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RESEARCH ARTICLE

Aortic Injury: A Rare, Challenging Injury in Multiorgan Trauma Patients

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RESUMEN

Introducción: la rotura aórtica puede seguir a lesiones penetrantes o predominantemente contundentes y puede resultar en un shock hemorrágico repentino que, en general, es letal. Las IA se clasifican en la Escala de lesiones en órganos propuesta por la Asociación Americana para la Cirugía de Trauma (AAST-OIS), que divide las lesiones aórticas en segmentos torácicos (grados IV a VI) y abdominales (grados IV a V).

Materiales y resultados: los datos demográficos, las lesiones concomitantes y las tasas de mortalidad se evaluaron retrospectivamente. Durante 9 años han sido hospitalizados 10191 pacientes. La lesión aórtica se reveló en 4 de los pacientes con traumatismo multiorgánico sometidos a cirugía. Todos los pacientes fueron víctimas de accidentes automovilísticos cerrados. La lesión revelada se localizó en la aorta torácica o abdominal. La laparotomía fue el abordaje quirúrgico para el tratamiento de la lesión de la aorta abdominal, mientras que la toracotomía izquierda o la toracotomía bilateral para las lesiones de la aorta torácica.

Discusión: El trauma multiorgánico es una condición severa. Cuando la aorta está afectada, la condición se vuelve excepcionalmente desafiante. Las lesiones aórticas son las segundas, después de las lesiones en la cabeza, las condiciones más letales en pacientes con traumatismo cerrado. Las lesiones torácicas y aórticas abdominales entre nuestros pacientes fueron de grado IV AAST-OIS. Existen varias modalidades de reparación incluyendo técnica abierta y endovascular. Los pacientes hemodinámicamente inestables con múltiples lesiones concomitantes deben recibir una cirugía de control de daños que permita la reparación de lesiones potencialmente mortales y una cirugía definitiva retrasada. La cirugía debe ser realizada por un cirujano vascular y de traumas altamente experimentado.

Conclusione: la rotura traumática de la aorta es una condición rara, pero potencialmente mortal y comúnmente letal. Por lo general, sigue un traumatismo cerrado en un vehículo motorizado y se refiere principalmente a la aorta torácica. El manejo óptimo de la IA requiere un equipo de trauma altamente experimentado y protocolos de tratamiento correctos.

Palabras clave: Cirugía, Lesión de la aorta, Politrauma, Trauma multiorgánico.

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ABSTRACT

Introduction: Aortic rupture may follow penetrating or predominantly blunt injuries and results in a sudden hemorrhagic shock which commonly is lethal. AIs are classified in the organ injury scale proposed by American Association for the Surgery of Trauma (AAST-OIS), dividing aortic injuries into thoracic (grades IV–VI) and abdominal (grades IV–V) segments.

Materials and results: The demographic data, concomitant injuries, and mortality rates were evaluated retrospectively. During 9 years 10191 patients have been hospitalized. The aortic injury was revealed in 4 of multiorgan trauma patients undergoing surgery. All patients were victims of blunt motor-vehicle accidents. The revealed injury was located in the thoracic or abdominal aorta. Laparotomy was the surgical approach for the management of abdominal aorta injury, while left thoracotomy or bilateral thoracotomy for thoracic aorta injuries.

Discussion: Multiorgan trauma is a severe condition. When the aorta is involved the condition becomes exceptionally challenging. Aortic injuries are the second, after head injuries, most lethal conditions in blunt trauma patients. Both thoracic and abdominal aortic injuries among our patients were AAST-OIS grade IV. There are several repair modalities including open and endovascular technique. The hemodynamically unstable patients with multiple concomitant injuries should receive a damage control surgery allowing repair of life-threatening injuries and delayed definitive surgery. The surgery has to be done by highly experienced vascular and trauma surgeon.

Conclusion: Traumatic rupture of the aorta is a rare, yet life-threatening and commonly lethal condition. It usually follows blunt motor-vehicle trauma and predominantly concerns thoracic aorta. The optimal management of AIs requires a highly experienced trauma team and correct treatment protocols.

Keywords: Aorta injury, Multiorgan trauma, Polytrauma, Surgery.

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INTRODUCTION

The aorta is the largest artery in the body.[1] Its rupture may follow penetrating or predominantly blunt injuries and

results in a sudden hemorrhagic shock which commonly is lethal.[2-7] The general rule is that the greater blunt force, the greater suspicion for aortic injury (AI).[3] AIs usually follow high-impact traumas, which predominantly are caused by a rapid deceleration in motor vehicle accidents, falls from heights, high kinetic energy contusions and explosions.[3,8-11] AIs are revealed in less than 1% of motor-vehicle accidents victims.[1,12] AIs are the second, after brain injuries, the cause of death in blunt trauma patients.[1,3,9,12] The outcome is highly connected with the severity of injury to other organs, since most cases of AIs occur with other associated injuries, including rib fractures, lungs, and myocardial contusions, diaphragmatic rupture, spleen, liver and bowel injuries, pelvis and extremity fractures.[1]

AIs are classified in the organ injury scale proposed by American Association for the Surgery of Trauma (AAST-OIS).[13] When AI appears it represents the highest grades of AAST-OIS (Table 1).

Despite the best results achieved in the high-volume centers, it is reported that the low-volume centers present similar results when management protocols and a multidisciplinary team is provided.[14] The survival of patients with aortic injury depends on an accurate and rapid diagnosis and prompt management, what is crucial to save the patients.[1]

We present a retrospective study of aortic injuries among multiorgan trauma patients receiving surgery in a level 1 trauma center.

MATERIALS AND RESULTS

During 9 years in the Department of General, Vascular and Trauma Surgery 10191 patients have been hospitalized, of which 393 (3.9%) received surgery due to multiorgan trauma. Four of multiorgan trauma patients undergoing surgery experienced AI (1.0% of receiving surgery multi- and 57 years for female) (Table 2). All patients were victims of blunt motor-vehicle accidents. The revealed AI was located in thoracic (3 patients; 2 males and 1 female; 75.0%) or abdominal aorta (1 male; 25.0%).

In presented cases, the severity of AI was rated according to the AAST-OIS scaling system for organ-specific injuries[13] (Table 1). In each case, the AI was assessed as AAST-OIS graded IV, what in 3 cases of thoracic AIs was equal to the injury to descending aorta, while in 1 case of abdominal aorta equals the injury to the infrarenal aorta.

Presented patients underwent a multiorgan trauma and AI was one of the multiple injuries. Among 3 patients with thoracic AI, the most frequent concomitant injuries were: lung contusions (3 cases; 100%) and rib fractures (bilateral in 2 cases, 66.7%; unilateral in 1 case, 33.3%). In each case, the hematoma in the mediastinum was revealed (3 cases, 100%). One case of abdominal AI was accompanied by injuries to ICV, spleen (grade II), liver (grade I), small intestine and sigmoid as well as pelvis and vertebral L3-L4 fractures.

Laparotomy was the surgical approach for the management of abdominal AI, while left thoracotomy (2 cases, 66.7%) or bilateral thoracotomy with transverse sternotomy (1 case, 33.3%) for the management of thoracic AIs. The intra-operative mortality was 50%.

DISCUSSION

Multiorgan trauma is a severe condition. When the aorta is involved the condition becomes exceptionally challenging and commonly results in a sudden hemorrhagic shock and is highly lethal.[1,8,15] AI may result from blunt or penetrating traumas.[9,12] It mostly follows high-impact blunt traumas caused by forces resulting in rapid deceleration: high-speed traffic accidents, falls from a height, contusions and explosions.[1,3,8,9,11] AIs are

Table 1: Thoracic and abdominal aorta injury scales according to the American Association for the Surgery of Trauma–Organ Injury Scale (AAST-OIS)[13]

AAST-OIS grade of aorta injury	*Thoracic vascular injury scale*	*Abdominal vascular injury scale*
I	–	–
II	–	–
III	–	–
IV	Descending aorta	Infrarenal aorta
V	Ascending aorta and aortic arch	Suprarenal, subdiaphragmatic aorta
VI	Uncontained total transection of thoracic aorta	

Table 2: All hospitalized patients, trauma-related hospitalizations, multiorgan and aortic injuries

	n of patients	*% of all hospitalized*	*% of trauma-related hospitallizations*	*% of multiorgan traumas*
All hospitalized	10191			
Trauma-related hospitalizations	1702	16.7		
Multiorgan trauma	393	3,9	23.1	
Aortic trauma	4	0.04	0.2	1.0

the second, after head injuries, most lethal conditions in blunt trauma patients.[1,3,9,12] Most of the AI patients are obese or overweight males.1 We noticed a predominance 3:1 of males. The predominance of males can be also seen in the statistics in most of the injuries.

Most patients with AI die on the scene. The instant mortality rate after blunt thoracic AIs is 70 to 90%.[3,11] Only 20% of traumatic aortic transections are reported to reach the hospital alive.[1,12,16] Even for those patients prognoses are disappointing. Their condition is usually extremely bad and they are hemodynamically unstable with an enormous blood loss. In blunt trauma patients who survive to presentation mortality related to AI is 5%, enlarged in non-penetrating aortic arch injuries to 23,1%.[5,10] Aortic transections are revealed in less than 1% of motor-vehicle accidents victims, but they are responsible for 16% of deaths.[1,12] The mortality rate in our multi-organ trauma patients with concomitant AI was 50% and concerned 2 patients with thoracic AIs. This means that two-thirds of multiorgan trauma patients who reach the hospital, when the thoracic aorta is involved, died during the surgery. The concomitant injuries augmented the AI mortality rate in our series. Additionally, our group was limited, since AI was revealed only in 0.04% of all hospitalized patients (Table 2), although our hospital is level 1 trauma center. The general rule is that the grater blunt trauma force is associated with the greater suspicion for traumatic AI.[3]

Penetrating AI is a rare condition; however, when it occurs, the massive blood loss generally causes death in a pre-hospital period. Not many patients reach the hospital alive.[16] The uncontrollable hemorrhage and cardiac arrest are the causes of mortality.[17] These patients did not reach our hospital alive. This may explain why we did not manage patients who experienced penetrating traumas.

AI is one of the pathologies called "acute aorta", which also includes aortic dissection, intramural hematoma, penetrating aortic ulcer, impending rupture and aneurysm rupture. Each of above is life-threatening, requiring prompt diagnosis and treatment.[4] The diagnostics to these patients should be extremely fast. Then they need to be forwarded immediately to the operating theatre to undergo life-saving surgery. The gold standard for acute aorta is computed tomography (CT) scanning, which reveals contrast extravasation.[3,12,18] CT is essential for both the diagnosis and planning of the repair.[1,3,4,18] Most cases of aortic rupture occur with other associated injuries, including rib fractures, lungs, and myocardial contusions, diaphragmatic rupture, spleen, liver and bowel injuries, pelvis, vertebral and extremity fractures.[1] Our patients presented with numerous concomitant injuries including: lung contusions (n = 3), rib fractures (bilateral in 2 cases; unilateral in 1 case), hematoma in the mediastinum (n = 3) or retroperitoneal space (n = 1), injuries to ICV, spleen (grade II), liver (grade I), small intestine and sigmoid as well as pelvis and vertebral L3–L4 fractures. Thus an important additional advantage of CT is an evaluation of injuries to other thoracic and abdominal organs.[3] The other diagnostic opportunities are X-ray and sonography. However, X-ray cannot exclude aortic rupture.[1] Transesophageal sonography may be used only in selected cases for evaluation of AI.1 Focused assessment with sonography for trauma (FAST) doesn't include visualization of the aorta but may reveal free fluid in the peritoneal or pleural cavities.[12]

The thoracic and abdominal AIs were evaluated in the AAST-OIS thoracic vascular injury scale and abdominal vascular injury scale (Table 1).[13] The thoracic vascular injury scale divides thoracic AIs into grades IV–VI, what equals injury to descending aorta, ascending aorta and aortic arch, uncontained total transection of thoracic aorta, respectively. While abdominal vascular injury Scale divides abdominal AIs into grades IV–V, what equals injury to the infrarenal aorta and suprarenal subdiaphragmatic aorta, respectively (Table 1). Both thoracic and abdominal AIs among our patients were grade IV, equal to injury to the descending thoracic aorta and infrarenal abdominal aorta. The reason why we did not treat the highest grades of AIs is that the highest grades are: injuries to ascending thoracic aorta and aortic arch, total transection of thoracic aorta as well as injuries of the sub-diaphragmatic, suprarenal abdominal aorta. Those patients did not reach the hospital due to the severity of both aorta and the other organs injuries. The force causing the AI in our patients was large enough to cause concomitant ribs, pelvis and vertebral fractures.

When the penetrating AI occurs, it generally leads to a massive hemorrhage to the pleural or peritoneal cavity, external hemorrhage and death on the place of the accident. However, even a blunt force may cause a hemorrhage to pleural cavity from thoracic aorta and to abdominal cavity from the abdominal aorta. These conditions usually lead to sudden death as well. In our series, each patient had a large hematoma in the mediastinum (for thoracic AIs) or retroperitoneal space (for abdominal AI). This means that the hemorrhage from the injured aorta was separated from natural cavities, what limited the blood loss and made possible reaching the hospital by a patient with such large trauma.

There are several repair modalities including open and endovascular technique.[1-3,18] The hemodynamically unstable patients with multiple concomitant injuries should receive damage control surgery.[6,19] The damage control concept gives primacy of hemorrhage control and allows repair of life-threatening injuries in massively injured and physiologically exhausted patients and

delays definitive surgery when the "lethal triad" of hypotonia, acidosis, and coagulopathy is corrected and normal physiology is restored.[6,19] The surgical access should be adopted to injury location. Each patient received a damage control surgery including laparotomy in 1 case and thoracotomy (unilateral or bilateral) in 3 cases. For abdominal AI, the medial abdominal incision provides fast and wide access to the abdominal cavity. For thoracic AIs we used left thoracotomy or bilateral thoracotomy with transverse sternotomy. This bilateral approach provides a wide insight into the entire chest, including both pleural cavities, both lungs as well as mediastinum with heart and big vessels including ascending, arch and descending thoracic aorta. However, the surgery has to be done by highly experienced vascular and trauma surgeon. The resuscitation thoracotomy is an element of damage control concept that allows decompression of pericardial tamponade, control of cardiac hemorrhage, cross-clamping of descending aorta, control of other intra-thoracic hemorrhages and lung injuries. Although fully justified, resuscitation thoracotomy is rarely performed.[20] Hybrid procedures that combine surgery and interventional radiology require hybrid operation theatres, but for blunt AIs provide an appropriate and prompt management, improve patients' outcome and survival rates, especially for isolated AIs, when concomitant injuries don't require an open surgery.[11,21] The endovascular repair may be applied to both thoracic and abdominal AIs.[8,15,22] Although it is rapid and minimally invasive, the outcome highly depends on the number and severity of injuries to other organs.[22] Each our patient required a damage control surgery due to injuries to other organs.

The survival of patients with AI depends on an accurate and rapid diagnosis and prompt management.[1,12] The high-volume centers achieve the best results on the expert level. However, low-volume centers are reported to have similar results in the AIs treatment when management protocols and a multidisciplinary team is provided.[14]

CONCLUSION

Traumatic rupture of the aorta is a rare, yet life-threatening and commonly lethal condition. It is an unusual component of multi-organ trauma. It usually follows blunt motor-vehicle trauma and predominantly concerns thoracic aorta. The diagnostics in patients who initially survived the trauma and reached the trauma centers would be prompt and the patients have to be forwarded immediately for life-saving, damage control surgery. The surgery is challenging. It requires experience in both vascular and trauma procedures and is crucial to save patients. Even when managed promptly the mortality rate remains significantly high, especially in the case of thoracic AIs. The optimal management of AIs requires a highly experienced trauma team and correct treatment protocols.

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