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Endovascular repair of thoracic and abdominal aortic ruptures: a single-center experience

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PURPOSE
We aimed to present our preliminary single-center experience of the endovascular management of thoracic and abdominal aortic ruptures.

MATERIALS AND METHODS
Between September 2010 and May 2012, 11 consecutive patients (nine males, two females; age range, 26–80 years) with thoracic and abdominal aortic ruptures underwent endovascular repair in our unit. Thoracoabdominal computed tomography (CT) angiography was performed for diagnosis and follow-up. Patients were selected for endovascular repair by a cardiovascular surgeon, anesthesiologist, and interventional radiologist. All repairs were performed using commercially available stent-grafts. The patients were followed up with CT angiography before discharge, at six months, and yearly thereafter.

RESULTS
Three patients died by day 30. One patient died due to an unsuccessful procedure and hemodynamic instability; two patients died because of comorbidities. The other eight patients were followed for six to 24 months after the procedure. No endoleaks or late ruptures were observed during the follow-up period. The patient with iatrogenic thoracic aortic rupture developed paraplegia after the procedure.

CONCLUSION
Reduced mortality due to aortic rupture has been reported with the expanding use of endovascular repair. Reports of small centers are important because of the rarity of these pathologies, and because transferring patients with aortic rupture to a referral center is not usually possible.

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Thoracic and abdominal aortic ruptures are life-threatening emergencies with high mortality rates; the vast majority of patients die before they can receive medical care. Traumatic injury of the aorta is usually immediately fatal; 57%–94% of these patients die at the scene or in the emergency room (1, 2). Furthermore, the mortality rate for patients with aortic rupture who survive until they reach the hospital is estimated to be 41%–50% (3).

Despite significant improvements in critical care support, noninvasive diagnosis, anesthesia, and cardiosurgery over the last few decades, the conventional open surgical repair of an aortic rupture still carries a significant risk of serious complications and mortality (4–6). Perioperative mortality rates associated with the surgical repair of a ruptured abdominal aortic aneurysm (rAAA) or a thoracic aortic injury (TAI) ranges from 32% to 70% (5, 7–9). Patients with rAAA and traumatic TAI are not frequently good surgical candidates because of old age, comorbidities, and concomitant multiple-system injuries, such as cranial injuries, multiple fractures, and pulmonary contusions. Surgical repair of the thoracic or abdominal aorta in patients with concomitant injuries and comorbidities is associated with high morbidity and mortality (4, 10, 11). Therefore, endovascular repair techniques have emerged as a promising alternative in these patients (12).

Several case reports and case series evaluating the technical feasibility and safety of endovascular treatment for rAAA and TAI suggest that between 40% and 80% of rAAAs are suitable for endovascular aortic repair (EVAR) (5, 7, 13, 14), and the perioperative mortality rates for endovascular repair of rAAA and TAI are 10%–29% (15–17) and 0%–20% (10, 11, 18), respectively.

The description of endovascular treatment for ruptured and symptomatic aneurysms marked a paradigm shift in aortic repair, with treatments for the condition advancing rapidly over the last two decades (19). Many hospitals now provide endovascular repair as a first-line treatment for patients who have suffered rAAA or TAI and are deemed to have suitable anatomy. Both conventional open surgical and endovascular treatment options for aortic ruptures are available in referral centers; however, the transfer of patients who need emergency treatment to a referral center is usually not possible. Therefore, the widespread use of endovascular techniques is important for the rapid and adequate treatment of these patients. The aim of this report was to present our preliminary single-center experience of the endovascular management of thoracic and abdominal aortic ruptures.

Materials and methods

Between September 2010 and May 2012, 15 patients with an acute aortic rupture were admitted to our center. The patients were initial-

ly evaluated in the emergency ward by an emergency room doctor. Under the clinical suspicion of aortic rupture, the patients were evaluated by a multidisciplinary team consisting of a cardiovascular surgeon, interventional radiologist, and anesthesiologist for possible endovascular treatment options. The hemodynamic situations of each patient and coexisting injuries were noted, and necessary consultations were made. A fluid resuscitation was administered to maintain a systolic blood pressure (BP) near the range of 60% to 70% of the usual systolic value (approximately 80 mmHg). Hemodynamic instability was defined as loss of consciousness or BP <80 mmHg at any time after admission. Of the 15 patients, one patient who had uncompensated shock (BP less than 60 mmHg that was not responding to fluid infusion and tachycardia) was immediately transferred to the operating room and excluded from endovascular treatment. All the other patients, who were hemodynamically stable or in whom a temporary hemodynamic stabilization could be achieved after resuscitation, were transferred to the computed tomography (CT) unit for CT angiography (Fig. 1).

CT angiography

Thoracoabdominal CT angiography was performed with three-dimensional reconstructions using 130 to 150 mL of nonionic contrast material. CT angiography examinations were performed with a 40-row multidetector CT scanner (Somatom Sensation 40, Siemens Medical Solutions, Forcheim, Germany). The parameters of the CT angiography protocol were consistent with CT parameters defined in the literature (20). CT images were interpreted by the interventional radiologist and cardiovascular surgeon. Signs of acute and impending rupture of the aorta, the location of the aortic lesion, its exact anatomy and morphology, the extent of the aneurysm sac, the relationships of the aneurysm neck and aortic injury site with adjacent aortic branch vessels, the amount of mural thrombus and calcification at the neck and the tortuosity of the vessels were noted. Secondary findings that may be related to trauma, such as mediastinal or intraperitoneal hematoma, bone fractures, and free fluid in the abdomen, were also evaluated. All anatomically suitable patients were chosen as candidates for a stent-graft procedure by the multidisciplinary team. The diameters of the proximal and distal landing zones and the dimensions of the aorta and iliac arteries were measured from CT images of anatomically suitable patients for the sizing of the stent-graft systems. All patients were confirmed to have acute aortic ruptures or impending rupture by the CT angiography. The CT scans were performed and images evaluated in 15–25 min, and during this period the angiography suite was prepared for the emergency endovascular treatment (Figs. 2a, 2b, 3a, 3b).

Retroperitoneal and mediastinal hematoma adjacent to the aorta, periaortic active extravasation of contrast material, and the presence of intraperitoneal or pleural high-density fluid were considered acute rupture. Draped aorta sign (defined as the posterior wall of the aneurysm sac being not identifiable as distinct from the adjacent structures or closely following the contour of adjacent vertebral bodies) and a hyperattenuating crescent sign within the aneurysm sac were considered as impending rupture (21).

Endovascular treatment criteria

Suitable anatomy for EVAR was defined as a minimum infrarenal neck length of 10 mm, maximum neck diameter of 30 mm, infrarenal neck angulation less than 60°, absence of circumferential thrombus and calcification within the landing zones, limited tortuosity of the iliac vessels and abdominal aorta and distal vascular access of a sufficient size (diameter >8 mm iliac arteries). Suitable anatomy for thoracic endovascular aortic repair (TEVAR) was defined as a minimum length of 15 mm from the aortic lesion to the left subclavian artery, maximum aortic landing zone diameter of 40 mm, absence of circumferential thrombus and calcification within the landing zone, limited tortuosity of the iliac vessels and thoracic aorta and distal vascular access of a sufficient size (diameter >8 mm iliac arteries). Aneurysms that were determined not to be ruptured were excluded. The procedure was explained to the patients while conscious as well as their relatives, and written informed consent was obtained in all cases.

Endovascular treatment procedure

All procedures were performed in a fully equipped angio-suite with a digital subtraction angiography (DSA) unit (Allura FD 20/20, Philips Medical System, Best, the Netherlands) under general anesthesia.

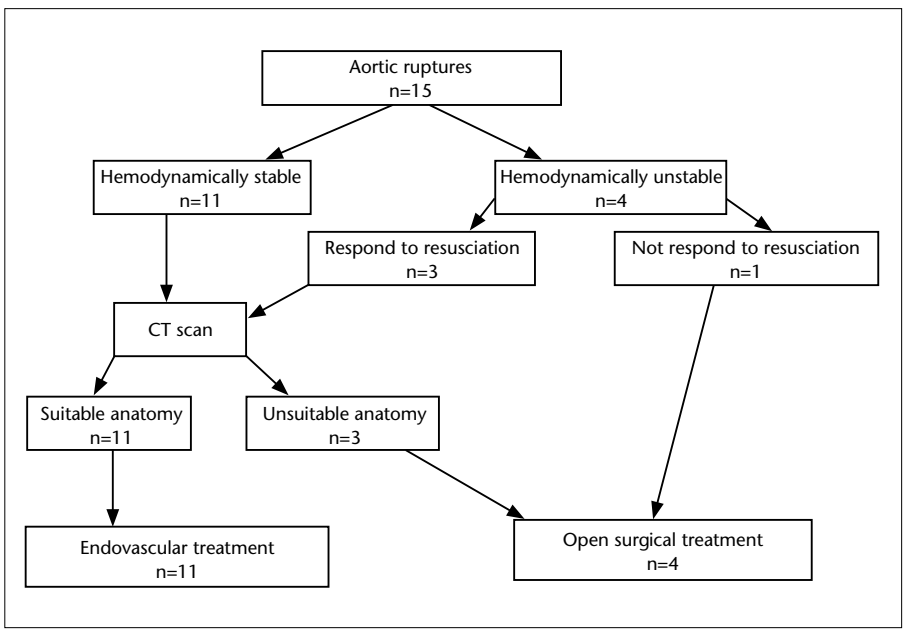

Figure 1. Management of the patients

During the EVAR procedure, both common femoral arteries (CFAs) were exposed surgically. After advancing a calibrated angiographic catheter into the suprarenal aorta, DSA was performed. The origins of the renal arteries were identified. The length of the proximal neck, the diameters of the proximal and distal landing zones, and the angulation of the neck were correlated with CT angiography scans. Active contrast material extravasation and rupture site could not be detected by DSA in any of the patients. After confirming the suitability of the proximal and distal landing zones, the main body of the stent-graft was deployed over a stiff guidewire (Fig. 2c, 2d). A series of aortograms were obtained during the deployment to ensure accurate proximal and distal positioning of the stent-graft. The main body was just below the orifice of the lower renal artery. In all patients the contralateral legs of the stent-grafts were deployed into the common iliac arteries without any internal iliac artery occlusions or external iliac artery extensions.

During TEVAR, one of the CFAs was surgically exposed, and contralateral CFA was percutaneously accessed. In one patient, according to CT findings, the proximity of the injury site to the left subclavian artery (SCA) was diagnosed, and closure of left SCA was decided. Therefore, additional brachial artery access was gained percutaneously to precisely define the ostium of the left SCA. A pigtail angiography catheter was then advanced into the ascending aorta. After a series of aortograms, the delivery system was advanced over a stiff guidewire and positioned at 2 cm proximal to the aortic injury. The proximal bare stent was placed above the left SCA in all patients but one, to allow free blood flow through the vessel (Fig. 3c). In one case, the left SCA was covered to ensure adequate graft fixation. During release of the device, a controlled systemic hypotension was induced.

For optimal fixation, all stent-grafts were oversized by 10%–15% but not more than 20%. Although there was a clinical preference for a bifurcated system to repair the abdominal aorta and achieve an anatomic reconstruction, one patient required the use of an aorto-uni-iliac (AUI) device because he became hemodynamically unstable during the procedure. The stent-graft systems were selected according to the local availability of the device, the experience of the endovascular team and the hemodynamic status of the patient. Three different stent-graft systems were used for the rAAA repair: the Endurant AUI stent-graft (Medtronic Vascular, Santa Rosa, California, USA; n=1), the Endurant aortic stent-graft system (Medtronic Vascular; n=2), and the Anaconda endoprosthesis (Vascutek Inc., Terumo Company, Renfrewshire, Scotland, UK; n=2). Valiant aortic stent-grafts (Medtronic Vascular) were used to repair TAI.

A completion angiography was performed at the end of the procedures to confirm correct stent-graft placement and to ensure the absence of endoleaks. In all patients except one, the stent-graft deployment was confirmed to be accurate, and balloon inflation was not applied at the attachment zones. In the one patient in whom the AUI stent-graft was used, there was a type 1 endoleak into the aneurysm sac, so an additional aortic cuff was deployed.

All patients were hospitalized in the intensive care unit after the procedure, and their hemodynamic status was monitored. The patients were also monitored for detection of any increases in intra-abdominal pressure by measuring urinary bladder pressure.

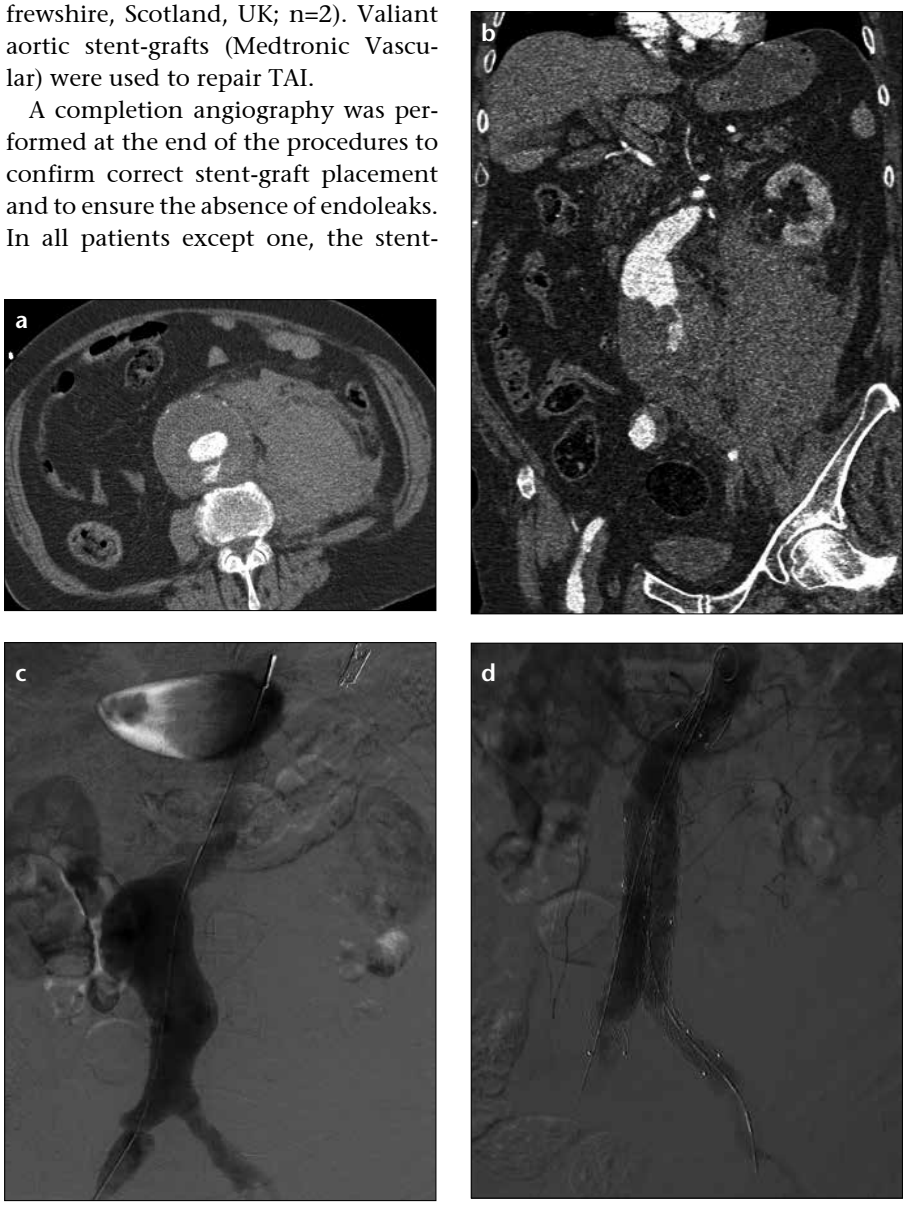

Figure 2. a–d. A 77-year-old male patient with ruptured abdominal aortic aneurysm. Primary diagnosis was based on CT angiography scans. Axial **(a)** and coronal reformatted **(b)** CT images show extravasation of the contrast agent and para-aortic hematoma due to rupture of an abdominal aortic aneurysm. Aortography **(c)** before the procedure was used to ensure accurate proximal and distal positioning. Aortography **(d)** shows the stent-graft after deployment.

Follow-up

The patients underwent CT angiography before hospital discharge. CT angiography was repeated at six months postdischarge and then yearly thereafter (Fig. 3d–3f). Follow-up CT images were evaluated for aneurysm sac and hematoma sizes, patency of the stent-grafts, late ruptures, and endoleaks.

Results

Hemodynamic status

All 15 patients had a BP <100 mmHg at admission. Two patients with thoracic aortic ruptures and two with abdominal aortic ruptures were hemodynamically unstable (BP <80 mmHg) when they were evaluated at the emergency ward. Despite adequate resuscitation, hemodynamic status of one patient could not be improved, and he was transferred to the operating room immediately. Stabilization of hemodynamic status of the other three patients was achieved, and CT angiography was performed on those patients.

CT angiography findings

There were seven patients with abdominal aortic aneurysm and seven patients with TAI. Of the seven TAI patients, five had traumatic TAI, one had aortic rupture due to mycotic aneurysm, and one had iatrogenic TAI after a vertebral biopsy.

Retroperitoneal hematoma was detected in six rAAA patients, and active contrast material extravasation and rupture site were detected in three of the six rAAA patients. A hyperattenuated crescent-shaped area within the aneurysm sac was considered as impending rupture in one patient.

CT angiography revealed hemothorax in all seven patients with TAI. The injury site was the aortic isthmus in five traumatic TAI patients and in one patient who had aortic rupture due to mycotic aneurysm. In the patient with iatrogenic TAI, injury was located at the level of the T9 vertebra. Concomitant multiple-system injuries were detected in all traumatic TAI patients (Table 1).

Of the 14 patients, two patients with rAAA were excluded from stent-graft treatment because of short neck length (<5 mm) and angulation of the neck greater than 60°, and one patient with TAI was excluded due to large neck di-

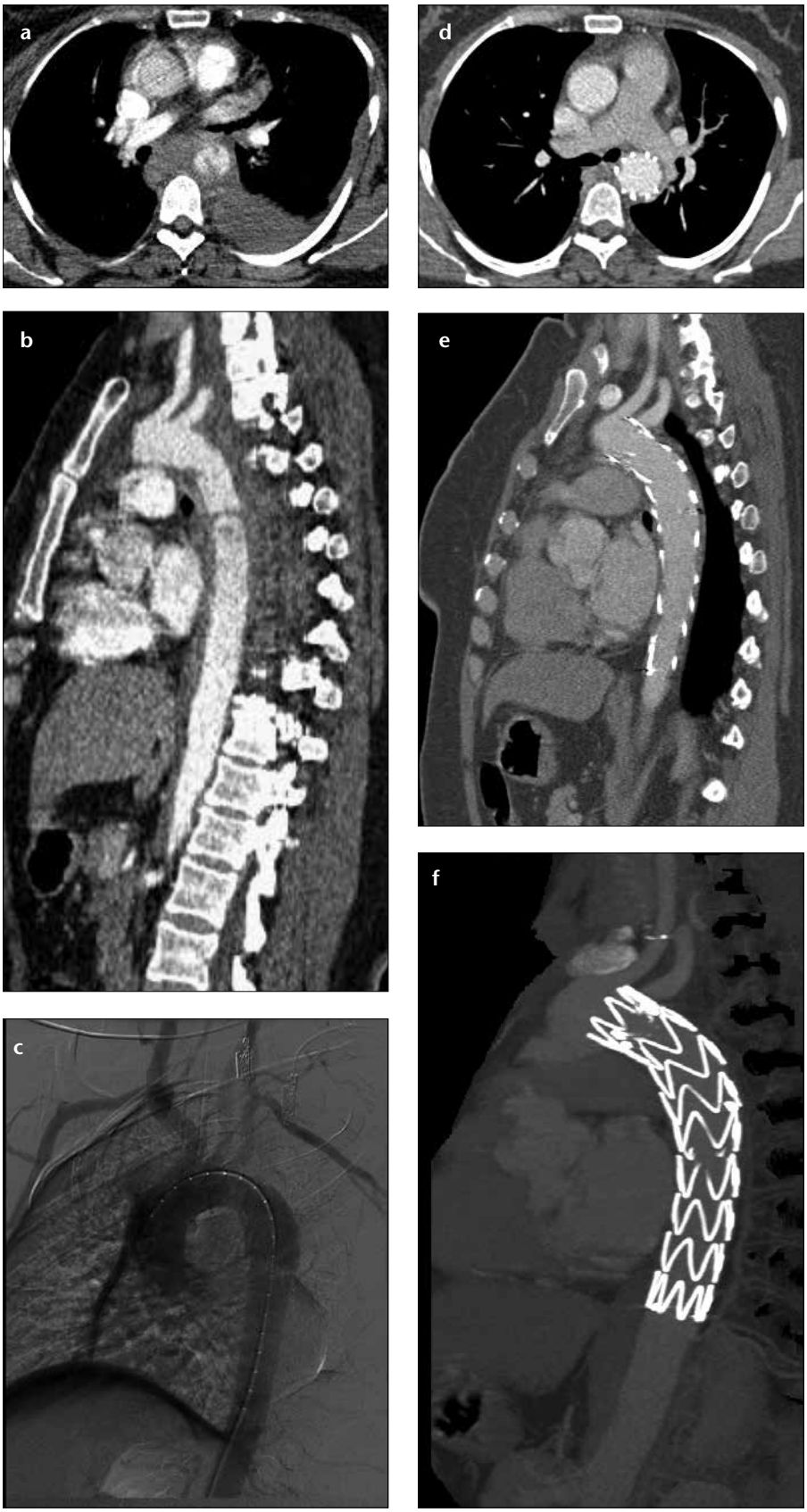

Figure 3. a–f. A 50-year-old female patient with traumatic thoracic aortic rupture. Axial **(a)** and sagittal reformatted **(b)** CT images show the traumatic thoracic aortic dissection and the extramural para-aortic thoracic hematoma. Aortography **(c)** before the deployment of the stent-graft was used to ensure accurate proximal and distal landing zones and for measurements. Follow-up CT images (**d, e,** and **f**) show no endoleak one year after the procedure.

Table 1. Comorbidities and coexisting injuries

Comorbidities/coexisting injuries	Number of patients (n=11)
Coronary	3
Hypertension	5
Cerebrovascular	1
Renal insufficiency	0
Diabetes mellitus	4
Chronic obstructive pulmonary disease	0
Cerebral contusion	1
Pulmonary contusion	4
Multiple bone fractures	3
Solid organ laceration	2 (laceration of spleen in both patients)

ameter. Thus 11 patients, aged 26–80 years (mean age, 59±21 years), were qualified to receive endovascular treatment. Five patients with rAAA underwent EVAR, while four patients with traumatic TAI, one patient with thoracic aortic rupture due to a mycotic aneurysm and one with iatrogenic TAI underwent TEVAR.

Endovascular aortic repair

The mean aneurysm diameter in the rAAA patients was 65.5±12.17 mm, and all aneurysms involved the infrarenal aorta. The mean proximal neck length was 24.7±14.2, and the mean stent-graft diameter was 29.0±4.5 mm. The primary technical success rate for the EVAR was 80% (n=4). During one procedure, a type 1 endoleak developed. This patient was hemodynamically unstable at admission (BP <80 mmHg), but he responded to resuscitation, and hemodynamic status was stabilized before the procedure. The hemodynamic situation was worsened during the exploration of the CFAs of this patient. Therefore, we decided to use an AUI device to ensure rapid exclusion of the aneurysm. Immediately after the deployment of the stent-graft, a type 1 endoleak was detected due to the malpositioning of the stent-graft. An aortic cuff had to be advanced proximal to the main body and deployed between the origin of the lower renal artery and the main body of the stent-graft. During the control angiography, filling of the aneurysm sac was detected, and the hemodynamic situation of the patient deteriorated. An aortic occlusion balloon (Reliant, Medtronic Vascular) was advanced transfemorally to the supravisceral aorta, and he was resuscitated accordingly, but the patient did not respond and was lost. The mean EVAR operating time was 81±11.8 min.

Thoracic endovascular aortic repair

The primary technical success rate for TEVAR was 100%. Two of the traumatic TAIs were due to motorcycle accidents, and two were due to car accidents. The mean stent-graft diameter was 30.6±3.77 mm. The mean distance from the origin of the left SCA to the site of injury was 23.5±6.1 mm. The mean operating time was 75±10.5 min. In one patient, the left SCA had to be occluded to ensure adequate proximal graft fixation.

The mean time interval between clinical suspicion of aortic rupture and the repair procedure was 105 min (range, 76–120 min). The median stay in the intensive care unit was 2±15.9 days (range, 1–55 days).

Complications

The 30-day mortality rate was 27% (three out of 11 patients). One death occurred due to hemodynamic collapse during the procedure, as described above. One patient with a mycotic aneurysm of the thoracic aorta died eight days after the procedure because of septic complications. One patient with a rAAA, who had previously undergone coronary bypass surgery, died two days after the procedure because of cardiovascular complications.

One patient suffered from an intraoperative type 1 endoleak as described above. The patient with the iatrogenic TAI developed paraplegia after the procedure, most likely due to ischemic damage secondary to blockage of the arterial supply to the spinal cord (Table 2). In the early postoperative period, cerebrospinal fluid drainage was suggested to the patient, but he did not accept. He recovered in 12–18 months with minor motor and sensory weakness of the bilateral lower extremities, without any major deficits. None of the procedures required conversion to an open repair.

Follow-up

The eight patients were followed up for six to 24 months. The mean clinical follow-up was 8±5.6 months. No endoleaks or late ruptures were observed during the follow-up period. In all patients, the hematomas decreased in size and eventually resolved. The size of the abdominal aortic aneurysms also decreased in all patients. No reinterventions were needed for any patient.

Discussion

In our study 11 of the 15 patients (73%) were selected for endovascular treatment due to the hemodynamic situation and anatomic suitability. In most centers where endovascular treatment is available, the policy is to treat acute aortic injury patients with endovascular approach who are stable enough for CT angiography scanning (22). In most studies, the decision to treat patients with a rAAA or TAI is based on the hemodynamic situation of the patient at presentation to the hospital, anatomic considerations or logistic reasons, such as availability of adequate endovascular equipment and sufficiently trained staff (5, 7, 22). Optimal patient selection for EVAR requires a team including an interventional radiologist, vascular surgeon, emergency doctor, and anesthesiologist. The hemodynamic stability of the patient, any associated comorbidities and concomitant injuries, and the suitability of the vascular anatomy for endovascular repair should all be assessed as part of patient selection.

We performed CT angiography in all patients with a clinical suspicion

of aortic rupture whose hemodynamic situation was stable enough for preoperative evaluation. CT angiography is widely recommended for assessing the feasibility of the endovascular procedure and for the measurement of vascular diameters when the patient is relatively stable and is able to tolerate CT examination (4, 5). In our study we did not have to use additional stent-graft segments due to the exact sizing of the stent-grafts according to CT angiography measurements, except in one procedure in which an inadequate deployment occurred. The operating room can be prepared for an emergency procedure during the time needed to perform and evaluate the CT angiography (14, 16), and this approach was followed in the present study. One study suggests that intraoperative calibrated angiography should be used instead of CT angiography for patients who are in profound shock (7); however, the rupture site can be missed by DSA because of its limited two dimensional imaging capability. Additionally, we could not detect the rupture sites in DSA. Furthermore, angiography may lead to incorrect graft sizing due to a failure to identify thrombi or calcifications lining the graft landing zones (15). Holst et al. (23) suggested that preoperative CT angiography could delay treatment and is not mandatory in these patients and that this plays much less role in the outcome of these patients than previously believed. However, we believe that most patients with aortic rupture can undergo an emergent preoperative CT scan, and this CT scan is extremely useful for planning the procedure. These findings still need to be confirmed by prospective studies.

The technical success rate of EVAR for rAAA in this study was 80%. This success rate is compatible with the reported technical success rates in the literature. Technical success rates reported by Castelli et al. (16), Larzon et al. (24), and Alsac et al. (7) with similar patient groups are 100%, 93%, and 76.5%, respectively. The technical success rate of TEVAR was 100% in our study, which is also compatible with the outcomes of similar studies, in which the technical success rates of TEVAR for TAI were 83% to 100% (11, 25). However, it is important to keep in mind that our series included very few patients.

Table 2. Patients' demographics and postoperative complications

Age (years)	Gender	Diagnosis	Intraoperative complications	Postoperative complications
52	M	Iatrogenic (vertebral biopsy)	No	Paraplegia
82	F	Thoracic aortic rupture due to mycotic aneurysm	No	No
26	M	Traumatic thoracic aortic rupture	No	No
50	F	Traumatic thoracic aortic rupture	No	No
27	M	Traumatic thoracic aortic rupture	No	No
43	M	Traumatic thoracic aortic rupture	No	No
84	M	Ruptured abdominal aort aneurysm	No	No
80	M	Ruptured abdominal aort aneurysm	Type 1 endoleak	No
77	M	Ruptured abdominal aort aneurysm	No	No
65	M	Ruptured abdominal aort aneurysm	No	No
62	M	Ruptured abdominal aort aneurysm	No	No

F, female; M, male.

We used bifurcated devices to achieve a more anatomic reconstruction of rAAAs, although AUI systems have been advocated for the management of emergency cases (14, 16). An AUI device generally enables more rapid exclusion of the aneurysm, and the bleeding and the pressure in the aneurysmal sac can be rapidly controlled. However, this requires a successful femorofemoral bypass after the procedure.

A total percutaneous approach with closure devices can be used for endovascular repair of the aorta, which is feasible in the hands of experienced surgeons. It may shorten the duration of the preprocedural preparation of the CFAs. The reported technical success rates are high (26). The surgeon must be comfortable with obtaining percutaneous access and using closure devices in patients who might be hemodynamically unstable. At our institution, our experience with closure devices is limited, and the standard protocol is to perform the procedures with femoral artery exploration.

Recently, the resuscitation protocol for patients with aortic ruptures has changed. Aggressive volume resuscitation may cause a larger volume of bleeding and a markedly higher death rate. Thus, controlled hypotension is now advocated during the resuscitation of these patients to slow the bleeding and allow local clot formation (7, 16). Permissive hypotensive resuscitation is also used in our practice, which let us gain time for preprocedural imaging.

In recent studies, the reported proximal fixation lengths have ranged between 22 and 28.5 mm (27). In the current study, the mean distance between the orifice of the left SCA and the thoracic aortic rupture was 23.5±6.1 mm. However, when the landing zone is not adequate, the subclavian artery can be covered, and concomitant carotid-subclavian bypass is performed if needed (28).

One patient in this series with an iatrogenic TAI due to a vertebral biopsy subsequently suffered from paraplegia, which can occur in up to 10% of cases after emergency stent-graft placement in the thoracic aorta (29). These rates may be viewed favorably compared with those after open surgery, for which paraplegia rates of up to 14% have been reported (29). Previous abdominal aortic surgery, extensive graft coverage of the thoracic aorta (below T6), left SCA coverage, and perioperative hypotension are reported risk factors for paraplegia following TEVAR. Our patient had the risk factors of extensive graft coverage below T6 and perioperative hypotension. Management strategies

for this entity include mean arterial pressure augmentation with pharmacologic agents, cerebrospinal fluid drainage, fluid administration, and avoidance of high central venous pressure, anemia, and hypoxia (30).

Our 30-day mortality rate was 27% (three out of 11 patients). The 30-day mortality rates of EVAR and TEVAR for aortic ruptures have been reported as 10%–29% (15–17) and 0%–20% (11, 12, 14), respectively. These mortality rates are lower than the 30-day mortality rates of conventional open surgical repair of the aorta, which are up to 41% and 45% for EVAR and TEVAR, respectively (4–6). EVAR for rAAA avoids major surgical morbidities, decreases cardiorespiratory stress due to hypothermia and coagulopathy, decreases the incidence of ischemic reperfusion syndrome after conventional laparotomy, and minimizes blood loss (15, 16). The most important criterion influencing the mortality rate is the hemodynamic stability of the patient (22). This was emphasized by the current study, in which the only lost patient was one of the hemodynamically unstable patients. The problem occurred not only because of a technical failure during endovascular treatment but also because the patient was hemodynamically unstable, so there was limited time to resolve the endoleak. However, Visser et al. (22) confirmed that open surgical treatment of hemodynamically unstable patients may result in poorer clinical outcomes than endovascular treatment. Therefore, patient selection should not just be based on the hemodynamic status of the patient (22, 31). Two of the four patients who were excluded from endovascular repair and underwent open surgical treatment were hemodynamically unstable. The perioperative mortality of the surgical repair was 50%; both of the hemodynamically unstable patients were lost.

TEVAR shows encouraging short and long-term results when used to repair traumatic ruptures (32, 33). The Talent thoracic retrospective registry (18) reported the results from 113 patients with acute thoracic aortic pathology who were treated endovascularly. The in-hospital mortality rate was only 8% in this study. Mosquera et al. (34) studied 66 patients with acute thoracic aortic pathology and reported higher short and long-term survival rates in the endovascular treatment group than in the surgical and conservative groups.

EVAR is associated with technical difficulties that may limit its feasibility in some cases. One such difficulty is the large size of the devices (16–22 F) relative to that of the access artery. In particular, the CFA in young patients and patients with atherosclerosis may not be large enough to accommodate these devices (12, 29). However, this was not a problem in the patients with acute aortic rupture treated in the current study. Improvements in stent-graft design have decreased the size of the devices to 16 F, and these improvements are most likely going to resolve the size problem in the near future. Neck angulation, iliac artery tortuosity, and inappropriate aortic neck length are the other difficulties limiting the feasibility of EVAR. The chimney technique and fenestrated stent-grafts may solve the problem of inappropriate neck length in the hands of experienced endovascular specialists, but these techniques usually require long deployment periods, which is not acceptable for emergency procedures.

The mean time interval between clinical suspicion of aortic rupture and treatment in this study was 105 min (range, 76–120 min). This time interval included the patient transfer time, CT imaging and interpretation, recruitment of trained staff, procurement of adequate endovascular equipment in the hospital and surgical exploration of femoral arteries. Alsac et al. (7) reported an average delay of 43±9 min due to the CT scan procedure. Our time delay may be considered long, especially for these emergency cases, most likely related to the infrastructure of the hospital. These problems can be resolved by making dedicated personnel and equipment readily available around the clock and accelerating the decision-making processes.

Long-term follow-up of these patients is crucial to minimize the risk of late rupture and endoleaks. CT angiography is the recommended imaging modality for the follow-up of these patients (35).

The main limitation of the present study is that it was a single-center, retrospective, small case series. Therefore, any attempt at generalization must be undertaken with caution.

In conclusion, this small single-center experience confirms that endovascular treatment of aortic ruptures is feasible and safe in selected patients based on hemodynamic status and anatomic suitability. Endovascular aortic repair is evolving and offers the potential for improved mortality rates in acute aortic injuries. We think that reports of small centers are important because of the rarity of these emergent pathologies and the fact that the transfer of aortic rupture patients to a referring center is not usually possible. Widespread utilization of endovascular treatment options, made possible by the availability of a trained and experienced endovascular team and the required equipment, could be lifesaving, especially for these emergent patients.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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