Clinical Report

Intraoperative rupture of an abdominal aortic aneurysm during an endovascular stent-graft procedure

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Purpose: To highlight the risk of intraoperative rupture as a complication of endovascular aortic repair.

Clinical features: An 81-yr-old man was admitted for endovascular aortic repair of a 6 cm infrarenal abdominal aortic aneurysm. After establishment of a conduction blockade using a combined spinal-epidural technique, a balloon-activated endovascular stent-graft was advanced to the proximal aneurysmal neck. Approximately four minutes after the stent-graft was deployed, the mean arterial pressure decreased to 30 mmHg and the heart rate increased to 135 bpm. While fluid and vasoactive medications were administered and the airway was secured, repeat aortography confirmed contrast extravasation into the retroperitoneal space at the junction of the proximal aortic neck and the aneurysm sac. The angioplasty deployment balloon was repositioned and inflated proximal to the presumed site of aortic rupture, thus providing aortic control until an open repair of the aorta was undertaken.

Conclusion: Although endovascular stent-graft placement may be a less invasive method than conventional open aortic reconstruction, it must be recognized that the potential for devastating consequences such as aortic rupture is present.

Objectif : Souligner le risque de rupture peropératoire comme complication d'une réparation aortique endovasculaire.

Éléments cliniques : Un homme de 81 ans a été admis pour la réparation aortique endovasculaire d'un anévrisme infrarénal de l'aorte abdominale. Après avoir établi un bloc de conduction selon une technique rachidienne et péridurale combinée, un greffon-tuteur endovasculaire, activé par un ballonnet, a été introduit jusqu'au collet proximal de l'anévrisme. Environ quatre minutes après le déploiement du greffon-tuteur, la tension artérielle moyenne a chuté à 30 mmHg et la fréquence cardiaque a augmenté à 135 bpm. Pendant l'administration de liquide et de médicaments vasoactifs et les manoeuvres visant à assurer la liberté des voies aériennes, l'aortographie répétée a confirmé une extravasation de contraste dans l'espace rétropéritonéal à la jonction du collet aortique proximal et du sac anévrisimal. Le ballonnet a été remplacé et gonflé près du site présumé de la rupture aortique, permettant ainsi de préserver l'aorte jusqu'à ce qu'une réparation chirurgicale soit réalisée.

Conclusion : Bien que la mise en place d'un greffon-tuteur endovasculaire soit moins effractive que la reconstruction aortique chirurgicale habituelle, il faut reconnaître la présence potentielle de graves conséquences, comme une rupture aortique.

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ENDOASCULAR stent-graft repair is currently being evaluated as an alternative to open surgery in the treatment of abdominal aortic aneurysms (AAA).^{1,2} While this procedure is generally less invasive than conventional aortic surgery, positioning and deployment of an endograft in an aorto-iliac system which contains extensive luminal pathology may be associated with unique challenges. In this report, we present a case of acute rupture of the aorta during the deployment of a balloon-expandable endograft that was successfully managed by temporary aortic balloon occlusion in preparation for immediate conversion to open repair of the aortic aneurysm.

Case Report

An 81-yr-old man was admitted for repair of a 6 cm infrarenal AAA. Past medical history included stable angina, previous myocardial infarction, ischemic cardiomyopathy, and hypertension. He had a history of a recent sigmoid resection for diverticulitis, which was complicated by an anastomotic failure and peritonitis. Six years ago, he underwent coronary artery bypass surgery which was without complications. Medications included digoxin, transdermal nitroglycerin, atenolol, lisinopril, furosemide, amlodipine, and aspirin (which was discontinued one week prior to surgery). He was a former smoker and had limited exercise tolerance. There was no family history of anesthetic complications. Physical examination was unremarkable except for mild obesity and a palpable, pulsatile abdominal mass. Laboratory examination and chest radiography did not reveal any abnormalities. Electrocardiogram showed normal sinus rhythm with left axis deviation and left bundle branch block. Transthoracic echocardiography revealed a dilated left ventricle with an ejection fraction of 25% and an exercise thallium test showed irreversible and reversible deficits.

After discussion of options and attendant risks associated with the severe medical comorbidities, endovascular repair of his abdominal aortic aneurysm was offered and selected. The procedure was performed in accordance with Institutional Review Board guidelines under an Investigational Device Evaluation protocol from the United States Food and Drug Administration. In the operating room, standard monitors were placed and the right radial artery and right internal jugular vein were cannulated for arterial pressure monitoring and pulmonary artery catheterization, respectively. Because of the ischemic cardiomyopathy, we did not wish to administer systemic anesthetics that would adversely effect the patient's ventricular function. Since only a relatively small segmental area of

anesthesia was necessary for the surgical procedure, regional anesthesia was planned. The epidural space was identified by loss of resistance technique at L₃₋₄. A 25 G Whitacre spinal needle was advanced through the 18 G Tuohy needle and 14mg tetracaine 1% with an equal volume of dextrose 7.5% was placed in the subarachnoid space to provide perioperative anesthesia. The spinal needle was removed, and an epidural catheter was inserted. A T₈ sensory level was achieved. After sterile preparation of the operative field, both femoral arteries were isolated for device insertion, and an angiogram was performed to define the aneurysm and its relationship to the renal vessels. Under fluoroscopic guidance, a balloon expandable endovascular graft was advanced as a unit transfemorally over a stiff guide-wire into the calcific aorta in an attempt to position it infrarenally so as to exclude the aneurysm.

The endograft was deployed by inflation of a coaxially placed angioplasty balloon. In order to ensure exact placement and to avoid distal migration of the stent-graft, temporary third degree AV block with asystole was induced using 24 mg adenosine *iv* via the central venous circulation.³ This dose of adenosine provided approximately 15 sec high degree AV block with an average mean arterial pressure of 20 mmHg. During this period of ventricular asystole, the angioplasty balloon was inflated to fix the attachment system to the proximal neck of the aorta above the aneurysm. After the ventricular asystole, the baseline hemodynamic state returned within 10 sec. After deployment, additional angiograms were performed to assess the placement of the stent-graft and to rule out the presence of an endoleak (continued blood flow from the central aorta into the aortic aneurysm at the margin of the endovascular stent-graft).

Approximately four minutes after the stent-graft was deployed, the mean arterial pressure decreased precipitously to 30 mmHg with concomitant development of sinus tachycardia (heart rate of 135 bpm). The patient was placed in Trendelenburg position and fluids and boluses of phenylephrine were administered to provide hemodynamic support. The patient became lethargic, ventilation was assisted and eventually controlled, and the trachea was intubated, facilitated by 10 mg etomidate and 100 mg succinylcholine *iv*. Anesthesia was maintained with O₂, fentanyl, scopolamine, and isoflurane as tolerated. Repeat aortography confirmed contrast extravasation at the junction of the proximal aortic neck and the aneurysm sac. The angioplasty deployment balloon was repositioned and inflated proximal to the presumed site of aortic rupture, thus providing aortic control while immediate preparation was made for conversion to open repair of the aorta.

Because of continued hemodynamic lability and the patient's history of dilated cardiomyopathy, transesophageal echocardiography was performed which demonstrated a moderately depressed and dilated left ventricle. Epinephrine, 25 - 200 ng·kg⁻¹·min⁻¹, and phenylephrine, 0.25 - 1 µg·kg⁻¹·min⁻¹, were started and titrated to provide cardiovascular support. When hemodynamically appropriate, 0.5 - 2 µg·kg⁻¹·min⁻¹ nitroglycerin was added to treat presumptive myocardial ischemia as evidenced by the patient's regional wall motion abnormalities.

Retroperitoneal exposure of the aorta allowed transition from balloon to clamp control of the aorta at the proximal aortic neck of the aneurysm above the device. After aortotomy, a rupture of the posterolateral aspect of the aorta was identified. The aorta and the aneurysm were repaired using a bifurcated dacron Hemashield graft extending from the infrarenal aorta to the femoral arteries. Total aortic occlusion time was 100 min. Fluid resuscitation was continued during the operative period, and the patient's hemodynamic parameters improved.

After the aorta was repaired, the patient was brought to the ICU with his trachea intubated, sedated and hemodynamically stable. Over the next few days the patient was weaned from inotropic support. His postoperative course was complicated by non Q-wave myocardial infarction, ischemic colitis, prolonged respiratory support, as well as renal insufficiency not requiring hemodialysis. The patient was eventually discharged to a rehabilitation facility.

Discussion

Endovascular stent-graft placement is currently being evaluated as an alternative to open surgical technique to repair AAA.⁴ The theoretical advantages of this technique over conventional repair of abdominal aortic aneurysms via laparotomy include: (1) a less invasive procedure thus allowing the use of local or regional anesthesia; (2) a short period of aortic occlusion during graft placement, thereby eliminating the hemodynamic effects of aortic occlusion; (3) less hemodynamic and metabolic stress related to aortic dissection; (4) earlier ambulation and discharge of the patient; and (5) reduced cost. Brewster *et al.* described reduced blood loss, ICU recovery period, and hospital stay in patients undergoing endovascular aortic repair compared with patients undergoing conventional aortic reconstruction.⁵ Although the incidence of complications did not differ between groups, the complications associated with endovascular repair tended to be local and easily treated, while the complications associated with conventional reconstruction were systemic and more severe.

Although endovascular stent-graft repair of AAA may be a less invasive alternative to conventional open repair of AAA, the procedure is still in its early stages of evaluation and is associated with many challenges. Acute complications related to endovascular stent-graft placement include: (1) migration or malpositioning of the stent-graft with the possibility of subsequent vessel occlusion or incomplete aneurysm exclusion; (2) distal embolization of arterial plaque or thrombus; (3) abdominal, pelvic or lower extremity ischemia; and (4) acute aortic disruption.⁶ This case describes the anesthetic and operative management of acute aortic rupture following endovascular stent-graft repair leading to emergent operative repair of an AAA.

Because of the possibility of acute intraoperative aortic rupture, the anesthesiology team must be prepared for rapid and extensive fluid resuscitation; this preparation should include the presence of large bore intravenous access, the availability of rapid fluid infusion systems, direct arterial pressure monitoring, and the consideration of central venous monitoring in order to detect early acute changes in preload. Inotropic and vasodilating agents are prepared prior to the case and blood should be immediately available. The use of a central venous catheter *vs* a pulmonary artery catheter is dictated by the patients' concomitant diseases. In the present case, transesophageal echocardiography provided a dynamic assessment of ventricular function; however, this modality would not be appropriate during a regional anesthetic.

In the case of intraoperative iatrogenic aortic rupture, laparotomy may be necessary in order to obtain immediate surgical control. As a temporizing measure, a balloon catheter used for device deployment was immediately re-inflated proximal to the presumed site of aortic rupture. This inflated balloon achieved immediate aortic occlusion controlling hemorrhage and improving hemodynamic stabilization prior to surgical exploration.

The differential diagnosis of acute hypotension after endovascular stent-graft deployment include sympathectomy secondary to conduction blockade by local anesthetics, acute aortic rupture, allergic reaction to angiographic contrast material, or a side effect of adenosine used during endovascular stent-graft deployment. Sympathectomy was unlikely since local anesthetics were not administered through the epidural catheter. The patient had had no previous reaction to contrast media, nor did he manifest any symptoms that were consistent with an acute anaphylactic or anaphylactoid reaction. Adenosine may result in peripheral dilation or hypotension due to high degree AV block. Alternatively, adenosine may cause a brief period of

myocardial ischemia secondary to coronary steal or hypotension with subsequent myocardial pump failure with possible hemodynamic changes. These effects of adenosine are usually short lived (approximately 10-40 sec) and rare. Since the patient's hemodynamic parameters temporarily returned to normal values prior to later decompensation, we felt that adenosine was an unlikely cause for the observed hypotension. The combination of the rapid time course of the hypotension and tachycardia, the temporal relationships to device deployment, and corroborating angiographic evidence made aortic rupture the obvious cause of the patient's acute hypotension.

In this case report, we described the perioperative course of endovascular aortic aneurysm repair complicated by acute perioperative aortic rupture. Although endovascular surgical repair is a less invasive procedure, the possibility of this potentially life threatening complication must be considered during the perioperative period.

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