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Contemporary management and prognosis of great vessels trauma

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ABSTRACT

Background: Great vessel trauma (GVT), which is defined as trauma to the aorta or vena cava, remains one of the most challenging injuries to treat and has a high mortality rate despite advances in modern medicine. Additionally, the optimal management of GVT is controversial. In this study, we review the incidence, management, and outcome of GVT, identify the current status and prognostic factors of GVT, and compare treatment outcomes.

Methods: We conducted a retrospective, single-center, cohort study of patients with GVT in a Level I trauma center from August 2008 to December 2013. We retrieved demographic data, physical and imaging findings, injury severity score (ISS), treatment choice, length of hospital stay, and mortality. We analyzed the risks of adverse outcomes and mortality.

Results: The seventy-four patients in this cohort had a mean age of 41.6 (SD 17.7) years and a high mortality rate of 27%. The prognostic factors of survival with GVT included male gender, lower ISS, higher GCS, higher SBP and DBP and vena caval injuries. We also determined that vena caval injury is the main factor that can predict mortality.

Conclusion: In conclusion, GVT is relatively rare but often lethal in clinical practice. Patient survival depends on injury severity and the shock status grade. Aggressive resuscitation and treatment play important roles in survival. The coordination of different levels of surgical expertise and the application of novel treatment methods are required to improve clinical outcomes for patients with vena caval injuries.

Introduction

Great vessel trauma (GVT), which is defined as trauma to the aorta or vena cava, remains one of the most challenging injuries to treat and has a high mortality rate despite advances in modern medicine. The incidence of GVT among all trauma patients is approximately 0.6–2% [1–3]. Because of the relatively low incidence of this type of injury, clinical experience is quite limited. Although the incidence is low, the reported mortality rates are 13.5–15% for aortic injuries [4,5] and 36–60% for vena caval injuries (VCI) [1,6].

An accurate diagnosis is difficult when the patient exhibits no symptoms, which could occur due to temporal compression via hematoma. Of these injuries, 5% will progress to a lethal situation within a day [7]. Recent developments in computed tomography have enabled an earlier diagnosis of GVT. Improvements in resuscitation management and surgical technique combined with rapid referral to an experienced trauma center have prolonged the survival of GVT patients [4,5,8].

Surgical intervention had traditionally been the standard procedure for GVT, but the prognosis with this treatment strategy is not satisfactory. The aorta and vena cava are difficult to approach surgically because of their anatomic location and their tendency for massive hemorrhage. Currently, nonoperative management is being applied for many types of trauma, including GVT [9–12]. In addition, endovascular techniques are well developed for treating aortic trauma and can significantly decrease mortality and morbidity [4,5]. By contrast, current treatments for vena caval trauma vary greatly, and the results appear less promising [1,11,13–18].

The aim of this study is to review the methods of treatment of GVT in our institution. The study also attempts to identify the current status and prognostic factors of GVT and compare treatment outcomes.

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Materials and methods

Data collection

We conducted prospective data collection using a trauma registry at Chang Gung Memorial Hospital (CGMH), Linkou, Taiwan. Demographic data, medical history, perioperative and hospital treatments, follow-up, and information regarding complications were prospectively recorded in a computerized database. We retrospectively reviewed all patients who suffered from GVT between August 2008 and December 2013 in CGMH, Linkou, which is a Level I trauma center in Taiwan that treats approximately 3500 trauma patients annually. The cases, which include aortic trauma and vena caval trauma, were retrieved by filtering according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes (901.0, 901.2, 902.0, and 902.1). The dataset was further limited to patients older than 16 years of age. The study was approved by the Internal Review Board of CGMH.

Study population

All patients were managed by a trauma team from their arrival at the emergency bay through discharge. Demographic information, physiological data and imaging findings were collected. In addition, the injury severity score (ISS) and associated injuries were recorded. The severity of blunt thoracic aortic injury (BTAI) was recorded according to the guideline of the Society of Vascular Surgery (SVS) [19]. The location of the GVT and the therapeutic procedure (e.g., surgery, endovascular treatment, conservative management) were collected.

Information on postoperative recovery, complications, and length of hospital stay (LOS) were collected. All patients were followed up with in the outpatient department, and information on associated complications or sequelae were collected. Mortality and cause were also recorded. We excluded patients without a definitive GVT diagnosis and those who did not follow-up in our hospital till final result confirmed from our study.

Statistical analysis

Pearson's *X2* test and Fisher's exact test were used as appropriate to compare categorical variables. Quantitative variables were compared using Student's *t*-test, and the Mann–Whitney U test for two groups analysis and ANOVA and the Kruskal-Wallis test for three groups analysis. All statistical analyses were performed with SPSS v. 20.0 for Macintosh (SPSS Inc, Chicago, IL, USA). A value of $p < 0.05$ was considered statistically significant.

Table 1
Demographic characteristics of patients with great vessel trauma.

Numbers	74
Age mean (SD)	41.6 (17.7)
Mechanism n,%	
Motor vehicle collision	54; 73%
Crushing	5; 7%
Fall	12; 16%
Penetration	3; 4%
Injury site n	
Aorta	61
Location	
Isthmus	43
Descending aorta	18
Grade	
I	8
II	12
III	34
IV	7
Vena cava	13
Location	
Intrathoracic	1
Suprahepatic intrabdominal	5
Suprarenal retrohepatic	3
Suprarenal infrahepatic	1
Infrarenal	3
Management n;%	
Surgery	25; 34%
Endovascular treatment	34; 46%
Conservative management	15; 21%
Length of hospital stay days, mean (SD)	21.9 (24.4)
Morbidity n;%	17/54; 32%
Mortality n;%	20/74; 27%

Results

During the study period, 76 patients were treated for GVT in our institution. There were two patients excluded from this study because they were transferred to other hospitals and we could not define the final result of these patients, leaving 74 patients for analysis. The demographic data of these 74 patients are summarized in Table 1. Male patients accounted for 85% (n = 63) of the study group. The mean age of the study group was 41.6 (17.7) years. Of the patients included in this study, 70 (95%) were admitted with blunt trauma. The causes of injury included motor vehicle collisions (73%, n = 54), falls (16%, n = 12), and crushing (6%, n = 5). Only three patients (4%) presented with penetrating injuries. Thirteen patients (18%) were diagnosed with VCI (Fig. 3), and 61 (82%) were diagnosed with BTAI (Fig. 1). The median ISS was 26.5 with an interquartile range (IQR) of 20.75 ~34.5. The median Glasgow Coma Scale (GCS) was 15 with an IQR of 10.5~15. Systolic blood pressure (SBP) upon arrival at the emergency department

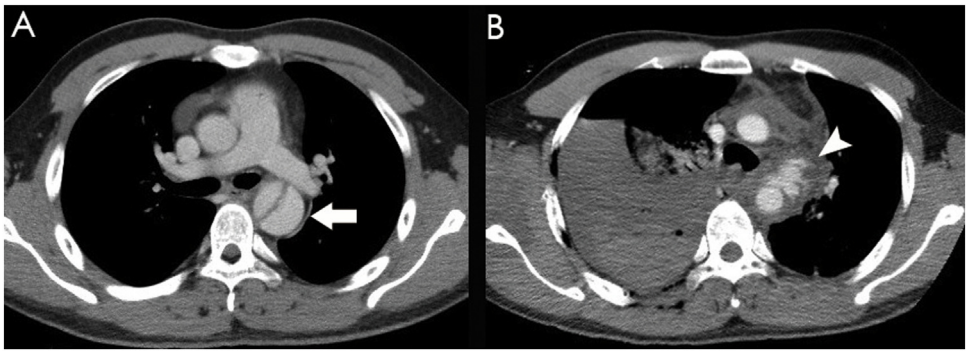

Fig. 1. Axial view of a computed tomography scan of aortic trauma. (A) An aortic injury with intimal flap and dissection (arrow). (B) An aortic injury with extravasation (arrowhead) and predominant right hemothorax.

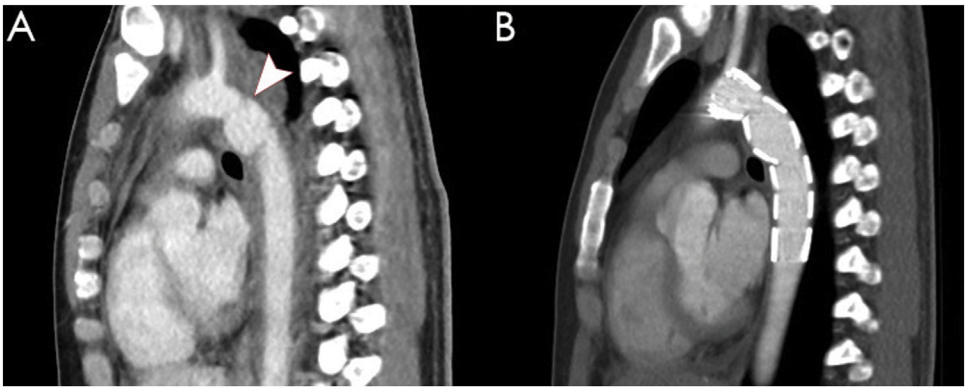

Fig. 2. Reconstructive view of a computed tomography scan of aortic trauma. (A) An injured aorta with pseudoaneurysm formation (arrowhead). (B) An injured aorta after endovascular stenting.

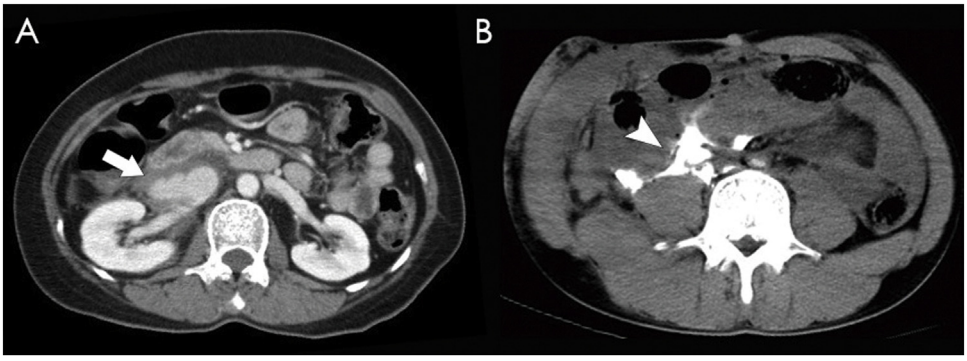

Fig. 3. Axial view of a computed tomography scan of vena caval trauma. (A) An infrarenal vena caval injury with pseudoaneurysm formation (arrow). (B) A vena caval injury with contrast extravasation (arrowhead).

averaged 112.2 (50.9) mmHg, and diastolic blood pressure (DBP) averaged 66.5 (31.5) mmHg. The average LOS was 21.9 (24.4) days. For BTAI, there were eight patients with grade I injuries (11%), twelve had grade II injuries (16%), thirty-four had grade III injuries (46%), and 7 had grade IV injuries (10%). In terms of injury location, forty-three BTAI were located in the isthmus zone (71%) and eighteen injuries were located in the descending aorta (29%). Surgical repair was performed on 13 patients (21%), and 34 patients (56%) underwent endovascular procedures (Fig. 2). The remaining patients (n = 14, 23%) were treated with nonoperative management. Among the thirteen patients with VCI, one had intrathoracic suprahepatic VCI (8%), five had intrabdominal suprahepatic VCI (38%), four had suprarenal VCI, including three retrohepatic VCI (23%) and one infrahepatic VCI (8%), and three had infrarenal VCI(23%). Twelve of these patients (12/13, 92%) underwent surgery. Venorrhaphy was performed on eight patents (8/12, 67%). Repair procedures could not be performed on three patients who were in grave condition. One patient with stable hemodynamics was treated with nonoperative management for a VCI (Fig. 4).

The overall mortality rate for GVT was 27% (20/74). The prognostic factors of survival, which were determined by comparing survivors and non-survivors, were the male sex (21% vs. 64%, p = 0.003), higher GCS (median = 15, IQR 15 ¯15 vs. median

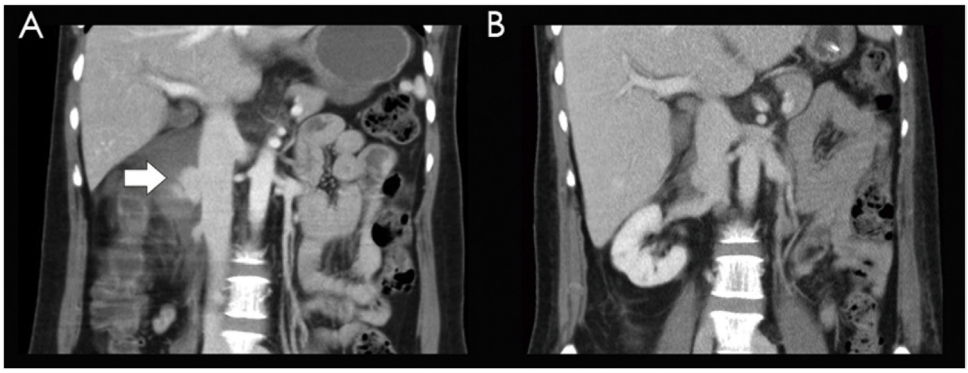

Fig. 4. Coronal view of a computed tomography scan of a vena caval trauma. (A) A suprarenal vena caval trauma with pseudoaneurysm formation (arrow). (B) After conservative management, pseudoaneurysm regression was observed.

Table 2
Prognostic factors of survival in patients with great vessel trauma.

	Univariate analysis		
	Survivors N = 54	Non-survivors N = 20	P-value
Age yr, Mean(SD)	42.4 (17)	39.6 (19.8)	0.574
Gender n, %			
Male	50 (79%)	13 (21%)	0.003
Female	4 (36%)	7 (64%)	
Mechanism			
Blunt	52 (73%)	19 (27%)	0.601
Penetration	2(67%)	1 (33%)	
ISS median(IQR)	25(20 - 34)	31(25-45)	0.051
GCS median(IQR)	15 (15-15)	8.5 (3 -15)	< **0.001**
SBP mmHg, Mean(SD)	125.8 (39.8)	75.3 (59.9)	< **0.001**
DBP mmHg, Mean(SD)	74.6 (26.9)	44.5 (33.0)	< **0.001**
Heart rate Mean(SD)	100.7 (26.3)	92.1 (54.4)	0.361
Management n, %			
Surgery	14 (56%)	11(44%)	0.063
Endovascular	28 (82%)	6 (18%)	
Conservative	12 (80%)	3 (20%)	
Injury site n, %			
Aorta	48 (79%)	13 (21%)	**0.034**
Vena cava	6 (46%)	7 (54%)	

SD:Standard deviation; ISS Injury severity score ; IQR Interquartile range ; GCS Glasgow coma scale ; SBP systolic blood pressure ; DBP Diastolic blood pressure.

8.5, IQR = 3-15, p < 0.001), higher SBP (125.8 (39.8) mmHg vs. 75.3 (59.8) mmHg, p < 0.001), and higher DBP (74.6 (26.9) mmHg vs. 44.5 (33.0) mmHg, p < 0.001). Moreover, patients with VCI had a higher mortality rate than those with BTAI (54% vs. 21%, p = 0.034). Although management of the patient did not have a statistically significant effect on mortality at the conventional 5% level, the observed mortality rate of 44% was more than double the rate of those receiving endovascular or conservative treatment. (Table 2).

A comparison of the BTAI and VCI groups is shown in Table 3. Age, sex, trauma mechanism, ISS, GCS, SBP, heart rate, and DBP were comparable between groups. The VCI group had a higher surgical intervention rate than the BTAI group (92% vs. 21%, p < 0.001). In advance, we divided the GVT injuries into three groups: low-grade BTAI (grades 1 and 2, n = 20), high-grade BTAI (grades 3 and 4, n = 41) and VCI. Comparing low-grade BTAI, high-grade BTAI and VCI, the mortality were also higher for the VCI group (54%), than high-grade BTAI (24%) and the low-grade BTAI (15%) respectively with a statistically significance (p = 0.042). We also found that morbidity is higher in VCI group (83%) than low-grade BTAI (28%) than high-grade BTAI (22%) with a significant difference (p = 0.011).

Discussion

This study evaluated the current status and prognostic factors of survival in patients with GVT. Initial blood pressure, ISS, GCS, necessity of surgery and VCI affect the outcomes of patients with GVT. It is reasonable that mortality would be related to injury severity, associated injuries, and physiological compensation. Patients who present with hemorrhagic shock tended to have a poor GCS, which led to irreversible coagulopathy, acidosis, hypothermia and an increased risk of mortality. Khan et al. found similar results that showed that hemorrhagic shock, the anatomical location of the injury, GCS, and ISS were important prognostic factors of mortality [11]. The mortality rate of these types of injuries is high, ranging from 36% to 65% in previous studies, and it has been associated with injury location, blunt trauma, and factors attributed to hemorrhage shock [20]. Appropriate fluid resuscitation to help maintain adequate blood pressure and subsequent tissue perfusion may be the first effort necessary for maintaining life [21,22].

In GVT, the necessity of surgical intervention is another prognostic factor for mortality. Demetriades et al. reported that 64.9% of patients with an aortic injury underwent endovascular treatment, resulting in a mortality rate of 7.2%, compared to the 23.5% mortality rate of patients who underwent open repair (p < 0.001). A significantly lower mortality and fewer blood transfusions were also found in an endovascular group [4]. Xenos et al. presented a meta-analysis showing that endovascular treatment was associated with lower postoperative mortality and ischemic spinal cord complication rates [5]. More than half of the BTAI in our study were managed by endovascular therapy, and the prognosis was promising compared to that of surgical treatment and comparable to that shown in previous reports [4,5]. A stent graft appears promising in the treatment of BTAI and might be the optimal treatment for certain patient groups.

Table 3
Comparison between patients suffering from low grade, high grade aortic and vena caval trauma.

	Low grade Aortic trauma N = 20	Hight grade Aortic trauma N = 41	Vena caval trauma N = 13	P-value
GCS median(IQR)	15 (15-15)	15 (7.5 - 15)	12 (6-15)	**0.025**
SBP mmHg, Mean(SD)	128.5 (45.9)	107.0 (49.9)	103.4 (58.9)	0.266
DBP mmHg, Mean(SD)	76.2 (23.2)	62.3 (29.6)	64.7 (45.0)	0.870
Associated injuries n, %				
Head & neck	4 (20%)	7 (17%)	3 (23%)	0.881
Chest	11 (55%)	27 (67%)	3 (23%)	**0.026**
Abdomen	14 (70%)	25 (63%)	10 (77%)	0.598
Extremity	7 (35%)	18 (44%)	2 (15%)	0.175
Face	1 (5%)	6 (14%)	1 (8%)	0.484
AIS median(IQR)				
Head & neck	0 (0-1.5)	0 (0-0)	0 (0-0.5)	0.653
Chest	3 (0-3)	3 (0-3)	0 (0-1.5)	0.093
Abdomen	2 (0-3)	2 (0-2)	3 (1-3)	0.162
Extremity	0 (0-0.5)	0 (0-3)	0 (0-0)	0.058
Face	0 (0-0)	0 (0-0)	0 (0-0)	0.955
ISS median(IQR)	25.5 (20 - 31.3)	26 (24-36)	29 (17 -40.5)	0.301
Management n, %				
Surgery	2 (10%)	11 (27%)	12 (92%)	< **0.001**
Endovascular	7 (35%)	27 (66%)	0 (0%)	
Conservative	11 (55%)	3 (2%)	1 (8%)	
Mortality n, %	3 (15%)	10 (24%)	7 (54%)	**0.042**
Morbidity n, %	5/18 (28%)	7/32 (22%)	5/6 (83%)	**0.011**

GCS:Glasgow coma scale ; IQR Interquartile range SBP systolic blood pressure ; SD Standard deviation; DBP Diastolic blood pressure ; ISS Injury severity score ; AIS Abbreviated Injury Scale.

Treatment options for VCI include conservative management, primary venography, prosthetic grafts, total ligation and endovascular stents. In the current study, direct repair was attempted in eight patients. However, the treatment outcome was unsatisfactory. Van Rooyen et al. suggested that the objective of surgery should be to stop the bleeding and not to achieve a patent, undistorted vena cava [8]. As recommended in the literature for operative management, venography, when feasible, offers the best chance of survival. In addition, because of associated injuries sustained by these patients, the use of damage control strategies is crucial. Total ligation of the vena cava as part of this damage control may be a life-saving procedure, but mortality and morbidity remained high in the literature [1]. A circulatory bypass to repair suprahepatic and retrohepatic caval injuries has been reported in a few studies [17,23,24]. In our study, there was one case of successful nonoperative management. Kuehne et al. reported only one patient who was treated with conservative management in a study of 136 patients with inferior vena caval injuries [21]. Patient selection and continuous close observation in the intensive care unit while maintaining low central venous pressure might be the key to successful nonoperative management [11]. The treatment modality should be based on the patient's condition and injury location, the surgeon's technique, and institution resources. In patients with stable hemodynamics and confined hematoma of VCI, nonoperative management may increase the probability of survival.

We identified the injury location as another prognostic factor and showed that the VCI itself is associated with a poor prognosis. The mortality rates in the current study were 54% in the VCI group and 21% in the BTAI group. Outcomes remained poor for VCI despite advances in acute care surgery for several reasons. First, there is no well-developed endovascular treatment for vena caval injuries. The use of endovascular treatment for VCI has been reported [14–16], but this treatment is neither readily available nor well studied worldwide. Second, more complicated anatomic limitations might be encountered when repairing the vena cava, which runs beneath numerous organs. Third, the vena cava has a thinner, weaker wall than the aorta, and the media layer of veins is not as well developed as that of arteries and offers only weak support [8]. Fourth, a VCI can lead to both major hemorrhage and a fatal air embolism, while a BTAI may lead only to hemorrhage.

The present study increased our knowledge of this rare trauma and demonstrated the mortality risk factors of GVT. However, there are several limitations to this investigation. First, this study was retrospective, and patient selection could not be randomized. Although all data were collected prospectively, and patient characteristics were similar and homogeneous, selection and recall bias could not be completely prevented due to the nature of this study. There were some differences in patient characteristics in our study from others. Previous studies have shown that penetrating mechanisms cause most VCI and can involve any portion of the vena cava [8,13,20,25]. However, because of the prohibition of firearms in our country, the majority (94.5%) of the traumas were caused was blunt injury, which also led to fewer penetrating cases of GVT and increased the number associated injuries of the patients and therefore the ISS. This factor might be one of the distinguishing differences between this study and others. The third limitation is that we excluded patients with severe liver lacerations from the IVC group of our cohort to clarify that the risk is related to vessel injury and not liver laceration or treatment complexity; the decreased number of cases might lower the precision and accuracy of the current study. Finally, there were two patients lost to follow up in our institute because the caregivers' request to transfer to other hospitals. We couldn't trace the final results of them; therefore, we had to omit them from this study which makes another potential bias on prognosis.

In conclusion, GVT is relatively rare but often highly lethal in clinical practice. Patient survival depends on injury severity and the grade of shock status. Aggressive resuscitation and treatment play important roles in survival. The prognosis of aortic trauma seemed promising with the advent of endovascular treatment, but the outcomes of patients with VCI are still disappointing. The coordination of different levels of surgical expertise and the application of novel treatment methods are required to improve the clinical outcomes of patients with vena caval injuries.

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References

[1] Sullivan PS, Dente CJ, Patel S, et al. Outcome of ligation of the inferior vena cava in the modern era. Am J Surg 2010;199:500–6.
[2] Ungar TC, Wolf SJ, Haukoos JS, Dyer DS, Moore EE. Derivation of a clinical decision rule to exclude thoracic aortic imaging in patients with blunt chest trauma after motor vehicle collisions. J Trauma 2006;61:1150–5.
[3] Steenburg SD, Ravenel JG. Acute traumatic thoracic aortic injuries: experience with 64-MDCT. AJR Am J Roentgenol 2008;191:1564–9.
[4] Demetriades D, Velmahos GC, Scalea TM, et al. Operative repair or endovascular stent graft in blunt traumatic thoracic aortic injuries: results of an American Association for the Surgery of Trauma Multicenter Study. J Trauma 2008;64:561–70.
[5] Xenos ES, Abedi NN, Davenport DL, et al. Meta-analysis of endovascular vs open repair for traumatic descending thoracic aortic rupture. J Vasc Surg 2008;48:1343–51.
[6] Buckman RF, Pathak AS, Badellino MM, Bradley KM. Injuries of the inferior vena cava. Surg Clin North Am 2001;81:1431–47.
[7] Osgood MJ, Heck JM, Rellinger EJ, et al. Natural history of grade I-II blunt traumatic aortic injury. J Vasc Surg 2014;59:334–42.
[8] van Rooyen PL, Karusseit VO, Mokoena T. Inferior vena cava injuries: a case series and review of the South African experience. Injury 2015;46:71–5.
[9] Kunkala M, Jenkins DH, McEachen J, Stockland A, Zielinski MD. Nonoperative management of traumatic suprahepatic inferior vena cava pseudoaneurysms. J Vasc Surg 2011;54(6 Suppl):80S–2S.
[10] Di Saverio S, Moore EE, Tugnoli G, et al. Non operative management of liver and spleen traumatic injuries: a giant with clay feet. World J Emerg Surg 2012;7:3.
[11] Khan IR, Hamidian Jahromi A, Khan FM, Youssef AM. Nonoperative management of contained retrohepatic caval injury. Ann Vasc Surg 2012;26 (420) e9–420.e12.
[12] Forcillo J, Philie M, Ojanguren A, et al. Outcomes of traumatic aortic injury in a primary open surgical approach paradigm. Trauma Mon 2015;20:e18198.
[13] Carr JA, Kralovich KA, Patton JH, Horst HM. Primary venorrhaphy for traumatic inferior vena cava injuries. Am Surg 2001;67:207–13.
[14] Castelli P, Caronno R, Piffaretti G, Tozzi M. Emergency endovascular repair for traumatic injury of the inferior vena cava. Eur J Cardiothorac Surg 2005;28:906–8.
[15] de Naeyer G, Degrieck I. Emergent infrahepatic vena cava stenting for life-threatening perforation. J Vasc Surg 2005;41:552–4.
[16] Sam 2nd AD, Frusha JD, McNeil JW, Olinde AJ. Repair of a blunt traumatic inferior vena cava laceration with commercially available endografts. J Vasc Surg 2006;43:841–3.
[17] Kaoutzanis C, Evangelakis E, Kokkinos C, Kaoutzanis G. Successful repair of injured hepatic veins and inferior vena cava following blunt traumatic injury, by using cardiopulmonary bypass and hypothermic circulatory arrest. Interact Cardiovasc Thorac Surg 2011;12:84–6.
[18] Filippini S, Desebbe O, Gamondes D, Henaine R. Synergy between stents and extracorporeal membrane oxygenation in multitrauma patients with inferior vena cava injury. Eur J Cardiothorac Surg 2013;44:1140–2.
[19] Azizzadeh A, Keyhani K, Miller CC, Coogan SM, Safi HJ, Estrera AL. Blunt traumatic aortic injury: initial experience with endovascular repair. J Vasc Surg 2009;49:1403–8.
[20] Hansen CJ, Bernadas C, West MA, et al. Abdominal vena caval injuries: outcomes remain dismal. Surgery 2000;128:572–8.
[21] Kuehne J, Frankhouse J, Modrall G, et al. Determinants of survival after inferior vena cava trauma. Am Surg 1999;65:976–81.

[22] Maciel JD, Plurad D, Gifford E, et al. Predictors of mortality in patients with penetrating inferior Vena Cava injuries surviving to the operating room. Am Surg 2015;81:1000–4.
[23] Marelli D, Tchervenkov CI, Metrakos P, Barayan S, Hasel R, Brown RA. Deep hypothermic circulatory arrest for blunt retrohepatic venous injury: a case report. J Trauma 1995;38:609–11.
[24] Kaemmerer D, Daffner W, Niwa M, Kuntze T, Hommann M. Reconstruction of a total avulsion of the hepatic veins and the suprahepatic inferior vena cava secondary to blunt thoracoabdominal trauma. Langenbecks Arch Surg 2011;396:261–5.
[25] Navsaria PH, de Bruyn P, Nicol AJ. Penetrating abdominal vena cava injuries. Eur J Vasc Endovasc Surg 2005;30:499–503.