperitoneal vascular structures, frequently associated with other intra-abdominal injuries, is questionable. As limb threatening complications can occur early, and until further evidence to support otherwise, we recommend that intimal injuries to the iliac vessels are excised and repaired without delay once suspected, or confirmed.

Our series has illustrated that iliac vein injuries are as lethal if not more so than iliac arterial injuries. Therefore it is essential that the surgical management especially in the unstable patient does not take more time or allow more bleeding than the minimum possible. Ligation of all venous injuries not easily amenable to repair is standard practise in our institution[10] and even after ligation of the infra renal vena cava the incidence of prolonged peripheral oedema is very low.[11] On the other hand there is some suggestion that venous repair can be safely and effectively performed in all cases of venous injuries thus preventing risk of long term venous stasis complications.[12] Our series of 47 patients with injuries to the common or external iliac vein suggests that the incidence of ongoing leg swelling following iliac vein ligation is low (3 out of 39).

There are no studies reporting isolated internal iliac vessel injuries. In our series, all these injuries were ligated without complications. However there were no bilateral iliac injuries which are more likely to lead to ischaemic complications. There are reports of bilateral ligation and pelvic packing or embolization of the internal iliac artery in the unstable patient with ongoing bleeding following pelvic fracture. Dubose et al.[13] describe 61 cases undergoing one of these procedures; among the survivors no ischaemic complications were reported. There is one case report describing delayed rectal stenosis in a patient following bilateral iliac artery ligation for pelvic trauma.[14] This study adds to the very small amount of data available regarding these injuries. However it is limited as only patients identified at surgery were included, and there was a very low rate of CT scanning. This is partly as this is a retrospective series over a 10 year period, and immediate access to rapid spiral CT imaging was not readily available earlier in the study period, but also due to the very unstable nature of these patients, and delay must be avoided in these situations. We have also not involved endovascular management of any of the patients, but there is a small group of patients with arterial injury and haemodynamic stability that may have benefitted from endovascular intervention prior to open management of associated injuries if necessary.

In summary, in a stable patient a primary repair of a common or external iliac artery is preferred but an interposition graft may be necessary. In the patient with an associated gastrointestinal injury it is the safest to avoid a synthetic interposition graft but a fem–fem crossover can be used if a natural conduit is not possible. Our study suggests that a TIVS can improve limb salvage if the patient is unstable and there is suggestion in the published literature that this procedure can also improve survival. Ligating the common or external iliac veins is associated with a low incidence of prolonged leg swelling. Internal iliac vessels can be safely ligated.

Acknowledgements

There are no sources of financial funding for this study. There are no possible sources of conflict of interest.

References

1 Asensio JA, Petrone P, Roldan G, Kuncir E, Rowe VL, Chan L, et al. Analysis of 185 iliacvessel injuries: risk factors and predictors of outcome. *Arch Surg* 2003;**138**:1187–93.
2 Haan J, Rodriguez A, Chiu W, Boswell S, Scott J, Scalea T. Operative management and outcome of iliac vessel injury: a ten-year experience. *Am Surg* 2003;**69**:581–6.
3 Degiannis E, Velmahos GC, Levy RD, Wouters S, Badicel TV, Saadia R. Penetrating injuries of the iliac arteries: a South African experience. *Surgery* 1996;**119**:146–50.
4 Degiannis E, Levy RD, Hatzitheofilou C, Florizoone MG, Saadia R. Gunshot arterial injuries to the groin: comparison of iliac and femoral injuries. *Injury* 1996;**27**:315–8.
5 Johnson CA. Endovascular management of peripheral vascular trauma. *Semin Intervent Radiol* 2010;**27**:38.
6 Gifford SM, Aidinian G, Clouse WD, Fox CJ, Porras CA, Jones WT, et al. Effect of temporary shunting on extremity vascular injury: an outcome analysis from the Global War on terror vascular injury initiative. *J Vasc Surg* 2009;**50**:549–55.
7 Ball CG, Feliciano DV. Damage control techniques for common and external iliac artery injuries: have temporary intravascular shunts replaced the need for ligation? *J Trauma* 2010;**68**:1117–20.
8 Muck PE, Nunez TC, Hruska L, Kasper GC, Chang CK, Welling RE. Blunt injury to the external iliac artery: a case report. *Am Surg* 2002;**68**:11–4.
9 Tufaro A, Arnold T, Rummel M, Matsumoto T, Kerstein MD. Adverse outcome of nonoperative management of intimal injuries caused by penetrating trauma. *J Vasc Surg* 1994;**2**:656–9.
10 Navsaria PH, de Bruyn P, Nicol AJ. Penetrating abdominal vena cava injuries. *Eur J Vasc Endo Surg* 2005;**30**:499–503.
11 Sullivan PS, Dente CJ, Patel S, Carmichael M, Srinivasan JK, Wyrzykowski AD, et al. Outcome of ligation of the inferior vena cava in the modern era. *Am J Surg* 2010;**199**:500–6.
12 Nitecki SS, Karram T, Hoffman A, Bass A. Venous trauma in the Lebanon War–2006. *Interact Cardiovasc Thorac Surg* 2007;**6**:647–50.
13 Dubose J, Inaba K, Barmparas G, Teixeira PG, Schnuriger B, Talving P, et al. Bilateral internal iliac artery ligation as a damage control approach in massive retroperitoneal bleeding after pelvic fracture. *J Trauma* 2010;**69**:1507–14.
14 Matsuhashi N, Mizoguchi T, Kanematsu M, Kondo H, Goshima S, Mitsuishi N, et al. A case of delayed rectal stenosis from severe pelvic fracture with massive bleeding successfully treated by bilateral internal iliac TAE: report on a patient survival. *Int J Colorectal Dis* 2007;**22**:853–4.