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Case Report

Ruptured Abdominal Aortic Aneurysm Treated by Double-Balloon Technique and Endovascular Strategy: Case Series

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Purpose: Mortality in patients with ruptured abdominal aortic aneurysms (rAAAs) has remained high despite advances in interventions. Endovascular aneurysm repair (EVAR) was recently developed for treatment of rAAAs. In this study, we assessed our endovascular strategy including a double-balloon technique for rAAA.
Methods: We analyzed 12 consecutive patients with rAAAs who were treated by our double-balloon technique and endovascular strategy from March 2013 to July 2016.
Results: The 30-day and 1-year mortality rates were both 17%. The mean times from admission to arrival at the hybrid operating room, from admission to aortic occlusion, and from admission to completion of EVAR were 46.8, 63.5, and 110.0 minutes, respectively.
Conclusion: This study indicates that the herein-described double-balloon endovascular technique is feasible for use in the management of rAAA.

Keywords: ruptured abdominal aortic aneurysm, endovascular aneurysm repair, intra-aortic balloon occlusion

Introduction

A ruptured abdominal aortic aneurysm (rAAA) is a catastrophic cardiovascular emergency with a high fatality rate in the absence of intervention. Despite therapeutic advances, the 30-day mortality rate has remained high at approximately 30%–50%,[1–4] especially for patients with more than one risk factor on the Hardman index.[5]

Endovascular aneurysm repair (EVAR) is a therapeutic modality for rAAA. A recent study showed that when compared with open surgery, EVAR was associated with lower mortality and a shorter duration of hospitalization for hemodynamically unstable patients with rAAAs.[4] However, some researchers have questioned the benefits of EVAR.[1–3]

Percutaneous intra-aortic balloon occlusion (IABO) is often used as an emergency procedure to control hemorrhage in patients with rAAA because it can be applied rapidly and with fewer hemodynamic risks in patients who are in shock. However, the efficacy of IABO for the treatment of rAAA has not been clarified.[6]

In contrast, EVAR is a newer treatment modality that shows considerable potential for advancement as endovascular techniques evolve. However, the technical strategy of emergency EVAR for rAAA has not been thoroughly assessed.

In this study, we evaluated the usefulness of a technical strategy involving the combination of IABO and EVAR for improving mortality in patients with rAAA.

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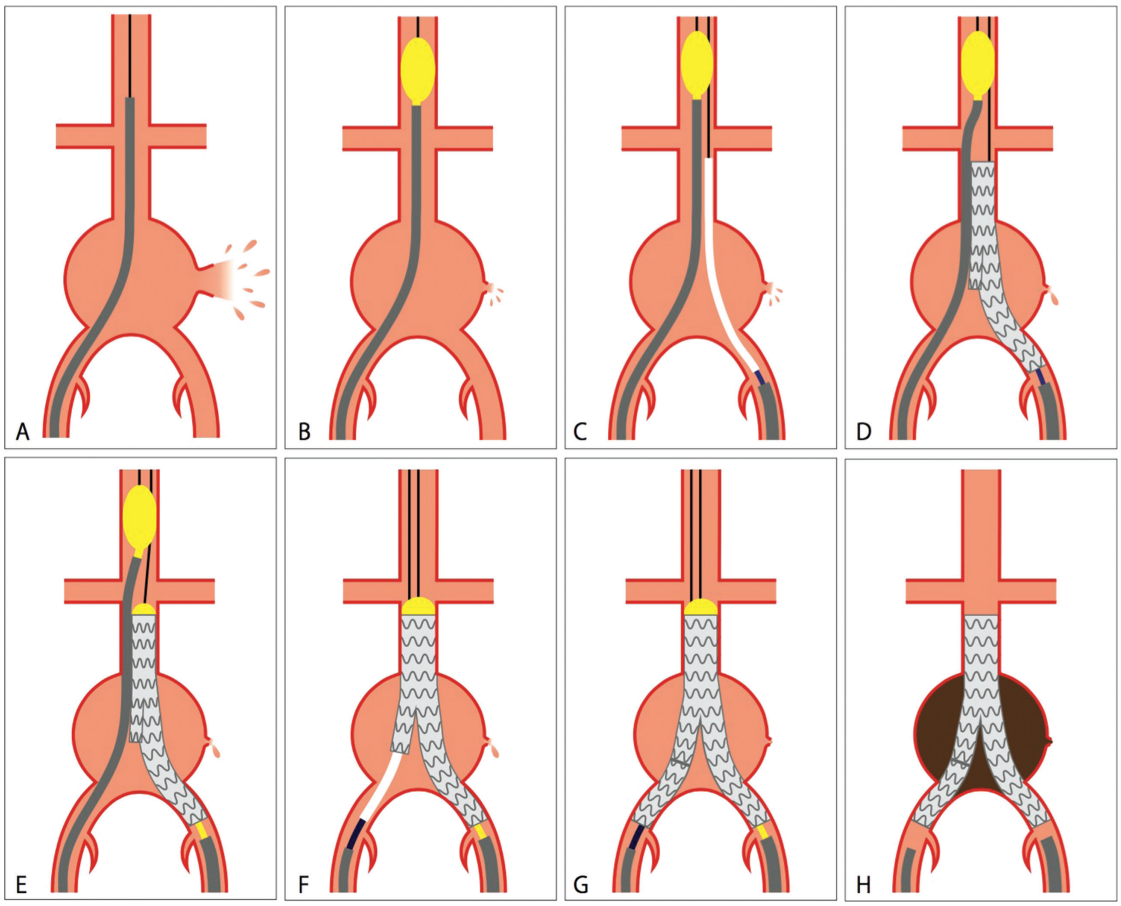

Fig. 1 Double-balloon technique for ruptured abdominal aortic aneurysm. An occlusion balloon is inserted via one side, supported by a stiff wire and sheath (**A** and **B**) for intra-aortic balloon occlusion. The main stent graft body is inserted via the other side (**C** and **D**). After switching occlusion balloons from one side to the other (**E**), a contralateral leg is inserted (**F** and **G**) for completion of the procedure (**H**).

Case Series

We analyzed 12 consecutive patients who presented with rAAA to our hospital from March 2013 to July 2016. This report was approved by the ethics committee of our institution, and informed consent was obtained from each patient. Two patients who developed cardiopulmonary arrest at admission or during diagnosis and one patient who was treated by open surgery because of anatomical incompatibility for EVAR were excluded. We used the Gore Excluder (Gore Medical, Flagstaff, AZ, USA) as the main stent graft in the repair of all rAAAs. Device sizes were determined using computed tomography (CT) or intravascular ultrasound. Diagnosis of rAAA was performed with CT. For patients who did not undergo CT, the diagnosis was made by intraoperative angiography. Hemodynamically unstable patients were defined as those who were unconscious, had a systolic blood pressure of <80 mmHg, or needed emergency endotracheal intubation.

For EVAR, we alternately used two aortic occlusion balloons via the bilateral common femoral arteries (double-balloon technique) to minimize hemorrhage during the endovascular therapy (**Fig. 1**). We inserted the first IABO balloon percutaneously from the opposite side of the main approach under local anesthesia (**Figs. 1A–1C**). The sheath was inserted just under the occlusion balloon, which supported the balloon and prevented the balloon from floating. After successful percutaneous IABO, general anesthesia was induced. We switched occlusion balloons from one side to the other after the main stent graft was deployed (**Figs. 1D–1F**). The second balloon was inflated in the proximal neck of the main stent graft. The first balloon could be easily placed into the sheath and removed without fracture of the main stent graft because the sheath had been inserted over the proximal neck.

The sheath was then pulled back to the common iliac artery. Finally, we inserted a contralateral leg and completed EVAR (**Figs. 1G** and **1H**).

We assessed the 30-day and 1-year mortality rates as well as the times from admission to aortic occlusion and from admission to completion of EVAR.

The baseline patient characteristics are shown in **Table 1**. The mean age was 75.6 years, and 10 patients (83%) were males. The mean Hardman index was 1.9 points, and nine patients (75%) were hemodynamically unstable either at admission or at the time of diagnosis.

The 30-day and 1-year mortality rates were both 17%. Two patients died during EVAR. The first patient developed cardiopulmonary arrest during transport from the emergency room to the operating room. The other patient with stable blood pressure underwent intratracheal intubation before IABO because of severe respiratory distress, but he developed cardiopulmonary arrest when general anesthesia was induced.

All surviving patients were hemodynamically stable after the IABO procedures. Induction of general anesthesia and intratracheal intubation were uneventful, but one patient was intubated in the emergency room without anesthesia because of unconsciousness and respiratory distress.

The mean duration of hospitalization was 34 days (range: 20–60 days). Finally, the mean times from admission to aortic occlusion and from admission to completion of EVAR were 63.5 and 110.0 minutes, respectively.

Discussion

In this study, we demonstrated the feasibility of our strategy for the treatment of rAAA. Likewise, a recent study indicated that outcomes were improved in hemodynamically unstable patients with rAAA when EVAR was used in preference to open surgery.[2,3] However, the reported 1-year mortality rate in patients with unstable rAAAs treated by EVAR is still approximately 40%.[1–3]

The plausibility of using IABO lies in the fact that in patients with unstable rAAA, any delay in providing definitive care can contribute to increased death rates.[7] Quick temporary aortic occlusion and minimal intraoperative hemorrhage are therefore necessary for successful outcomes.

This strategy is also based on the sound rationale that local anesthesia has lower risks than general anesthesia. Inducing general anesthesia in patients with hemorrhagic shock caused by unstable rAAA, for example, may increase the risk of vital collapse. Consequently, general

Table 1 Baseline characteristics, aneurysm morphology, procedural/postoperative details, and prognoses

Variable	Patients											
	1	2	3	4	5	6	7	8	9	10	11	12
Baseline characteristics												
Age, years	83	79	89	76	70	59	81	78	81	70	69	75
Sex	Female	Male	Female	Male	Male	Male	Female	Male	Female	Male	Male	Male
Systolic blood pressure, mmHg	70	80	100	80	80	69	80	60	NA	110	70	65
Heart rate, bpm	100	100	77	100	80	97	70	108	NA	95	102	92
Hemoglobin (g/dL)	7.2	9.2	7.3	11.7	10.7	13.1	11.1	10.6	6.8	7.9	10.8	8.7
Creatinine, μM/L	133	152	116	88	192	47.7	80	126	69	155	91	98
Acute myocardial ischemia on electrocardiogram	Yes	Yes	No	No	No	Yes	Yes	No	Yes	Yes	No	Yes
Loss of consciousness	Yes	Yes	No	No	No	Yes	No	No	No	Yes	No	No
Hardman index	4	3	2	0	1	2	2	1	3	3	0	2
Maximum aortic aneurysm diameter, mm	64	59	NA	76	83	72	67	67	30	67	71	84
Procedural/postoperative details, minute												
Time from admission to aortic occlusion, minute	85	63	66	33	47	85	117	66	NA	111	70	60
Time from admission to completion of stent grafting, minute	115	NA	NA	51	177	125	177	66	NA	111	70	99
Re-intervention in 30-day	No	No	No	No	No	No	No	No	No	No	No	No
Alive in 30-day	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Alive in 1-year	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NA: not available

anesthesia is best induced only after temporary occlusion or completion of EVAR under local anesthesia. EVAR can be completed under local anesthesia alone; however, patients in the shock who do not undergo general anesthesia are at risk of complications such as airway difficulty or aspiration pneumonia. Therefore, we routinely induce general anesthesia in patients with rAAA after IABO.

Furthermore, percutaneous IABO can shorten the door-to-balloon time, and the double-balloon technique reduces the risk of intraoperative hemorrhage. These procedures are not technically difficult and can minimize the total hemorrhage from rAAA.

EVAR is also less invasive than open surgery. Patients undergoing EVAR for rAAAs are able to go home sooner than patients treated by open surgery.[1] In our study, all patients who survived the acute phase of therapy reported full recovery of their activities of daily living.

If we need to embolize the internal iliac artery (IIA) for the distal landing zone because of an IIA aneurysm or short distal landing zone of common iliac artery, we perform this embolization during the first IABO. Actually, we embolized the right IIA because of a short distal landing zone in the first case. During IABO performed with the first balloon, the superior mesenteric artery is occluded. The average time of superior mesenteric artery occlusion was 18.8 minutes (7.3–29.5) in the present study. This is an acceptable time for intestinal ischemia based on a previous report.[8] In fact, no patients developed complications related to intestinal ischemia.

The anatomy of rAAA is associated with its prognosis.[9] Notably, because the patient is first stabilized by IABO, the strategy described in this report can safely be converted from EVAR to open surgery when anatomical incompatibility is identified. Indeed, one patient in the present study who was admitted to our hospital with rAAA was successfully converted to open surgery after IABO, and he survived to discharge. The reason for conversion was a short proximal neck.

Abdominal compartment syndrome is one of most critical complications of rAAA. We routinely measure the bladder pressure after EVAR. If the bladder pressure is >20 mmHg,[10] we consider open-abdomen management to reduce the intra-abdominal pressure.[11] In fact, one patient in the present study required this management and was finally discharged alive from our hospital.

Conclusion

The herein-described double-balloon endovascular technique appears feasible for the treatment of rAAA. However, this study has some limitations, such as the small sample size and the fact that only infra-renal rAAAs were studied. The merits of this strategy therefore need to be evaluated more rigorously in a larger, appropriately designed study.

Disclosure Statement

The authors have no conflicts of interest to report.

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