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Overdrive pacing for endovascular repair of an aortic arch aneurysm

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Abstract
The endovascular treatment of aortic arch aneurysms is a relatively new technique and is associated with significant surgical and anesthetic challenges. We report a case of a 77-year-old patient with an aortic arch aneurysm at the level of the isthmus, measuring 4.9 × 6.5 cm. The aneurysm involved the origin of the left subclavian and vertebral arteries. The arch was of the bovine type and the left vertebral artery came directly off the aorta. The patient underwent an uneventful open left carotid-to-subclavian bypass several days before the aortic repair. During the endovascular surgery, a stent-graft was deployed just distal to the innominate trunk. Endoleak was noted at the inferior aspect of the stent-graft, which failed to seal with placement of an extension stent-graft. The surgeon then chose to employ a Palmaz stent, to seal the endoleak. Balloon expansion in the ascending aorta was required in order to properly seat the Palmaz stent. Overdrive pacing at a rate of 220 beats·min^{-1}, which lowered the systolic blood pressure (SBP) to 40s mmHg was used during this process after connecting the patient to a Zoll defibrillator with external pads. The Palmaz stent was successfully deployed at the proximal end of the previously deployed stent-graft, using a Tyshak balloon. The patient reverted to normal sinus rhythm with no evidence of ischemia at the conclusion of the overdrive pacing. No endoleak was appreciated after the Palmaz stent was placed.

Key words Overdrive pacing · Endovascular repair · Aortic arch aneurysm

Introduction

The endovascular repair of an aortic aneurysm was first described in 1991, and since then there has been an increasing trend to apply this technology to progressively more complicated pathologies [1,2]. Endovascular treatment of aortic arch aneurysms is relatively rare, and to our knowledge may only be done in a very few centers. Significant surgical and anesthetic challenges are inherent in this type of surgery. We report a case of a patient with an aortic arch aneurysm that was repaired using an endovascular approach. During this surgery we encountered several unique challenges in hemodynamic management, which we report here.

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Case description

A 77-year-old man with history of hypertension, hyperlipidemia, tobacco abuse, and coronary artery disease with remote myocardial infarction presented for endovascular repair of a large aortic arch aneurysm. A thoracic computerized axial tomography (CAT) scan showed a saccular aortic aneurysm at the level of the isthmus, measuring 4.9 × 6.5 cm. The aneurysm involved the origin of the left subclavian and vertebral arteries (Fig. 1). The arch was of the bovine type (the second most common type of aortic arch, with the left common carotid artery sharing a common origin with the innominate artery) [3], and the left vertebral artery came directly off the aorta. A preoperative dobutamine-stress-echo showed a reversible ischemic area in the apex and inferior septum, and a fixed defect of the posterior wall consistent with a previous myocardial infarction. This was unchanged from a previous study several years ago. The patient was able to walk 3 miles (4.8 km) with no angina, and was felt to be optimized for surgery by his cardiologist. Several days prior to the aorta repair the patient underwent an uneventful open left carotid-to-subclavian bypass under general anesthesia.

On the day of the endovascular surgery, the patient was brought to the operating room, where standard American Society of Anesthesiologists monitors plus invasive blood pressure monitoring were started before induction of general anesthesia. Induction was achieved

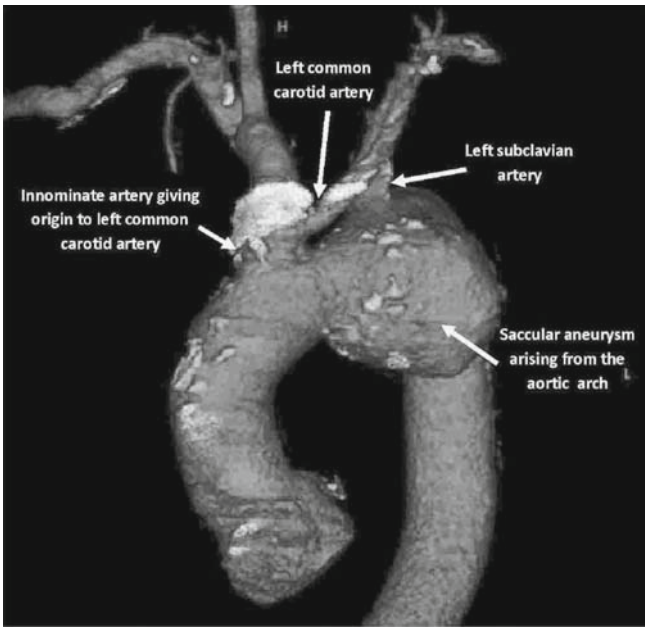

Fig. 1. Reconstructed three-dimensional (3D) image of the aortic arch aneurysm

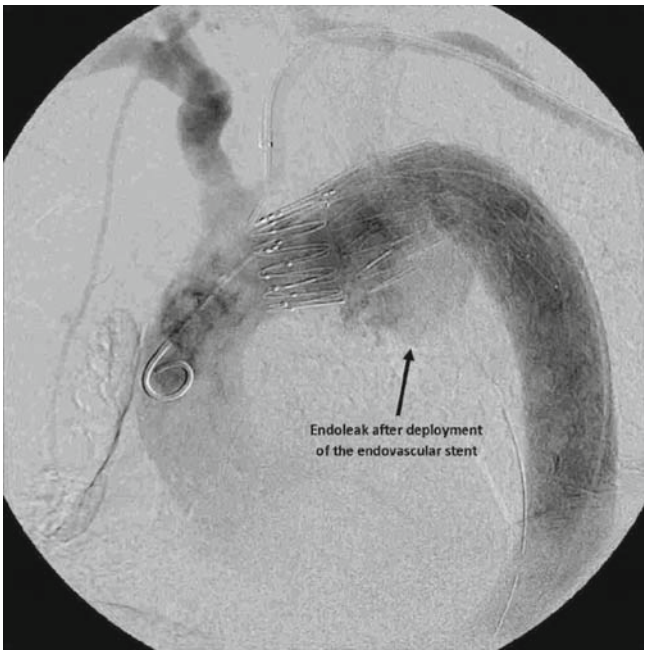

Fig. 2. Endoleak after placement of the endovascular stent-graft

using fentanyl, thiopental, and rocuronium and the patient's trachea was intubated without difficulty while maintaining stable hemodynamics. The patient was mechanically ventilated, using volume controlled ventilation with 50% oxygen in air, and anesthesia was maintained using isoflurane titrated to a bispectral index of 40–60. Wide-pore central venous access, using a 9-French multi access cather (MAC) was achieved after intubation for possible rapid transfusion and/or vasoactive medication use intraoperatively. A rapid transfuser (Belmont Rapid infuser; Belmont Instrument Corporation, Buston, MA, USA) was set up and made ready in the operating room to help with fluid and blood transfusion especially in case of massive bleeding. The surgeon deployed a stent-graft just distal to the innominate trunk. Endoleak was noted at the inferior aspect of the stent-graft, with delayed filling of the aneurysmal sac (Fig. 2). The surgeon then deployed an extension stent-graft in an attempt to seal the leak, but without success. The surgeon then chose to employ a Palmaz stent, which has greater radial force than the stent-graft, to seal the endoleak. Balloon expansion was required in order to properly seat the Palmaz stent.

Inflating an occluding balloon in the ascending aorta for this purpose was impossible without cessation of aortic blood blow. The option to use adenosine to provide a brief asystole was considered, but the rapid and unpredictable kinetics of adenosine were deemed unacceptable. We decided to overdrive pace the heart at a ventricular rate high enough to significantly lower the cardiac output for a controlled period of time. The patient was connected to a Zoll defibrillator with external pads. A venous pacer wire was introduced through the left femoral vein. Several brief episodes of overdrive pacing (<30 s) were employed to adequately seat the Palmaz stent (Palmnz Stent, Cordis Corporation, Bridge Water, NJ, USA. the Palmaz Balloon-Expandable Stent is a stainless steel, expandable, wire-mesh tube, mounted over a balloon on the end of a long thin flexible tube called a delivery catheter) at the proximal end of the previously deployed stent-graft, using a Tyshak balloon (Tyshak II & Brawn Medical Inc., Bethleham, PA, USA. the Tyshak balloon dilatation catheter is a coaxially constructed catheter with a distally mounted noncompliant balloon which exhibits an extremely low profile) (Fig. 3). Overdrive pacing at a rate of 220 beats·min^{-1} lowered the systolic blood pressure (SBP) to 40s mmHg, during which the arterial trace showed no evidence of cardiac output. The duration of asystole corresponded exactly to the duration of overdrive pacing during each episode. The patient reverted to normal sinus rhythm with no evidence of ischemia at the conclusion of each episode of overdrive pacing. No endoleak was appreciated after the Palmaz stent was placed. The left subclavian artery was then coiled, using two Nestor coils, to prevent retrograde blood flow into the aneurismal sac through the subclavian artery, which can lead to type II endoleak. Figure 4 shows a picture of the aortic arch after the complex endovascular repair was completed.

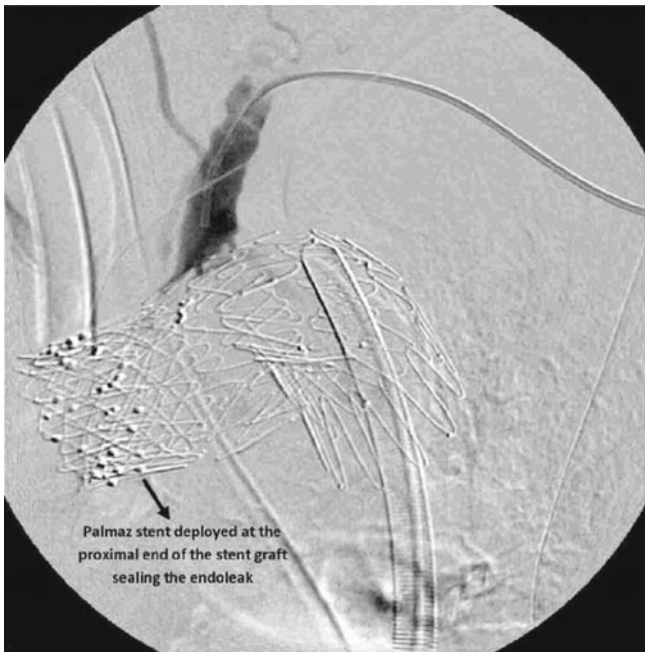

Fig. 3. Aortic arch after placement of the Palmaz stent

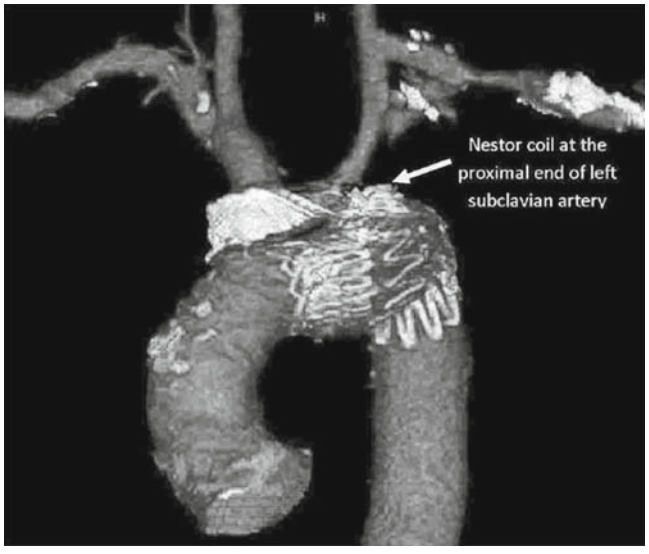

Fig. 4. Reconstructed 3D image of the aortic arch after completion of the endovascular repair

Discussion

The endovascular repair of aortic arch aneurysms is a promising surgical technique which may significantly reduce perioperative morbidity and mortality [1,2]. In the case presented here, the only other surgical option was to perform a conventional open repair under deep hypothermic cardiac arrest with all the inherent risks of this type of procedure.

Endovascular graft treatment for aortic arch aneurysms may be complicated by the variations in patient anatomy and the need to temporarily stop aortic blood flow. Adenosine has been employed to provide a temporary asystole, though the duration is typically short and unpredictable. Induction of temporary ventricular fibrillation followed by external defibrillation has also been used in this setting. Overdrive ventricular pacing for aortic arch stent graft placement may be an attractive alternative in patients requiring a longer and more predictable period of asystole [4–6]. The decision to use overdrive pacing should be based on mutual agreement of both the surgeon and the anesthesiologist. The anesthesiologist should be aware of the potential risks and complications with this technique, such as myocardial infarction (MI) or stroke. Careful follow up in the postoperative period is mandatory and should include early neurological examination, pre- and postoperative electrocardiograms (EKGs), and serial cardiac enzymes.

References

1. Saccani S, Busy M, Frantic C, Agostinelli A, Borrello B, Nicolini F, Gherli T. Surgical repair and stent positioning for type A acute aortic dissection: a step forward? Ann Thorac Surg. 2005;79: 1761–3.
2. Brueck M, Heidt MC, Szente-Varga M, Bandorski D, Kramer W, Vogt PR. Hybrid treatment for complex aortic problems combining surgery and stenting in the integrated operating theater. J Intervent Cardiol. 2006;19:539–43.
3. Layton KF, Kallmes DF, Cloft HJ, Lindell EP, Cox VS. Bovine aortic arch variant in humans: clarification of a common misnomer. Am J Neuroradiol. 2006;27:1541–2.
4. Vankawala V. Markabawi B. Dainiak S. Werner M. Hager WD. Farrel W, Katz AM, Silverman DI. Left ventricular function in atrial fibrillation during overdrive pacing. Am Heart J. 2002;143: 827–32.
5. Carlson MD. Ip J. Messenger J. Beau S. Kalbfleisch S. Gervais P. Cameron DA, Duran A, Val-Mejias J, Mackall J, Gold M. Atrial Dynamic Overdrive Pacing Trial (ADOPT) Investigators. A new pacemaker algorithm for the treatment of atrial fibrillation: results of the Atrial Dynamic Overdrive Pacing Trial (ADOPT). J Am Coll Cardiol. 2003;42:627–33.
6. Taneja T. Kadish AH. Parker MA. Goldberger JJ. Acute blood pressure effects at the onset of supraventricular and ventricular tachycardia. Am J Cardiol. 2002;90:1294–9.