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# Comparison of open versus endovascular surgical treatment of abdominal aortic aneurysm

**Abstract:** Abdominal aortic aneurysm (AAA) is a common condition of increasing prevalence, particularly among older men. An AAA is defined as a permanent dilation of the abdominal aorta, with a diameter greater than 30 mm or a diameter greater than 50% of the aortic diameter at the level of the diaphragm. As the size of the aneurysm increases, so does the risk of rupture. Therefore, prophylactic repair with insertion of a prosthetic graft is offered. Since 1951 traditional open aneurysm repair (OAR) was reported and minimally invasive endovascular repair (EVAR) was first reported in 1986.

Data from four randomized controlled trials (EVAR-1, DREAM, OVER, ACE) for abdominal aortic aneurysm, which enrolled almost 3000 patients, in a period from 1999 to 2008, were summarized. In addition, registry databases on the treatment of AAA of average 4000 patients per year, based from 2015 to 2018 of the German Institute for Vascular Medicine Healthcare Research of the German Society for Vascular Surgery and Vascular Medicine, were compared.

The EVAR procedure for AAA showed a lower risk of perioperative mortality but was associated with a higher cardiovascular and aneurysm-related complication rate. In particular, patients aged 80 years or older benefited from EVAR since the 30-day mortality of patients receiving OAR was higher. In mid-term and long-term follow-up there were no differences in survival after endovascular and open aortic repair. Overall, it depends on the respective underlying disease and anatomy which of the two approaches is to be preferred. In conclusion, both treatment options can be considered as equal and can be offered to patients.

**Keywords:** abdominal aortic aneurysm, endovascular aortic repair, open aortic repair.

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## 1 Introduction

An abdominal aortic aneurysm (AAA) is defined as a permanent, localized focal dilation of the aortic with an aortic diameter of 30 mm or greater is [1,2]. Epidemiological studies of AAA have shown an increased incidence worldwide, ranging from 4.5% to 7.7% per year [3,4].

AAAs are often asymptomatic, and the size of the aneurysm has been shown to correlate with the risk of rupture [5,6], which has a mortality rate of 85–95% [7]. AAA is a common disease that particularly affects men older than 60 years. As the size of the aneurysm increases the risk of rupture also increases. Risk factors include smoking, hypertension, gender, and a possible hereditary predisposition [8].

AAA is treated using two different surgical methods, endovascular placement of an aortic stent graft (EVAR) and traditional open aneurysm repair (OAR). In 1951 the OAR was first practiced as invasive treatment of AAA [6]. 40 years later the introduction of endovascular aortic repair (EVAR) was preferred as an alternative to traditional OAR for the elective repair of AAA [9]. This is primarily due to a decrease in recovery time and perioperative mortality even if an inferior late survival and higher need for re-intervention with EVAR was observed [10].

## 2 Methods

The 2018 Society of Vascular Surgery Guidelines recommend elective repair of intact AAA in asymptomatic patients with an aneurysm diameter greater than 5.4 cm [11].

Data from four randomized controlled trials (EVAR-1, DREAM, OVER, ACE) [10,12–14] on the treatment of asymptomatic AAA patients were randomly allocated to either minimal invasive EVAR or open surgery OAR (Table

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1). In addition, registry databases on the treatment of AAA, Society for Vascular Surgery and Vascular Medicine, were based from 2015 to 2018 of the German Institute for Vascular Medicine Healthcare Research of the German compared [15–18].

**Table 1:** Randomized controlled trials for elective treatment of the abdominal aortic aneurysm (OAR versus EVAR).

Study	EVAR-1		DREAM		OVER		ACE	
Country	UK		Netherlands		USA		France	
Number of centres	37		7		42		25	
Period	09/99 – 08/04		11/00 – 12/03		10/02 – 04/08		03/05 – 03/08	
Follow-up (year)	6		6.4		5.2		2.5	
Treatment	OAR	EVAR	OAR	EVAR	OAR	EVAR	OAR	EVAR
Randomized (n)	626	626	178	173	437	444	149	150
Total	1252		351		881		299	
Age (year)	74	74	70	71	71	70	70	69
AAA-diameter (mm)	65	64	60	61	57	57	56	55
Men (n/%)	570/91	565/90	161/90	161/93	435/99	441/99	146/98	150/100
30-day-mortality (%)	4.3	1.8	4.6	1.2	2.3	0.2	0.7	1.3
2-year survival (%)	89	85	89	89	88	92	n. i.	n. i.
Long-term survival (%)	65	65	69	69	61	60	n. i.	n. i.
Re-intervention (n/%)	55/8.8	145/23.2	30/16.9	48/27.7	78/17.8	98/22.1	2/1.3	8/5.3

AAA: abdominal aortic aneurysm, OAR: open aneurysm repair, EVAR: endovascular aneurysm repair, EVAR-1: The United Kingdom Endovascular Aneurysm Repair Trial 1, DREAM: The Dutch Randomized Endovascular Aneurysm Management, OVER: Open versus Endovascular Repair, ACE: Anévrisme de l'aorte abdominale Chirurgie versus Endoprothèse, n. i.: no information.

**Table 2:** Registry survey on the treatment of the abdominal aortic aneurysm, based on the database from 2015 to 2018 of the German Institute for Vascular Medicine Healthcare Research of the German Society for Vascular Surgery and Vascular Medicine (OAR versus EVAR).

Year	2015		2016		2017		2018	
Number of centres	160		139		161		133	
Treatment	OAR	EVAR	OAR	EVAR	OAR	EVAR	OAR	EVAR
Randomized (n)	1001	3767	641	2840	872	3221	895	2800
Total	4768		3481		4093		3695	
Age (year)	70	74	69	74	70	74	70	74
AAA-diameter (mm)	53	55	55	53	55	53	55	54
Men (n/%)	826/83	3301/88	540/84	2456/87	716/82	2789/87	763/85	2464/88
30-day-mortality (n/%)	54/5.4	44/1.2	26/4.1	27/1.0	34/3.9	30/0.9	42/4.7	32/1.1
Complication (n/%)	312/31.2	467/12.4	186/29.0	317/11.2	263/30.2	392/12.2	237/26.6	400/13.6

AAA: abdominal aortic aneurysm, OAR: open aneurysm repair, EVAR: endovascular aneurysm repair.

### 3 Results and Conclusion

In the four randomized controlled trials the mean diameter of AAA in EVAR and OAR was given as 60 mm, respectively. In the German registry the mean diameter of AAA in patients who underwent EVAR was 54 mm versus 55 mm for OAR. Over 80% of the patients treated for AAA were men.

Re-interventions had to be performed in 11% of patients who underwent traditional open surgery, compared to 20% in patients who underwent minimally invasive endovascular repair. According to the data from the four randomized trials, 3% of patients died after open surgery and 1% after endovascular repair within 30 day of the intervention. This shows an advantage of EVAR after 30 days. In particular, patients older than 80 years benefit from EVAR. However, this benefit disappears after 3-4 years. In mid-term and long-term follow-up there were no differences in survival after endovascular and open aortic repair (Table 1).

Hospital mortality and complication rate for AAA with EVAR or OAR was nearly identical compared to 2015 to 2018 registry reports from the German Institute of Vascular Healthcare Research of the German Society for Vascular Surgery and Vascular Medicine. In 87% of the cases of endovascular intervention for AAA no complications occurred and 1.8% patients died within 30 days of the intervention. In 71% of the cases of open surgery for AAA no complications occurred but a total of 4.5% patients died within 30 days (Table 2).

With the introduction of EVAR more than twenty years ago, patients with AAA were presented with a new option for a treatment wherein a shorter hospital lay time and thus a faster return to their usual activities was observed.

Both treatment options can be considered as equal and can be offered to patients. The EVAR procedure should be the first choice of treatment of AAA in physically fit patients with suitable anatomy. OAR should be preferred when EVAR does not seem to be technically feasible or for patients where lifelong surveillance is not possible.

In conclusion, careful attention to the choice of operative strategy along with optimal treatment of medical comorbidities is critical to achieving excellent outcomes. Moreover, appropriate postoperative surveillance is necessary to minimize subsequent aneurysm-related death or morbidity [11].

#### Author Statement

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