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Original Article

Early outcome of endovascular repair for contained ruptured abdominal aortic aneurysm

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Abstract

Background: Endovascular aneurysm repair (EVAR) has become a well-established technique in the treatment of elective surgery for abdominal aortic aneurysms (AAAs) due to proven benefits in mortality, hospital stay and operation time compared to open repair. The aim of this study was to report our experience in establishing the treatment protocol for EVAR of contained ruptured abdominal aortic aneurysms (rAAAs) and to illustrate the real impact of endovascular rAAA repair on surgical strategy.
Methods: Eighteen patients underwent rAAA between January 2008 and October 2009. Six of them were enrolled in our study. The inclusion criteria were contained rAAA and the same anatomic consideration as in elective EVAR cases. The implant material was the Zenith AAA modular bifurcated device. Computed tomography (CT) scan was obtained in all patients pre-operatively and used as a follow-up tool.
Results: The mean age was 81 years (range 79−87 years). The procedural time was 259 ± 146 minutes, the maximal diameter of aneurismal sac was 8.4 ± 1.8 cm, and the pre-operative hemoglobin was 9.0 ± 1.2 mg/dL. The mean intensive care unit (ICU) stay was 10.5 ± 15 days. There was no surgical or in-hospital mortality. Complications included abdominal compartment syndrome, renal failure, wound infection and pneumonia. The mean follow-up period was 22 (range 19−29) months, with satisfactory result.
Conclusion: Endovascular repair of rAAAs is feasible, and short-term results are promising, especially for contained and hemodynamic subgroup patients. It is indicated for elder patients with severe underlying diseases. Good logistics and adequate training of physicians or staff in an elective setting are prerequisites for this type of treatment program.

Keywords: Endovascular aneurysm repair (EVAR); Rupture abdominal aortic aneurysm (rAAA); Stent graft

1. Introduction

Although major improvements have made elective repair of abdominal aortic aneurysms a safe procedure, the mortality and morbidity of ruptured abdominal aortic aneurysms (rAAAs) remain unsatisfactory. rAAA patients still suffer from a high in-hospital mortality of 40−50% despite improvements in peri-operative care.[1] Over the last 15 years, the successful application of the endovascular approach for the elective treatment of abdominal aortic aneurysms has proven it superior to open repair (OR).[2−4] This development encouraged a strong interest in its role for the long-standing challenge of rAAAs. The program of our elective endovascular aneurysm repair (EVAR) was begun in 2005 and it has become one of the top treatment centers for aortic aneurysm by volume. So far, we have treated over 200 patients with EVAR, and 71% of our elective aortic aneurysm repair is currently EVAR. The experience gained from elective operations has set the stage for applying endovascular repair to contained rAAA.[5,6]

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The purpose of this article is to retrospectively observe the outcomes of patients with infra-renal contained rAAAs treated by endovascular approaches at a single institute in a consistent setting.

2. Methods

Between January 2008 and October 2009, 18 patients with rAAA were enrolled in the study (diagnosed at our institute or referred from other hospitals). Six patients with contained rAAA were treated with EVAR procedure. The other 12 patients received conventional OR due to the presence of free rAAA or the family's refusing of EVAR because of the high cost or uncertain prognosis. This study was approved by the Institutional Review Board of Taipei Veterans General Hospital, Taiwan. Eligibility was assessed in patients enrolled for EVAR for an arrival-to-treatment protocol using a Zenith AAA Endovascular Graft (Cook Inc.; Bloomington, IN) modular bifurcated device.

Pre-operative computed tomography (CT) scan with rAAA obtained at the emergency room or from the referring hospital was evaluated immediately to establish anatomical eligibility and the status of rupture. These anatomic criteria included infra-renal neck >10 mm in length for adequate secure fixation zone, aortic neck diameter <32 mm and external iliac diameter >7 mm.[7] The treatment algorithm was determined not only by the anatomic suitability but also by the patient's agreement, with informed consent forms outlining the possible risks and benefits. The patients with unstable vital signs, non-contained rAAA, mycotic aneurysm or those declined enrollment were excluded from endovascular approach.

Two of the patients were transferred from other hospitals, three were sent to our emergency department immediately and one suffered from contained rAAA during hospitalization. Contained rAAA was defined as retroperitoneal hematoma surrounding the aortic wall without any contrast leak into the peritoneal cavity (Fig. 1).[8]

The demography of patients is shown in Table 1. Mean age was 81.8 years (range 79−87 years), and 84% were male (5 male and 1 female). All patients had a past history of hypertension. During resuscitation, permissive hypotension was kept. Fluid was given and restricted to an amount needed to maintain patient consciousness and blood pressure greater than 75 mmHg. All patients were sent to the operating room as soon as possible after the necessary examinations and treated by the same endovascular team on-call 24 hours.

The EVAR procedure for rAAA was performed as an elective surgery. Under general anesthesia, the patient's chest, abdomen and thighs were sterilized and draped in a supine position. Bilateral common femoral arteries were identified and looped. An 8 Fr. sheath was inserted into the common femoral artery percutaneously. Catheter and guide-wire were advanced into the ascending aorta under fluoroscopic guidance. After being exchanged with stiff guide-wire, the main body of the stent graft was advanced up to the infra-renal aorta, and then deployed just below the lowest renal artery. Bilateral iliac grafts were lodged into the main stent graft separately. Active clotting time (ACT) was kept above 200 seconds with heparin during the procedure. No endoleaks and complete seal of rupture were confirmed by completion aortogram. Femoral artery was repaired directly by Prolone, and the inguinal wounds were closed in layers. After the surgery, the patient was sent to the ICU.

If the patient suffered from unstable vital signs or blood pressure drop, an aortic occlusive balloon could pass through the rAAA and endovascular occlusion was reached. The procedure will convert into conventional OR. Fortunately, no conversions or utilization of aortic occlusion balloons were needed during these endovascular procedures in these patients.

3. Results

The parameters of operation were shown in Table 2. Mean follow-up time was 22 (range 19−29) months. Pre-operative hemoglobin was 9.0 ± 1.2 mg/dL, mean operating time was 259 ± 146 minutes and maximal aneurysmal diameter was 8.4 ± 1.8 cm. Mean ICU stay was 10.5 ± 15 days. No surgical, in-hospital mortality or endoleak was noted.

Patient A had a history of respiratory disease without medical evaluation. After emergent operation, respiratory failure and ventilator dependence occurred. Pneumonia and pulmonary tuberculosis (TB) infection were diagnosed, then he was transferred to isolation room of chest medicine for TB control. This resulted in a longer rehabilitation program and respiratory care. His hospitalization was the longest.

Patient B was a typical case of contained rAAA (Fig. 1). There was a massive retroperitoneal hematoma surrounding the aortic wall without contrast leak into the peritoneal cavity.

Patient C had a history of renal insufficiency requiring hemodialysis. He was transferred from another center for stent graft insertion, but unfortunately acute limb ischemia was complicated with poor pulsation over the left femoral artery after stent graft insertion due to severe tortuous common iliac artery with limb graft kinking. Femoro−femoral bypass was performed. Post-operative rehabilitation and hemodialysis were the reasons for his longer hospitalization.

Patient D was an emaciated woman with massive hematoma over retroperitoneal region disclosed by CT examination. She suffered from a rAAA 2 weeks previous to admission which she had initially ignored. When severe abdominal pain occurred, she was transferred to our hospital and emergent EVAR was performed. Abdominal compartment syndrome developed 4 days after EVAR, with oligouria and poor gastrointestinal function. The patient received mini-exploratory laparotomy for hematoma removal. The longer duration of hospital stay was due to general weakness and rehabilitation.

4. Discussion

The overall mortality rate of rAAA is 75−90%, and the mortality rate of traditional open surgical repair is as high as 45−50%.[4,7,9] EVAR has been shown to have fewer adverse effects on the cardiac, respiratory and renal systems.[10,11] The beneficial effect of reduced physiological insult in elective EVAR can be extended to patients with rAAA logically.

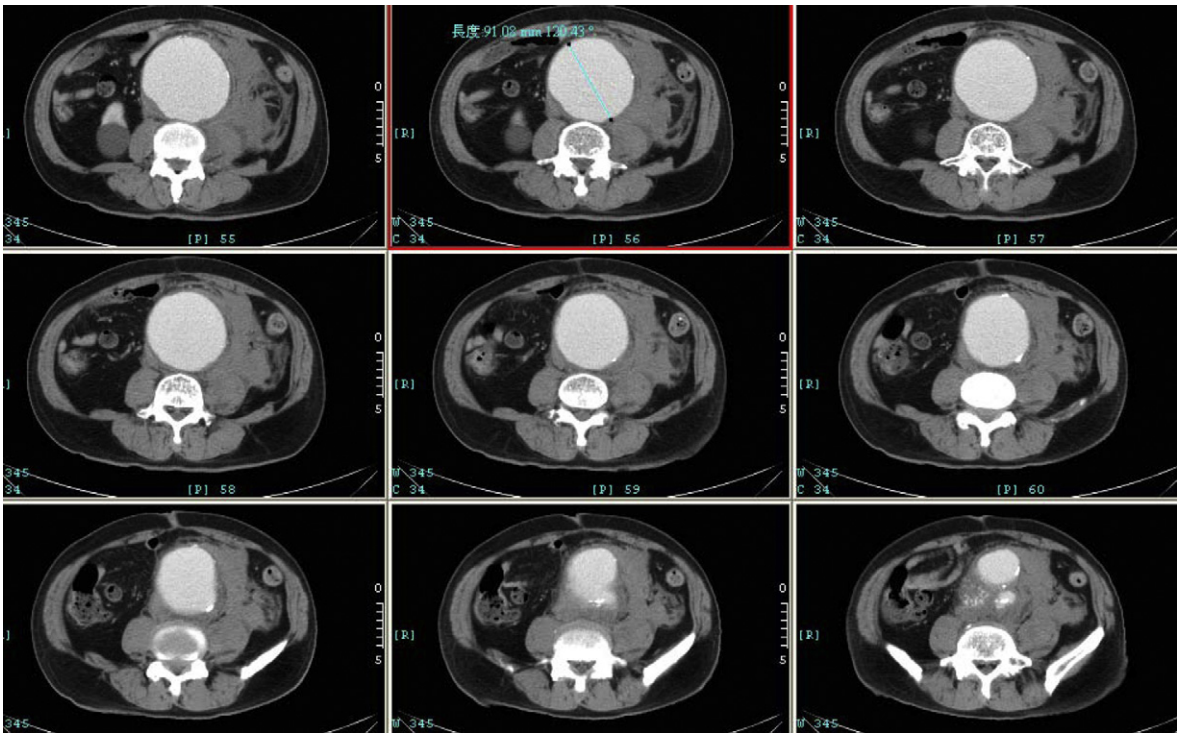

Fig. 1. Computed tomograpy of typical contained rupture abdominal aortic aneurysm in patient B. There is massive retroperitoneal hematoma surrounding the aortic wall but no contrast leak into the peritoneal cavity. The largest diameter is 9.8 cm.

Cytokines are implicated in the development of multiple organ failure (MOF) following aortic surgery,[12] and MOF is the leading cause of peri-operative mortality following surgery for rAAA.[13,14] Of specific interest in rAAA is a reduced inflammatory (cytokine) response during EVAR,[15] and the procedure also avoids the collateral damage associated with dissection of the aortic neck in the presence of free intra-peritoneal blood or a large retroperitoneal hematoma. Up to 68% of patients who die in the peri-operative period have associated iatrogenic injuries, which are more common in those present with hypotension.[16] Furthermore, EVAR can avoid laparotomy-associated hypothermia which exacerbates coagulopathy.

Table 1
Characteristics and coexisting conditions of patients who received endovascular aneurysm repair

Patient	Age (yr)	Sex	Underlying disease	Others
A	79	Male	Hypertension, arrhythmia, smoker	
B	85	Male	Hypertension, coronary artery disease status post coronary artery bypass grafting	
C	79	Male	Hypertension, diabetes mellitus, renal insufficiency, gouty arthritis	
D	87	Female	Hypertension, severe left ventricular dysfunction	rAAA for 2 wk
E	79	Male	Hypertension, rectal cancer status post operation with lung mets	
F	82	Male	Hypertension, COPD and coronary artery disease status PCI	
Mean	81.8			

AAA = abdominal aortic aneurysm; COPD = chronic obstructive pulmonary disease; PCI = percutaneous coronary interventions.

The abdominal compartment syndrome is an important cause of MOF and a leading cause of peri-operative death in those patients undergoing repair of rAAA.[17] One of the concerns about the technique of EVAR is that there may be an increase in intra-abdominal pressure secondary to the retroperitoneal hematoma which might lead to compartment syndrome. Although Hong et al. confirmed that a raised intra-abdominal pressure does not necessarily result in the compartment syndrome,[18] the abdominal compartment syndrome is still a potential complication after EVAR of rAAA with significantly mortality. Massive retroperitoneal hematoma with diffuse bowel edema, sometimes with gastrointestinal dysfunction, has been found in such patients during laparotomy.[19] Careful assessment of bladder pressure, especially in patients who had the symptoms of abdominal discomfort, is recommended.[20] Laparotomy drainage of retroperitoneal hematoma was performed in one of our patients because the hematoma was considered to endanger the patient's respiratory function and renal function. The gastrointestinal function also improved dramatically after abdominal decompression.

Although the 30-day surgical mortality rate is still around 10–20% for EVAR of rAAA,[21,22] Rutledge et al. have also indicated that being over 65 years of age is a critical risk predictor that the mortality rate would be greater than 50%.[23] Elderly male patients accounted for the majority of subjects in our study, and the average age was older than in other

Table 2
Prediction factors and outcome

Patient	Pre-op Hg (g/dL)	Aneurysm MD (cm)	Pre-op Cr (mg/dL)	Op time (min)	Contrast (mL)	ICU stay (d)	Hospital stay (d)	30-day mortality
A	8.7	8	1.5	260	245.5	40	88	N
B	10.1	9.8	1.3	210	194.6	3	15	N
C	10.1	10.7	4.35	510	346	15	83	N
D	7.4	6.6	1.21	165	203	3	45	N
E	8.5	7	1.13	150	119.5	3	12	N
F	9.0	8.5	1.1	245	220	4	16	N
Mean	9.0 ± 1.2	8.4 ± 1.8	1.76 ± 1.2	259 ± 146	221.4 ± 74.2	10.5 ± 15	43.2 ± 34.9	

Cr = creatinine; Hg = hemoglobin; ICU = intensive care unit; MD = maximal diameter; Op = operative.

Table 3
Complications of patients

Patient	Endoleak	Complications	Other surgical intervention	Follow-up time (mo)
A	N	TB infection, urinary bladder incontinence, pneumonia	–	29
B	N	Delirium	–	22
C	N	Wound infection, acute on chronic renal failure, limb ischemia	Femoro–femoral bypass after stent graft insertion. Wound debridement 2 wk later	21
D	N	Abdominal compartment syndrome	Exploratory laparotomy with decompression 4 d later	21
E	N	Wound lymph leak	Wound closure 1 wk later	20
F	N	–	–	19

TB = tubuculosis; N = no.

studies.[4,24] Our preliminary results are rather promising in consideration of co-existence of severe systemic diseases. There was no surgical or in-hospital mortality, no endoleaks but aneurysmal sac shrinkage confirmed during follow-up period. The ICU length of stay and hospital length of stay differed due to underlying conditions like TB infection or renal function impairment (Table 3).

However, EVAR still has some drawbacks. The limited durability of stent grafts and the considerable rate of incompletely excluded aneurysmal sacs remain unsolved issues. Therefore, lifelong imaging follow-up has been advocated after EVAR. As for rAAAs, the morphologic evolution of the aneurysm has not yet been studied. CT is regarded as the standard diagnostic method for surveillance of EVAR of rAAAs because it provides useful information on the evolution of the aneurysm, the patency of the conduit, the presence of endoleaks and, to a limited extent, the stent graft integrity.[25] Even if subsequent follow-ups after more than 1 year show no obvious signs of aneurysm enlargement and endoleaks, long-term follow-up is necessary.

Another factor which contributed to our excellent outcome was the on-call endovascular team with experience in open and EVAR of rAAAs in our hospital. Egorova et al. showed that peri-operative mortality decreased with increasing surgeon experience for EVAR and open repair of rAAA. A 10% decline in 30-day mortality was observed when annual volume of rAAA procedures increased from 1 to 3 or more. The surgical team's experience and hospital volume are important predictors of long-term survival,[26] and contribute to the qualitative and acceptable result.

Although a number of investigators have shown that hospital and surgeon volume is a critical factor in the outcome after AAA open repair,[27,28] larger hospitals may accept transfer of patients referred by regional hospitals. Referral patients would then be more likely to have "stable" contained ruptures, an entity that is associated with a less significant operative mortality rate. Only small sample size of patients and the use of devices from the same manufacturer may have introduced a selection bias. Most of the patients with free wall rAAA or the unusual anatomy would be referred to open repair, but the sick elderly ones with higher potential of comorbid diseases would be referred to the EVAR approach.

In conclusion, endovascular repair of ruptured abdominal aortic aneurysms is feasible, and short-term results are promising, especially for contained and hemodynamic subgroup patients. EVAR is indicated for elderly patients with severe underlying diseases. Good logistics and adequate training of physicians or staffs in an elective setting are prerequisites for this type of treatment program.

Acknowledgments

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