

Low mortality and morbidity after endovascular repair of ruptured aortic aneurysm

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ABSTRACT

INTRODUCTION: The objective of this study was to describe the implementation and to evaluate the short-term outcome of the first Danish experience with endovascular repair of ruptured abdominal aortic aneurysm (RAAA).

METHODS: This was a historical prospective cohort study including all patients at Odense University Hospital, Denmark, treated for RAAA and/or iliac artery aneurysm rupture from 1 October 2012 to December 2013.

RESULTS: A total of 53 patients were treated due to RAAA or iliac aneurysms at our institution in this period. Twenty-seven (51%) of these patients were treated with endovascular aneurysm repair and 26 (49%) with open repair. Two patients (7%) died within the first 30 days post-operatively in the endovascular group. One patient died perioperatively due to myocardial infarction verified by autopsy. The other patient died due to massive coagulopathy and multiorgan failure shortly after the procedure. In the group with open repair, seven patients (30.7%) died within 30 days. This yields a mortality of all patients treated for rupture at our institution of 19% compared with 32% in Denmark at large.

CONCLUSION: Endovascular treatment of RAAA is feasible, and the overall post-operative mortality and morbidity of RAAA can probably be reduced by implementation of RAAA.

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The treatment of ruptured abdominal aortic aneurysm (RAAA) remains challenging. Less than half reach surgery; among these, about 40% die within 30 days post-operatively despite improved peri- and post-operative care [1, 2]. The traditional intervention is open surgical repair (OR) with exclusion of the aneurysm by either a synthetic tube or bifurcated graft. Endovascular aneurysm repair (EVAR) was developed in the 1990s. The experience with elective EVAR has entailed growing use of endovascular repair in emergency settings (REVAR), i.e. when feasible given the anatomical criteria and the patient's haemodynamic status [3-6]. Between 46% and 64% of patients with RAAA have an aortic and iliac anatomy suitable for REVAR [3-6].

Observational studies have reported an approx. 50% risk reduction in 30-day post-operative mortality after REVAR compared with OR, whereas randomised trials cannot demonstrate either the superiority or the

inferiority of REVAR. In case of equality, patients as well as relatives, professionals and health administrators will definitely prefer the minimally invasive therapy, unless there are significant unfavourable cost differences. However, REVAR was reported to be associated with a significant reduction in the use of blood products, a shorter stay in intensive care, a reduced length of stay at hospital and an improved long-term survival. This indicates that REVAR is clearly superior on secondary outcomes. Consequently, 24-hour support for emergency endovascular treatment of ruptured AAA was implemented at Odense University Hospital as from 1 October 2012. The purposes of this article were to describe REVAR implementation and to evaluate the effect of REVAR on mortality in a short-term follow-up period.

METHODS

Transdisciplinary collaboration by interventional radiologists, vascular surgeons and anaesthesiologists was implemented after approval from the hospital administration [7]. The radiological department has provided a good stock of endografts available for RAAA treatment.

Initially one and subsequently three interventional radiologists covered the emergency service, and radiographs were trained to assist them 24 hours a day along with the on-duty vascular surgery staff, of whom two are in training.

We started with REVAR on 1 October 2012; and prospective data on REVAR-treated cases were collected until December 2013. The cohort included all patients with ruptured AAA and/or iliac artery aneurysm rupture, confirmed by computed tomography (CT), demonstrating retro- and/or intraperitoneal/pelvic haematoma. Initially, patients with ruptured AAA and/or iliac artery aneurysm rupture who were relatively haemodynamically stable with a systolic blood pressure > 80 mmHg were considered as potential candidates for EVAR, i.e. if well-known anatomical CT-based criteria allowed this procedure to be performed [7]. As experience accumulated, haemodynamically unstable patients were also included as well as selected cases with a challenging morphology [8]. The intention was to perform the intervention in local anaesthesia with additional intravenous sedation and analgesia. General anaesthesia was only used if the patient could not cooperate or became

ORIGINAL ARTICLE

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haemodynamically unstable during the intervention. A percutaneous approach on one side was preferred to facilitate the insertion of an occlusive aortic balloon for fast bleeding control, if necessary. However, when anatomical constraints made percutaneous access impossible, bilateral surgical cut-down was performed. Bifurcated stent graft was the primary choice; but only if anatomical characteristics did not allow for placing of a bifurcated graft, and only if anaorto-uniiliacal device was used and cross-over bypass performed.

The primary clinical outcome was 30-day post-operative mortality. Secondary outcomes were technical success defined as absence of open conversion and no type 1 or type 3 endoleak on the final angiography, as well as mortality and secondary interventions within 12 months.

All patients treated with EVAR were offered our scheduled surveillance programme, which in the first year consists of CT angiography and clinical control after three and 12 months.

All patients gave informed consent. Ethical approval was not necessary.

Statistical methods

Using descriptive statistics in Microsoft Excel, observations have been summarised as counts with percentages and mean values, as appropriate. The mortality analysis was made using the chi-squared test.

Trial registration: not relevant.

RESULTS

From October 2012 to December 2013, a total of 53 patients were treated due to RAAA or iliac aneurysms. Of these, 27 (51%) patients were treated with REVAR.

A total of 24 patients (89%) were men and three patients were (11%) women. Patients were aged 65-86 years (mean 74.4 years). The maximal AAA diameter ranged 6-12 cm (mean 8.1 cm). Two cases of ruptured common iliac artery aneurysms were included because of placement of an EVAR stent graft. Six (26%) patients were converted to general anaesthesia due to lack of cooperation or because they became haemodynamically unstable. In five (20%) cases, we chose a percutaneous approach from one side and in one (4%) case a total percutaneous approach. In all other cases (76%), bilateral groin cut-down was performed due to severe calcifications. A bifurcated stent graft was deployed in 26 (96%) of the cases (**Figure 1A-C**). In one case (4%), an aorto-uniiliacal stent graft (**Figure 2 A-B**) was employed followed by femoral crossover bypass.

Thirty-day mortality and morbidity

Two patients (7%) died within the first 30 days post-operatively after REVAR. One patient died perioperatively due to myocardial infarction verified by autopsy. The other died due to massive coagulopathy and multiorgan failure shortly after the procedure due to a ruptured aneurysm of the common iliac artery and co-existing non-ruptured AAA.

In the same period, 26 patients were (49%) treated

FIGURE 1

A. A 79-year-old man with a 9-cm ruptured abdominal aortic aneurysm and retroperitoneal haematoma. **B.** The same patient three months after endovascular repair in an emergency setting and placement of the bifurcated stent graft. Computed tomography angiogram showed a good result without endoleak. **C.** 3D reconstruction angiography of the same patient three months after endovascular repair in an emergency setting.



 FIGURE 2


A. A 67-year-old male patient with ruptured abdominal aortic aneurysm and active contrast extravasation.

B. The same patient after deployment of the aorto-uniliac stent graft and subsequent femoral crossover by-pass.

by open repair for ruptured AAA due to anatomical and/or haemodynamic contraindications for REVAR, of whom seven (30.7) died within the first 30 post-operative days. Patients died due to myocardial infarction ($n = 2$), bowel ischaemia ($n = 3$), multiorgan failure ($n = 1$) and, finally, severe haemorrhagia ($n = 1$). Consequently, the mortality of all patients treated for rupture at our institution was 19%, (95% confidence interval (CI): 0.09-0.29) compared with 30% (95% CI: 0.23-0.37) in Denmark in 2012 (chi-squared test: $p = 0.11$) [9].

Four patients (16%) developed compartment syndrome defined as an abdominal pressure > 28 mmHg and clinical multiorgan deterioration. All patients underwent laparotomy with evacuation of haematoma. All except for one patient had ischaemic changes of the colon and underwent colectomy and formation of a stomy (Hartmann's procedure). All four patients stayed more than one month in the intensive unit.

Two of the four patients died 55 and 64 days after REVAR due to respiratory insufficiency. These were the only two cases of death in the 1-12 month follow-up period after REVAR.

Technical success and secondary perioperative interventions

In all, the technical success proportion was 86% of the intended REVAR cases who left the hybrid suite without any type 1 or type 3 endoleaks and without being converted to open surgery.

Two patients (7%) were converted to open surgery due to endoleak of type 1 after deployment of a bifurcated prosthesis and haemodynamic deterioration. Additional perioperative interventions were performed in four cases after control angiography. In two cases with endoleak of type 1A, an extra aortic "cuff" (short-

stent graft) was successfully placed because the stent graft was placed too distally from the renal artery. In a third case, a plaque occluded the right renal artery after stent graft placement. In this case using transbrachial access and a renal stent placement, reperfusion of the right kidney was achieved shortly after occlusion. Due to a short neck, in the fourth patient the stent graft was deployed above the left renal artery supplemented by a Chimney stent placed into the left renal artery with good result; without type 1 or 3 endoleak and without subsequent renal failure.

First 30-day stent graft-related complications

One patient had left prosthesis leg thrombosis five days after the primary intervention. After unsuccessful trombectomy the primary intervention was converted into successful surgical femoro-femoral cross-over by-pass. Two other patients developed wound complications in the groin. These complications were treated successfully with debridement and antibiotics. In the remaining 91% of cases, there were no stent graft-related complications during the early 30-day period.

Follow-up

The follow-up ranged from 30 days to 12 months, with a mean follow-up period of 6.5 months. Neither mortality nor secondary interventions were related to the EVAR procedure during the follow-up period.

DISCUSSION

After careful consideration and planning, 24-hour access to emergency interventional radiology for REVAR was implemented at Odense University Hospital as the first place in Denmark. The first year of experience demonstrated a 30-day post-operative mortality after REVAR of

only 7% and an overall 30-day post-operative mortality of RAAA of 19% compared with 30% at national level ($p = 0.11$).

Periprocedural and early mortality are at least as low as other observational reports. We experienced two open conversions; one due to under-sizing of the stent graft and one due to a challenging anatomy – similar cases may be prevented in the future.

Numerous non-randomised studies have shown promising results of EVAR compared with surgery. These results include significant reductions in mortality and morbidity even after proper adjustment for haemodynamic instability [10-13]. However, the randomised studies (RCTs) published so far have shown a non-significant 10% relative risk reduction by REVAR compared with open repair [14-16].

Consequently, the key question is to evaluate population-based effectiveness of having two methods instead of one for treating ruptured AAA. In an attempt to answer to this question, we need to evaluate the overall mortality of ruptured AAA at the population level and the hospital level with and without REVAR. This study clearly demonstrates a potential game change in the overall 30-day mortality at our institution compared with the rest of Denmark.

Nevertheless, based upon the RCTs, REVAR is at least not inferior to open repair as far as short-term survival is concerned. In terms of equality, costs assume particular importance, and reports have indicated that time of stay at intensive unit, use of blood products, total length of stay are significantly reduced by REVAR. This is also our impression although experience remains inadequate to make conclusions.

This creates a novel and challenging situation as a 24-hour quality service of both REVAR and open repair performed by experienced surgeons and interventional radiologists who need to perform a minimal volume of procedures to maintain acceptable experience will be very unlikely in all vascular departments due to its costs and the number of specialists available.

CONCLUSION

Endovascular treatment of ruptured and symptomatic AAA is feasible, and the mortality and morbidity may probably be reduced. Nevertheless, secondary interventions remain a problem, but these may be handled by endovascular re-interventions in the majority of cases.

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