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◆ CLINICAL INVESTIGATION ◆

Combined Cardiac Surgery and Endovascular Repair of Abdominal Aortic Aneurysms

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Purpose: To report an initial experience of concomitant endovascular repair of abdominal aortic aneurysms (AAA) and cardiac surgery.

Methods: Records for 10 consecutive patients (all men; median age 68 years, range 60–79) with AAA treated by a multidisciplinary team at a tertiary specialist center were retrospectively reviewed. Each patient had independent indications for surgical correction of their cardiac disease and AAAs. The patients underwent endovascular aneurysm repair (EVAR) followed by cardiac surgery under the same anesthesia. Eight patients had concomitant coronary artery bypass grafting (CABG; 4 off-pump), 1 patient had CABG and left ventricular aneurysmectomy, and 1 patient required aortic root replacement.

Results: All combined procedures were performed successfully under a single general anesthesia and took a median of 508 minutes (range 425–625). Median intensive care stay was 3 days (range 2–4), while hospital stay was 8 days (range 7–21) days. There were no deaths in-hospital or within 30 days. Complications were minor and self-limiting; there were no instances of renal failure. At a median follow-up of 29 months (range 14–38), no EVAR-related secondary interventions were required.

Conclusion: Concomitant EVAR and cardiac surgery delivered by a multidisciplinary team is feasible, appears safe, and eliminates the risk associated with staged operations. Improved patient satisfaction and efficient use of resources are potential advantages.

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Key words: abdominal aortic aneurysm, coronary artery disease, coronary artery bypass graft, endovascular aneurysm repair, cardiopulmonary bypass

Cardiac disease is common in patients undergoing abdominal aortic aneurysm (AAA) repair,^{1–3} and the dual pathology is responsible for mortality in both the perioperative period and during late follow-up.⁴ While the role of routine preoperative coronary revascularization (or other cardiac procedures) solely to prevent the morbidity and mortality of vascular surgery is limited,⁵ a proportion of patients with large AAAs present with inde-

pendent indications for cardiac surgery, most often coronary artery bypass grafting (CABG). Such instances create a specific dilemma. If cardiac surgery is performed first, there is a risk of aneurysm rupture in the perioperative period in >10% of patients.^{6,7} On the other hand, aneurysm repair ahead of cardiac surgery creates a higher risk of perioperative cardiac complications. These events may be avoided by performing cardiac and aortic

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TABLE

Details of 10 Patients Undergoing Combined Cardiac Surgery and EVAR

Age, y	Cardiac Disease	AAA Size, mm	Cardiac Procedure	LOP, min	LOS, d
66	2-vessel CAD	72	CABG ×2	470	8
68*	3-vessel CAD	73	CABG ×2	625	9
76	2-vessel CAD	55	CABG ×2	425	8
61	3-vessel CAD	57	CABG ×3	535	9
71	3-vessel CAD	73	CABG ×3	480	7
60	3-vessel CAD	57	CABG ×3	470	12
78	3-vessel CAD	61	CABG ×3	580	10
79	2-vessel CAD	63	CABG ×2	470	8
68	LAD stenosis, LV aneurysm	62	CABG ×1 aneurysmectomy	565	21
62	AR, aortic root dilation	55	Root and aortic valve replacement	610	7

EVAR: endovascular aneurysm repair, CAD: coronary artery disease, LAD: left anterior descending, LV: left ventricle, AR: aortic regurgitation, AAA: abdominal aortic aneurysm, CABG: coronary artery bypass graft, LOP: length of procedure. LOS: length of stay.

* This patient also underwent left common femoral artery replacement and external iliac artery angioplasty.

surgery simultaneously. Combined open AAA repair and CABG has been reported with mixed results.^{8–11} Endovascular aneurysm repair (EVAR) is an established treatment modality for patients with suitable anatomy and is associated with lower mortality and morbidity compared with open repair.¹¹ In patients with large AAAs who also require cardiac surgery, EVAR offers an opportunity for combined surgery. This article presents an initial experience of combined EVAR and cardiac surgery in suitable patients with independent indications for each procedure.

METHODS

A retrospective analysis was performed of all patients who underwent concomitant EVAR and cardiac surgery in our institution between April 2006 and January 2010. During that interval, 10 men (median age 68 years, range 60–79) with 1, 2, or 3-vessel coronary artery disease and varying AAA sizes (Table) underwent EVAR and cardiac surgery under one anesthesia. Indications for treatment were established at a multidisciplinary meeting (including cardiac/vascular surgeons, radiologists, and cardiologists) according to contemporary evidence.^{12–14} Patients underwent surgery in a dedicated hybrid cardiovascular operating theatre (Allura Xper FD20; Philips Healthcare, Best, The Netherlands) equipped to undertake digital subtraction

angiography-guided intervention and conventional cardiac surgery as previously described.¹⁵ In all patients, EVAR was performed first followed by cardiac surgery under general anesthesia.

EVAR was planned on 3D image analysis of arterial phase computed tomography (CT) scans. Access was achieved via bilateral femoral artery exposure, and Zenith endografts (William Cook Europe, Bjaeverskov, Denmark) were deployed in all cases. For CABG, the preference was for a left internal mammary artery to the left anterior descending artery graft where appropriate, followed by either radial artery or greater saphenous vein to other vessels, depending on coronary anatomy, patient factors (including conduit quality), and surgeon's preference. The choice between on-pump and off-pump surgery was also according to surgeon's preference.

For on-pump surgery, cardiopulmonary bypass was established before cardiac arrest was induced with a single shot of antegrade cold blood cardioplegia followed by retrograde cold blood. Arrest was maintained with retrograde cardioplegia boluses every 20 minutes, and passive hypothermia (to 34°C) was allowed. For off-pump bypass, hearts were positioned and stabilized using deep pericardial sutures as well as an Octopus device (Medtronic, Minneapolis, MN, USA). Following coronary arteriotomy, shunts of appropriate size were inserted, and the distal

anastomoses were constructed with the aid of a CO₂ blower for visualization. Proximal anastomoses were completed following side clamping of the ascending aorta. Root replacement was performed using a modified Bentall-type procedure with reimplantation of coronary buttons.¹⁶

Following discharge, patients were entered into a structured post-EVAR surveillance that included plain radiography according to a standard protocol at discharge, contrast-enhanced CT and duplex sonography at 1 month, and annual duplex and plain radiography.¹⁷ CT scans were used selectively after the first scan at 1 month.

RESULTS

EVAR was successfully performed in all patients according to plan with no graft-related endoleaks at completion in any patient. One patient with disabling left leg claudication also underwent a planned reconstruction of an occluded left common femoral artery and left external iliac angioplasty with stent insertion. Eight patients underwent concomitant CABG (4 off-pump), 1 patient had CABG and left ventricular aneurysmectomy, and 1 patient required aortic root replacement (Table).

All combined procedures were performed under a single general anesthesia and took a median of 508 minutes (range 425–625). Median intensive care stay was 3 days (range 2–4), while hospital stay was 8 days (range 7–21). Two of 10 patients sustained atrial fibrillation, and 1 patient developed postoperative ileus, which settled with conservative management. One patient developed a lower respiratory tract infection that resolved with antibiotics. In 1 patient, creatine kinase (CK) levels rose to 193 U/L on day 1, with no electrocardiographic (ECG) changes or symptoms and no need for inotropes; echocardiography was also unremarkable. There were no instances of renal failure.

At a median follow-up of 29 months (range 14–38), no EVAR-related secondary interventions were required; the patient with claudication needed a further external iliac artery angioplasty for recurrent symptoms. All patients were alive at the time of their last EVAR

surveillance appointment and free from major complications of EVAR.

DISCUSSION

Our experience demonstrates the feasibility of combined cardiac surgery and EVAR in patients with independent indications for both. No perioperative mortality was observed in any of the patients treated in our institution, suggesting that the simultaneous performance of EVAR does not substantially increase the perioperative risk. Postoperative recovery times also appear to be similar to those of cardiac surgery alone. This contrasts favorably with published experience of combined cardiac surgery and open aortic surgery, probably due to the minimally invasive nature of EVAR. Credible comparisons with a control group of sequential treatment were, however, not attempted due to the small sample size.

Every patient presenting with simultaneous indications for cardiac surgery and an AAA >55 mm in diameter was considered for simultaneous treatment, which was carried out in all patients in whom the aneurysm was anatomically suitable for EVAR. A collaborative multidisciplinary team comprised of vascular and cardiac surgeons, cardiologists, radiologists, and anesthesiologists is essential for correctly identifying these patients and carrying out the combined procedure safely. From our experience it would appear that the need for such simultaneous treatment is relatively rare.

Our reason for performing EVAR first is because of the relatively higher risk of hemodynamic instability after cardiac surgery, potentially precluding subsequent EVAR in a proportion of patients and thus risking postoperative aneurysm rupture. Some may argue that this approach creates a risk of myocardial ischemia during EVAR. Reassuringly, only one patient displayed a small CK rise postoperatively, but no symptoms or ECG changes.

Local conditions could have influenced the favorable outcomes noted in this series. The presence of a team that is highly experienced in EVAR and the availability of a dedicated hybrid operating theatre with high-quality

fixed imaging equipment specifically designed for complex endovascular and hybrid procedures could have played a role in the favorable outcomes noted. It was possible to minimize the volume of radiographic contrast material used intraoperatively due to the high quality of the imaging equipment and also by using contrast diluted to half strength for hand-injected angiographic sequences, e.g., for the demonstration of the iliac artery bifurcation.

From a patient perspective, the simultaneous correction of two serious surgical pathologies and shorter time spent in recuperation may be attractive. There also appears to be a potential for saving healthcare costs.

Conclusion

Concomitant EVAR and cardiac surgery for patients with dual pathology is feasible and appears safe; it eliminates some risks of a staged approach, such as perioperative myocardial ischemia (if EVAR is performed first) or postoperative AAA rupture (if cardiac surgery is performed first). Potential advantages, such as reduction of healthcare costs and increased patient satisfaction, suggest that further evaluation is appropriate.

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