Emergency EVAR for ruptured abdominal aortic aneurysms: New Zealand experience
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ABSTRACT

AIM: A ruptured abdominal aortic aneurysm (rAAA) remains a significant threat to life, with a 30–50% in-hospital mortality rate. The recent introduction of emergency endovascular aneurysm repair (rEVAR) in New Zealand presents an alternative to open repair for rAAAs. The aim of this paper is to review the current experience in New Zealand in the repair of rAAAs.

METHODS: Data from the Australasian Vascular Audit (AVA) was reviewed, with data pertaining to rAAAs collected for the five-year period from January 2010 to December 2014.

RESULTS: Two hundred and eighty-five rAAAs were reported over the five-year period, with an overall mortality rate of 34.0%. There was no significant difference in in-hospital mortality rates alone after rEVAR vs open repair (rOR) (OR 0.39, 95% CI 0.14–1.06, P=0.065). Significant reductions in length of hospital stay (9.710.2 days vs 16.812.9 days, P=0.0125) and the combined in-hospital mortality/post-operative complication rate (35.7% vs 63.6%, OR 0.3, 95% CI 0.1–0.7, P=0.005) were observed after rEVAR vs rOR.

CONCLUSION: A primary rEVAR approach is appropriate in selected patients and may represent a paradigm shift in the management of ruptured AAAs in New Zealand.
other outcomes such as a shorter stay in ICU, and a shorter overall stay in hospital favour the endovascular approach. However, there is emerging evidence that these benefits may be offset by higher re-intervention rates in the rEVAR group.

Regardless of whether or not a true benefit exists following rEVARs compared to rORs, the recent introduction of rEVARs may represent a paradigm shift in the treatment of ruptured AAAs in New Zealand. Here we review the New Zealand experience in the setting of rEVARs.

**Method**

A search of the AVA was undertaken for all ruptured AAAs in New Zealand from 1 January 2010 to 31 December 2014. Emergency and semi-urgent surgery types were included. Operative site terms included were ‘Aorta (AAA rupture no bypass)’, ‘Aortic tube-endoluminal’, ‘Aortic tube-open’, ‘Aorto fem bypass(aneurysm)’, ‘Aorto iliac-open(aneurysm)’ and ‘Aorto/iliac-endoluminal’. All supra-renal and solitary unilateral or bilateral iliac aneurysms were excluded.

**Statistical analysis**

Baseline and post-operative outcomes were compared between the rEVAR and rOR groups using unpaired t-tests and Fisher’s exact test as appropriate. A two-tailed P-value <0.05 was taken to indicate statistical significance. Data analysis was performed using GraphPad (Graphpad Software, Inc., La Jolla, CA, US).

**Results**

**Overview**

There were 285 reported rAAAs in New Zealand between January 2010 and December 2014, all of which were graded as emergency surgery. Of these, 78.9% were male and the overall mean age was 74.68.79 years. The mean duration of stay in hospital among survivors was 15.912.8 days, based on the 188 patients who were discharged alive. Mean AAA diameter on presentation was 7.41.7 cm and the overall mortality rate was 34.0%.

The majority of patients (43%) had an ASA score of 4, with a mortality rate of 38%. Five patients (1.8%) had an ASA score of 1, all of whom underwent an open repair and survived, while 37 (13%) had an ASA score of 5, with a mortality rate of 48.6%.

In regards to recorded co-morbidities, 106 (42%) had a background of ischemic heart disease, 22 (7.7%) diabetes and 202 (70.9%) hypertension. A serum creatinine level >150mMol/L was present in 38 (14.8%) of patients on admission.

**rEVAR vs rOR demographics**

Of the 285 rAAAs, 257 (90.2%) underwent a rOR and the remaining 28 (9.8%) had a rEVAR. There was no increasing trend in the rate of rEVAR on a year-to-year basis (Figure 1).

*Figure 1: Yearly number of rEVAR and rOR in New Zealand.*
There were no significant differences between the rEVAR and rOR groups with respect to mean age (76.5 ± 7.6 years vs 74.4 ± 8.9 years), male gender (OR 1.2, 95% CI 0.5–3.4), mean AAA diameter (7.0 ± 1.7 cm vs 7.5 ± 1.7 cm) or proportion of individual ASA scores within each group (P > 0.15 for each ASA score).

There was also no significant difference in the prevalence of co-morbidities between the two groups, both overall and by type of co-morbidity; Ischemic heart disease (OR 1.4 95% CI 0.7–3.1), Diabetes (OR 2.1 95% CI 0.7–6.7), Hypertension (OR 1.0 95% CI 0.4–2.4), serum creatinine > 150 mMol/L (OR 0.5 95% CI 0.1–2.1).

dEVAR vs rOR in-hospital mortality rate

There were five (17.9%) rEVAR and 92 (35.7%) rOR in-hospital deaths. Although the difference between the in-hospital mortality rates was suggestive of a benefit towards rEVARs, this was not significant (OR 0.39 95% CI 0.1–1.06, P = 0.065).

dEVAR vs rOR duration of hospital stay

There was a significantly shorter duration of stay in hospital for the survivors within the rEVAR group compared to those who underwent a rOR (9.7 ± 10.2 days vs 16.8 ± 12.9 days, P = 0.0125).

dEVAR vs rOR complication rate

In-hospital post-operative complications were recorded as wound, cardiac, respiratory, renal, gastrointestinal or central nervous-system related. Among the survivors in each of the rEVAR and rOR groups, there were five (21.7%) and 73 (43.9%) patients respectively who had one or more post-operative complications. The difference was not statistically significant (P = 0.069).

When combining mortality and reported post-operative complications together, there was a significant reduction in this composite rate within the rEVAR group compared to those undergoing a rOR (35.7% vs 63.6%, OR 0.3, 95% CI 0.1–0.7, P = 0.005).

Of the 28 patients who underwent an emergency EVAR, one (3.6%) was converted to an open repair due to a persistent type 1 endoleak.

There was no data available on late complications or re-interventions.

Survivors vs non-survivors

Overall 97 patients died in hospital, while 188 were discharged alive. Survivors were significantly younger (73.29 ± 7.7 vs 77.27 ± 7.5, P = 0.0002) and had a significantly lower proportion with an ASA of four or five than non-survivors (49.7% vs 67.0%, OR 0.5 95% CI 0.3–0.8, P = 0.009). The proportion of rOR patients with a > 3L blood loss intra-operatively was also significantly lower in the survivors group (18.1% vs 50.0%, OR 0.2 95% CI 0.1–0.4, P < 0.0001).

There was no significant difference between the survivor and non-survivor groups with respect to AAA size (7.5 ± 1.6 vs 7.4 ± 1.8), male gender (OR 1.4 95% CI 0.8–2.5), rate of rEVAR (OR 2.2 95% CI 0.8–6.0) or presence of specific co-morbidities; Ischemic heart disease (OR 0.8 95% CI 0.5–1.3); Diabetes (OR 0.8 95% CI 0.4–2.0); Hypertension (OR 0.8 95% CI 0.5–1.4); Creatinine > 150mMol/L (OR 0.8 95% CI 0.4–1.5).

Local anaesthetic rates in emergency EVARs

Emergency EVAR under local anaesthesia took place in six (21.4%) of the endovascular cases while the remaining 22 (78.6%) had general anaesthesia. None of the local group required a conversion to general anaesthesia intra-operatively. There were two deaths (33.3%) in the local anaesthetic group and three (13.6%) in the general anaesthetic group.

Due to the small number of cases, no meaningful comparisons could be made between the general anaesthetic and the local anaesthetic groups.

Discussion

New Zealand is a relative newcomer to the field of rEVARs. Factors such as level of endovascular experience, available resources and volume of cases may explain the lower rates of rEVARs compared to international data. However, the recent introduction of rEVARs may represent a paradigm shift in the treatment of rAAAs in New Zealand.

Our overall in-hospital mortality rate of 34.0% was comparable to the mean peri-operative mortality averaged across nine countries with EVAR capable centres between 2005–2009 (31.6%, 95% CI 30.6–32.8%).
while our treatment modality specific in-hospital mortality rates compared well with two recent meta-analyses,6,11 which included over 40 observational studies and two to three RCTs comparing rEVARs to rORs (Figure 2).

Although the trend of in-hospital mortality after rEVAR vs rOR in New Zealand was suggestive of a benefit towards rEVAR, there was no significant difference between these two groups (OR 0.39 95% CI 0.14–1.06, P=0.065).

To date there have been three RCTs comparing short-term mortality after rEVARs to rORs, one of which was a pilot study.8,9,11 Of the remaining two trials, one carried out a direct comparison between the two groups, with randomisation after computerised topography angiogram (CTA). As a result, they excluded those who were unstable for imaging and those who were anatomically unsuitable for a rEVAR. There was no difference between the two groups in short-term mortality rates.8 The largest and more recent IMPROVE study conducted a real world trial where randomisation occurred prior to CTA imaging. Patients with clinically ruptured AAAs were randomised into either an endovascular-first strategy or open repair first strategy. In the endovascular group there was a crossover rate of 44% to open repair, either because of anatomical unsuitability or rapid clinical deterioration. They reported a trend towards a reduction in short-term mortality rates in the endovascular-first group 35.4% vs 37.4%, OR 0.92, P=0.62).8 Although this was not significant, it may suggest non-inferiority compared to the primary open repair group.

The results of the two RCTs contrast those of a large body of observational studies which have consistently reported a significant reduction in short-term mortality rates in the endovascular group. A recent meta-analysis of 29 observational studies noted a pooled odds ratio for death after EVAR vs open repair of 0.44 (95% CI 0.37–0.53), suggesting a benefit in the endovascular group.10 In the same study, the pooled odds ratio among the three RCTs was 0.9 (95% CI 0.65–1.24), which shows no benefit. They noted a major limitation of the observational studies was a high risk of patient selection bias, in that patients with a higher-risk profile tended to undergo a rOR while the more stable patients proceeded for CTA imaging to assess suitability for rEVAR.

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This is in agreement with our limited experience in three rEVARs at our centre which took place after the cut-off date of the AVA data collection where all three patients were both hemodynamically stable and anatomically suitable on CTA for a rEVAR.

We also noted no significant differences between the rEVAR and rOR groups in the New Zealand cohort when looking at short-term post-operative complication rates alone. This is in contrast to the findings of Antoniou et al in their meta-analysis, who observed a significant reduction in respiratory (OR 0.59, P<.01) and acute renal failure complications (OR 0.65, P<.01) within the rEVAR group, as well as of a more recent

Figure 2: Comparison of New Zealand and international mortality rates following rEVAR and rOR.
A retrospective review of 514 rEVARs and 651 rORs who reported a significant reduction in several post-operative morbidity types following rEVAR vs rOR; cardiac complications (29% vs 38%, P=.001); respiratory complications (28% vs 46%, P<.0001); renal insufficiency (24% vs 38%, P<.0001); lower extremity ischaemia (2.7% vs 8.1%, P<.0001) and bowel ischaemia (3.9% vs 10%, P<.0001). When we combined our post-operative complication and in-hospital mortality rates, we observed a significant reduction within the rEVAR group (35.7% vs 63.6%, OR 0.3, 95% CI 0.1–0.7, P=0.005). This may be a combination of the reduced physiological impact of rEVAR compared to rOR, and of the lower risk profile patients being selected for rEVARs. The largest RCT to date did not report on post-operative complications.9

There was a significant reduction in length of hospital stay in our rEVAR group. This outcome is in agreement with Ali et al in their large retrospective observational study (six days [interquartile range 4–12] vs 13 days, P<0.001). The IMPROVE trial also noted a reduction in length of hospital stay in their rEVAR cohort but this was not significant (9.89.0 days vs 12.210.2 days) (Figure 3).

A small proportion (21.4%) of emergency EVARs in New Zealand were performed under LA. This has a theoretical benefit in preserving the tamponade effect of the abdominal wall muscles, which is lost on induction of GA. None of the LA group were converted to GA. There were two deaths (33.3%) in the LA group and three (13.6%) in the GA group, however this difference was not significant. International experience suggests that local anaesthetic use is proportionally low despite its theoretical benefits.7–9 Patient agitation or hemodynamic instability may account for this.

We did not analyse the cost-effectiveness of emergency EVARs in New Zealand. In the IMPROVE trial, the mean total 30-day cost in the endovascular-first strategy was similar to the open repair-first strategy (£13,433+/– £10,354 vs £14,619+/– £12,353). Shorter duration of stay in intensive care, shorter length of hospital stay and potentially reduced complication rates are significant drivers in lowering costs in patients undergoing an emergency EVAR. A small amount of data on long-term outcomes following rEVARs, in combination with long-term follow up of elective EVARs in intact AAAs data suggests that late re-interventions may offset these benefits in the rEVAR group.5,13

A potential limitation of this study is the reliance on the AVA database which is dependant on the surgeon updating the patient information. However, the capture rate of AVA in New Zealand with regards to both ruptured and non-ruptured AAAs has been recently reported as greater than 80% in a validation study.14 Other limitations include the small number of reported cases and the lack of follow-up data beyond discharge.

In conclusion, an endovascular-first strategy has been previously shown to be non-inferior to a primary open repair with regards to short-term mortality rates and has the benefit of a shorter stay in hospital. The results of this review indicate an association between rEVARs in New Zealand and significant reductions in length of hospital stay and combined in-hospital mortality/post-operative morbidity rates. Its recent introduction here may represent the beginning of a shift in the management of ruptured AAAs in New Zealand although it is currently unlikely to be an option available 24/7 outside the few New Zealand centres with well-established EVAR capabilities.

Figure 3: Comparison of New Zealand and international mean duration of hospital stay following rEVAR and rOR.
Competing interests:
Nil.

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