

AAA-Leitlinie

(Abdominelles Aortenaneurysma)



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Empfehlung, Evidenz

Evidenzgrad (EvG)

Prof. Dr. C. Bünger

Deutschland	Europa	Nord-Amerika
S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
EvG	Level of Evidence	Quality of Evidence
1A, 1B, 1C 2A, 2B, 2C 3A, 3B 4 5	A: Metaanalyses, RCT's B: RCT C: expert-opinion, Non-RCT	A: High B: Moderate C: Low

Evidenzgrad (EvG)

S3-Leitlinie AWMF 07/2018

Grad	Studien zu Therapie / Prävention / Ätiologie
1a	Systematische Übersicht über randomisierte kontrollierte Studien (RCT)
1b	Eine RCT (mit engem Konfidenzintervall)
1c	Alle-oder-Keiner-Prinzip
2a	Systematische Übersicht gut geplanter Kohortenstudien
2b	Eine gut geplante Kohortenstudie oder ein RCT minderer Qualität
2c	Outcome-Studien, Ökologische Studien
3a	Systematische Übersicht über Fall-Kontrollstudien
3b	Eine Fall-Kontroll-Studie
4	Fallserien oder Kohorten- / Fall-Kontrollstudien minderer Qualität
5	Expertenmeinung ohne explizite Bewertung der Evidenz oder basierend auf physiologischen Modellen / Laborforschung

Level of Evidence

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Table 1.1. Levels of evidence.

Level of evidence A	Data derived from multiple randomised clinical trials or meta-analyses.
Level of evidence B	Data derived from a single randomized clinical trial or large non-randomised studies.
Level of evidence C	Consensus of opinion of the experts and/or small studies, retrospective studies, registries.

Empfehlungsgrad (EG)

Prof. Dr. C. Büniger

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EG	Class of Recommendation	Level of Recommendation
A: soll/ soll nicht B: sollte/ sollte nicht 0: Empfehlung offen	I: is recommended IIA: should be considered IIB: may be considered III: not recommended	1: strong 2: weak
GCP: klinischer Konsens		Good Practice Statement

Empfehlungsgrad (EG)

Prof. Dr. C. Bünge

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Empfehlungsgrad	Beschreibung	Syntax
A	Starke Empfehlung	soll / soll nicht
B	Empfehlung	sollte / sollte nicht
0	Empfehlung offen	kann erwogen werden / kann verzichtet werden

Class of Recommendation

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Table 1.2. Classes of recommendations.

Classes of recommendations	Definition
Class I	Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.
Class II	Conflicting evidence and/ or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.
<i>Class IIa</i>	<i>Weight of evidence/opinion is in favour of usefulness/efficacy.</i>
<i>Class IIb</i>	<i>Usefulness/efficacy is less well established by evidence/opinion.</i>
Class III	Evidence or general agreement that the given treatment or procedure is not useful/ effective, and in some cases may be harmful.

Definition AAA

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DM*: $\geq 30\text{mm}$ (anteroposterior oder transversal)	1,5fold diameter increase (infrarenal or suprarenal)	

* DM: maximaler Durchmesser

AAA-Prävalenz Männer

Prof. Dr. C. Büniger

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
1,3 bis 1,7% * EvG 2b	h/o smoking: 5%	

* England und Schweden

Table 3 The prevalence of AAA detected by population screening.

ESVS 2011

Study location	Chichester, UK ¹⁶	Viborg, Denmark ¹⁷	Western Australia ¹⁸	MASS UK ¹⁹	Rotterdam, Netherlands ²⁰	Tromsø, Norway ²¹
n	15,775	12,628	41,000	67,800	5419	6386
Gender	Men & women	Men	Men	Men	Men & women	Men & women
Age (years)	65–80	65–73	65–79	65–74	>55	55–74
Sampling dates	1988–90	1994–8	1996–8	1997–9	1994–5	1994–5
Date published	1995	2002	2004	2002	1995	2001
Aneurysm prevalence	4.0% (7.6% in men, 1.3% in women)	4.0%	7.2%	4.9%	4.1% men, 0.7% women	8.9% men, 2.2% women

Risikofaktoren für AAA-Genese

AAA-Risikofaktoren

Prof. Dr. C. Bünge

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• Alter • männlich (OR 5,69) • Rauchen (OR 2,41) EvG 2a	DM (v.a. Typ II) <u>reduziert</u> Risiko um 50%	• > 90% of patients with AAA have smoked cigarettes at some point. • ... AAA is <u>second</u> only to lung cancer in epidemiologic <u>association to cigarette smoking</u> ...⁴⁷
Das AAA ist neben der pAVK am stärksten mit dem Rauchen assoziiert ist. (kardiovaskuläre Erkrankungen) EvG 2a		• Current smokers are more than 7x likely to have an aneurysm than nonsmokers, ... • Each year of smoking increases the relative risk for AAA development of by 4%.⁴⁸

Rauchen als Risikofaktor bei AAA

Prof. Dr. C. Bünge

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- ... that smoking increased the rate of aneurysm enlargement by **35%**.⁹

Patienten sollen von ... Ärzten angehalten werden, das **Rauchen aufzugeben**, speziell auch nach AAA-Versorgung.
EG A/
EvG 2a

Recommendation 18

Patients with a small abdominal aortic aneurysm are recommended to stop smoking (to reduce the abdominal aortic aneurysm growth rate and risk of rupture) and to receive help to do this

Class	Level	References
I	B	[176,91]

Medical management during the period of AAA surveillance. We recommend smoking cessation to reduce the risk of AAA growth and rupture.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

- ... smoking cessation is ... associated with an ... **20%** reduction in growth rate, as well as halving the risk of aneurysm rupture.⁹¹

... the risk of AAA after smoking cessation declines more rapidly in **women** than in men.⁶⁴

Rauchen als Risikofaktor für AAA

Prof. Dr. C. Büniger

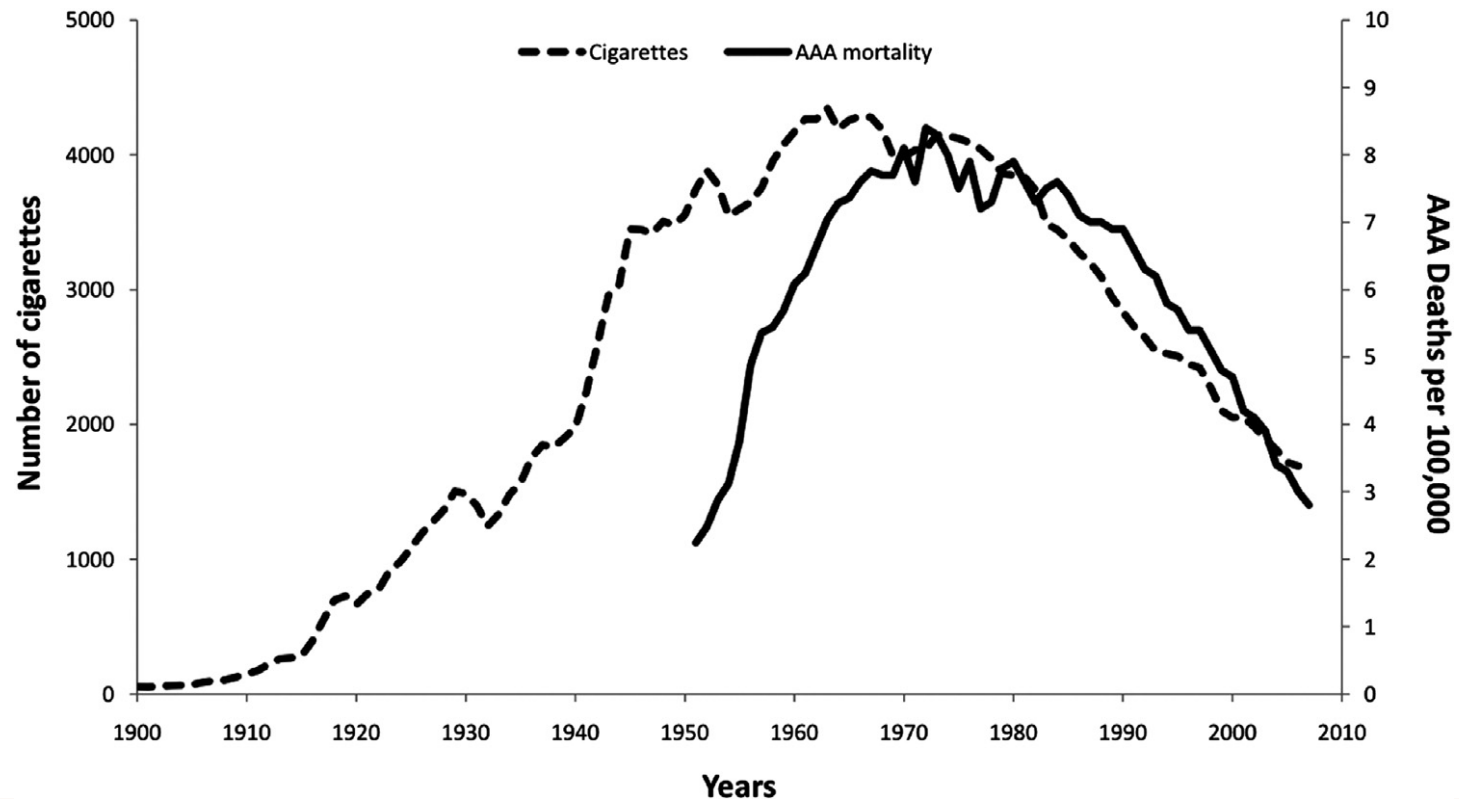


Fig 1. The annual adult per capita cigarette consumption and age-adjusted abdominal aortic aneurysm (AAA) deaths per 100,000 white men by year in the United States. (From Lederle FA. The rise and fall of abdominal aortic aneurysm. Circulation 2011;124:1097-9.).

AAA-Wachstum

Prof. Dr. C. Bünner

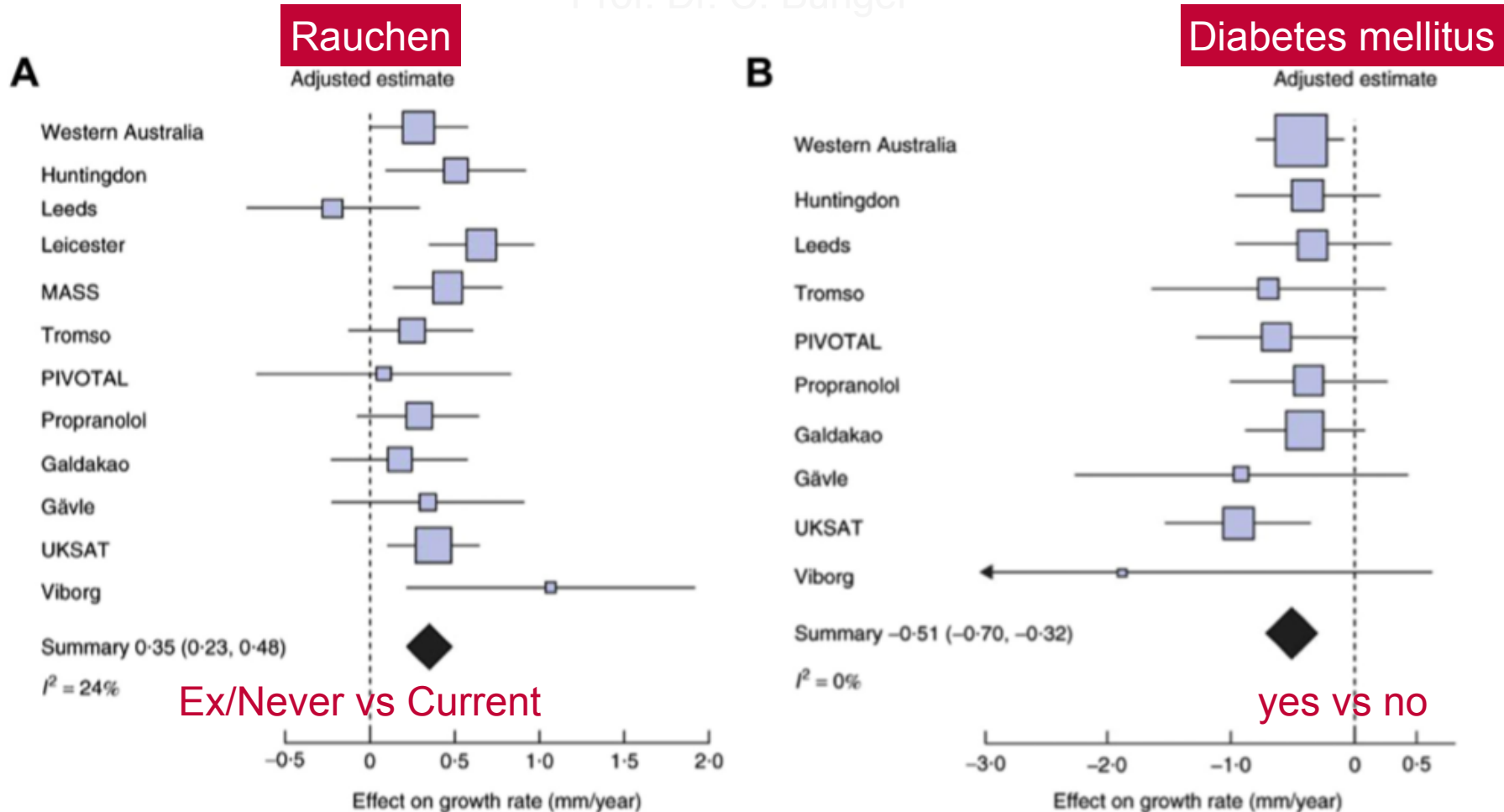


Fig 2. A, Influence of smoking (current vs ex/never) on aneurysm enlargement in individual studies and meta-analysis (see primary source for individual study citations). **B,** Influence of diabetes on aneurysm enlargement in individual studies and meta-analysis (see primary source for individual study citations). MASS, Multicenter Aneurysm Screening Study; PIVOTAL, Positive Impact of Endovascular Options for Treating Aneurysm Early; UKSAT, UK Small Aneurysm Trial. (From Sweeting MJ, Thompson SG, Brown LC, Powell JT. Meta-analysis of individual patient data to examine factors affecting growth and rupture of small abdominal aortic aneurysms. Br J Surg 2012;99:655-65.).

AAA-Risikofaktoren

Prof. Dr. C. Büniger

Table II. Risk factors for the development of an abdominal aortic aneurysm (AAA)

Variable	Estimate	P	OR	95% CI	Score
Male (vs female)	1.74	<.0001	5.71	5.57-5.85	18
Age, years (vs <55 years)					
55-59	1.01	<.0001	2.76	2.55-3.00	11
60-64	1.68	<.0001	5.35	4.97-5.76	17
65-69	2.24	<.0001	9.41	8.76-10.12	23
70-74	2.67	<.0001	14.46	13.45-15.55	28
75-79	3.02	<.0001	20.43	18.99-21.99	31
80-84	3.35	<.0001	28.37	26.31-30.59	35
Race/ethnicity (vs white)					
Hispanic	-0.37	<.0001	0.69		
African American	-0.33	<.0001	0.72		
Asian	-0.41	<.0001	0.72		
High blood pressure	0.22	<.0001	1.25		
Coronary artery disease	0.54	<.0001	1.72		
Family history of AAA	1.34	<.0001	3.80		
High cholesterol	0.29	<.0001	1.34		
Diabetes	-0.29	<.0001	0.75		
Peripheral arterial disease	0.47	<.0001	1.59		
Carotid disease	0.41	<.0001	1.51		
Cerebrovascular history	0.16	<.0001	1.18		
Smoking, packs/day					
≤10 years					
<0.5	0.96	<.0001	2.61		
0.5-1	1.16	<.0001	3.19		
>1	1.16	<.0001	3.20		
11-20 years					
<0.5	1.58	<.0001	4.87		
0.5-1	1.76	<.0001	5.79		
>1	1.79	<.0001	6.00		
21-35 years					
<0.5	2.09	<.0001	7.29		
0.5-1	2.06	<.0001	7.99		
>1	2.13	<.0001	8.41		
>35 years					
<0.5	2.19	<.0001	8.96		
0.5-1	2.42	<.0001	11.19		
>1	2.50	<.0001	12.13		
Quit smoking					
<5 years ago	-0.14	<.0001	0.87		
5-10 years ago	-0.39	<.0001	0.68		
>10 years ago	-0.87	<.0001	0.42	0.41-0.43	-9
Fruits and vegetables, >3 times/week	-0.10	<.0001	0.91	0.88-0.92	-1
Nuts, >3 times/week	-0.11	<.0001	0.90	0.89-0.93	-1
Exercise, ≥1 time/week	-0.15	<.0001	0.86	0.85-0.88	-2
BMI ≥25 kg/m ²	0.18	<.0001	1.20	1.17-1.22	2

BMI, Body mass index; CI, confidence interval; OR, odds ratio.
 The model was developed on 50% of the Life Line Screening cohort and validated on the other 50%. The area under the receiver operating characteristic curve of the model (C statistic) was 0.893. From this model, a scoring system was derived. The overall accuracy of the scoring system as measured by the C statistic was 0.842.
 From Kent KC, Zwolak RM, Egorova NN, Riles TS, Manganaro A, Moskowitz AJ, et al. Analysis of risk factors for abdominal aortic aneurysm in a cohort of more than 3 million individuals. J Vasc Surg 2010;52:539-48.

	OR
High blood pressure	1.25
Coronary artery disease	1.72
Family history of AAA	3.80
High cholesterol	1.34
Diabetes	0.75
Peripheral arterial disease	1.59
Carotid disease	1.51
Cerebrovascular history	1.18

Risikofaktoren für AAA-Ruptur

AAA-Rupturrisiko

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3,5% für AAA von 5,5 bis 6,0 cm
4,1% für AAA von 6,1 bis 7,0 cm
6,3% für AAA > 7,0 cm
(bei Nichteignung für einen
operativen Eingriff):
EvG 2b

ESVS 2019

- The risk of rupture for small AAA is about four times higher in **women** than men.^{171,91,198}

SVS 01/2018

- ...**female gender, large initial aneurysm diameter, low FEV1, current smoking history, and elevated mean blood pressure.**^{57,58}

Table 4 12-month AAA rupture risk by diameter.^{8,82–84}

AAA Diameter	Rupture Risk (%)
30–39	0
40–49	1
50–59	1.0–11
60–69	10–22
>70	30–33

AAA, abdominal aortic aneurysm.

ESVS 2011

- Multiple studies have suggested that **women** are at **greater risk** for rupture,^{59,60} as are patients receiving **immunomodulatory therapy** after major organ transplantation.^{61–63}

- Increased **aortic mural calcification** has also been suggested as a risk factor for rupture.⁶⁵

AAA-Rupturrisiko

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SVS 01/2018

Recommendation 5

Once the intervention threshold has been reached, the waiting time for vascular surgical care is recommended to be kept to a minimum, with an eight week pathway as a reasonable upper limit from referral to elective treatment of abdominal aortic aneurysms^{*}

Class	Level	References
I	C	[52,53,55,56,51,50,54]

* A shorter timeframe should be considered for larger abdominal aortic aneurysms while a lengthier planning or work up time may be justified for more complex aneurysms or comorbid patients.

Screening

Ultraschalltechnik

Prof. Dr. C. Bunger

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Recommendation 7

Ultrasonography is recommended for the first line diagnosis and surveillance of small abdominal aortic aneurysms

Class	Level	References
I	B	[111,71,103,112]

Aneurysm imaging. We recommend using ultrasound, when feasible, as the preferred imaging modality for aneurysm screening and surveillance.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Recommendation 8

The antero-posterior measuring plane with a consistent calliper placement should be considered the preferred method for ultrasound abdominal aortic diameter measurement

Class	Level	References
IIa	B	[108,106,75,76,103,77]

We suggest that the maximum aneurysm diameter derived from computed tomography (CT) imaging should be based on an outer wall to outer wall measurement perpendicular to the path of the aorta.

Level of recommendation	Good Practice Statement
Quality of evidence	Ungraded

Die **Leading-edge-Methode** in senkrechter Messung rechtwinklig zur Langsachse des Gefaes soll fur das Ultraschallscreening angewandt werden.
EG A/ EvG 3b

Ultraschalltechnik

Prof. Dr. C. Bünner

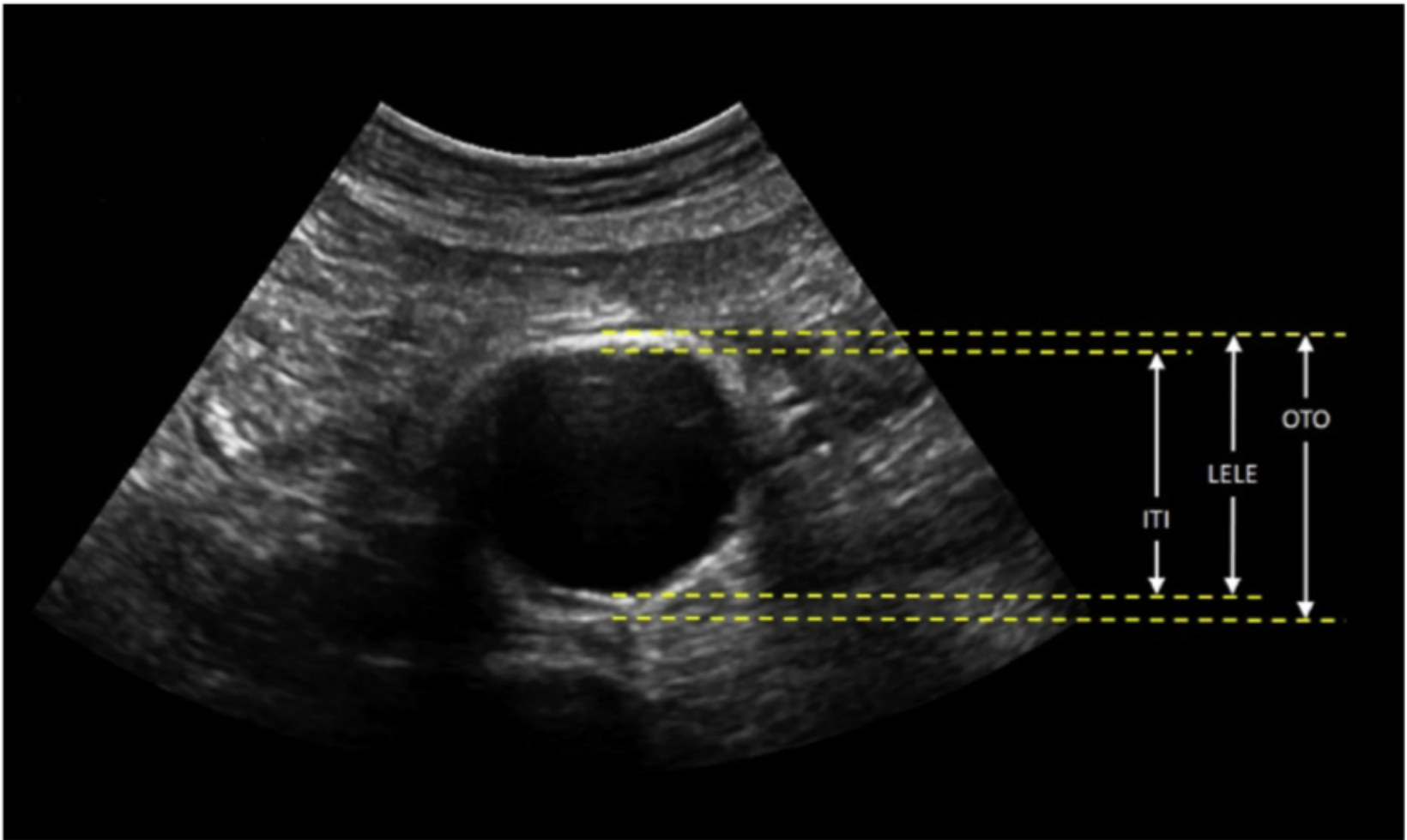


Figure 2.1. Caliper placement for measurement of aortic diameter. ITI = inner to inner; LELE = leading edge to leading edge; OTO = outer to outer.

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RCT Screening

Prof. Dr. C. Bünge

Table 2.1. Summary of randomised trials of population based screening for abdominal aortic aneurysm in men.

Trial characteristics	Chichester UK, ¹³⁵	Viborg Denmark, ¹³²	MASS UK, ¹³³	Western Australia, ¹³⁴
Number randomised	15,775	12,628	67,800	41,000
Gender	Men and women	Men	Men	Men
Age (year)	65–80	65–73	65–74	65–79
Period recruited	1988–1990	1994–1998	1997–1999	1996–1998
Year published	1995	2002	2002	2004
Attendance rate	68%	76%	80%	70% ^a
AAA detection rate	4% (7.6% in men)	4%	4.9%	7.2%
Place of screening	Hospital	Hospital	Community	Community
Intervention policy	At 6.0 cm	At 5.0 cm measured as external diameter	At 5.5 cm measured as internal diameter	none
Mean follow up (year)	4.1	13.0	13.1	12.8
AAA mortality, odds ratio (95% CI) Screened vs. not	0.59 men only (0.27–1.29)	0.31 (0.13–0.79)	0.58 (0.42–0.78)	0.91 (0.68–1.21)
All cause mortality, odds ratio (95% CI) Screened vs. not	1.07 (men only) (0.93–1.22)	0.98 (0.95–1.02)	0.97 (0.93–1.02)	0.98 (0.96–1.01)

Screening

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**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Soll allen Männern
> 65 Jahre
empfohlen werden.
EG A/ EvG 1a

Recommendation 12

Population screening for abdominal aortic aneurysm with a single ultrasound scan for all men at age 65 years is recommended

Class	Level	References
I	A	[139,142,132,144,133-137,143]

We recommend a one-time ultrasound screening for AAAs in men or women 65 to 75 years of age with a history of tobacco use.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Soll Frauen > 65
Jahre mit einer
jetzigen oder
vergangenen
Raucheranamnese
empfohlen werden.
EG A/ EvG 2a

We suggest a one-time ultrasound screening for AAAs in men or women older than 75 years with a history of tobacco use and in otherwise good health who have not previously received a screening ultrasound examination.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Recommendation 13

Men with an aorta 2.5–2.9 cm in diameter at initial screening may be considered for rescreening after 5–10 years

Class	Level	References
IIb	C	[159,92,151-154,158,157]

Screening

Prof. Dr. C. Bünge

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

**Nichtraucherinnen
mit fehlender
Familienanamnese
nicht empfehlen**
EG B/ EvG 2a

Recommendation 14

Population screening for abdominal aortic aneurysm in women is not recommended

Class	Level	References
III	B	[161,138,162,74]

In patients with a suspected or known AAA, we recommend performing physical examination that includes an assessment of femoral and popliteal arteries.

In patients with a popliteal or femoral artery aneurysm, we recommend evaluation for an AAA.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

**Sollte bei
Geschwistern 1.
Grades eines
Patienten mit AAA
erwogen werden.**
EG B/ EvG 2c

Recommendation 15

All men and women aged 50 years and older with a first degree relative with an abdominal aortic aneurysm may be considered for abdominal aortic aneurysm screening at 10 year intervals

Class	Level	References
IIb	C	[165,164,166]

We suggest ultrasound screening for AAA in first-degree relatives of patients who present with an AAA. Screening should be performed in first-degree relatives who are between 65 and 75 years of age or in those older than 75 years and in good health.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Recommendation 16

Screening for abdominal aortic aneurysm at 5–10 year intervals may be considered for all men and women with a true peripheral arterial aneurysm

Class	Level	References
IIb	C	[167]

Surveillance

Surveillance Ektasie

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S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
		If initial ultrasound screening identified an aortic diameter >2.5 cm but <3 cm, we suggest <u>rescreening after 10 years</u>. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Level of recommendation	2 (Weak)					
Quality of evidence	C (Low)					
		The decision to treat. We suggest referral to a <u>vascular surgeon</u> at the time of initial diagnosis of an aortic aneurysm. <table><tr><td>Level of recommendation</td><td>Good Practice Statement</td></tr><tr><td>Quality of evidence</td><td>Ungraded</td></tr></table>	Level of recommendation	Good Practice Statement	Quality of evidence	Ungraded
Level of recommendation	Good Practice Statement					
Quality of evidence	Ungraded					

Surveillance kleiner AAA Männer

Prof. Dr. C. Bünge

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018																
DM 3,0-3,9 cm: <u>Alle 2 Jahre</u> EG A/ EvG 2a		We suggest surveillance imaging at <u>3-year intervals</u> for patients with an AAA between 3.0 and 3.9 cm. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)												
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	
DM 4,0 bis 4,9 cm: <u>1-mal jährlich</u> EG A/ EvG 2a	<table><tr><td colspan="3">Recommendation 17</td></tr><tr><td colspan="3">Ultrasonography is recommended for aneurysm surveillance; every three years for aneurysms 3–3.9 cm in diameter, annually for aneurysms 4.0–4.9 cm, and <u>every 3–6 month</u> for aneurysms ≥5.0 cm</td></tr><tr><td>Class</td><td>Level</td><td>References</td></tr><tr><td>I</td><td>B</td><td>[171]</td></tr></table>	Recommendation 17			Ultrasonography is recommended for aneurysm surveillance; every three years for aneurysms 3–3.9 cm in diameter, annually for aneurysms 4.0–4.9 cm, and <u>every 3–6 month</u> for aneurysms ≥5.0 cm			Class	Level	References	I	B	[171]	We suggest surveillance imaging at 12-month intervals for patients with an AAA of 4.0 to 4.9 cm in diameter. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Recommendation 17																		
Ultrasonography is recommended for aneurysm surveillance; every three years for aneurysms 3–3.9 cm in diameter, annually for aneurysms 4.0–4.9 cm, and <u>every 3–6 month</u> for aneurysms ≥5.0 cm																		
Class	Level	References																
I	B	[171]																
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	
DM 5,0-5,4 cm: <u>Alle 6 Monate</u> EG A/ EvG 2a		We suggest surveillance imaging at 6-month intervals for patients with an AAA between 5.0 and 5.4 cm in diameter. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)												
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	

Surveillance kleiner AAA bei Frauen

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S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
DM 3,0 bis 3,9 cm: <u>Alle 2 bis 3 Jahre</u> DM 4,0 bis 4,5 cm: <u>Alle 6 Monate *</u> DM > 4,5 bis 4,9 cm: <u>Alle 3 Monate *</u> EG B/ EvG 3b		

* Bei Größenkonstanz
kann das Intervall
verlängert werden

Wachstumsgeschwindigkeit AAA Männer

Jahre bis Durchmesser von 5.5cm erreicht wird (10% Wahrscheinlichkeit)

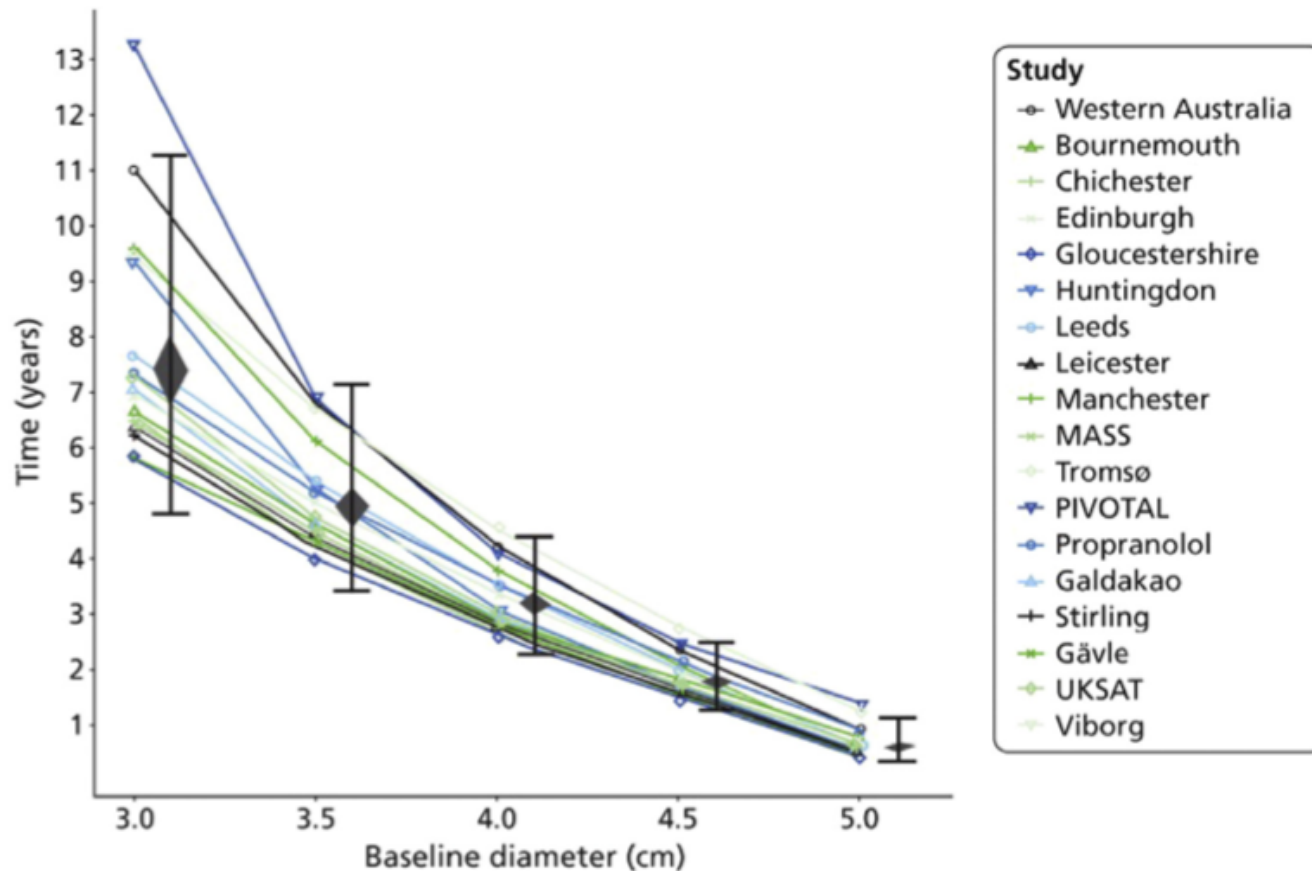


Fig 4. Estimated time to have a 10% probability of attaining an aortic diameter of 5.5 cm in male patients (see primary source for individual study citations). The *black diamonds* represent 95% confidence intervals and *error bars* represent 95% prediction intervals. MASS, Multicenter Aneurysm Screening Study; PIVOTAL, Positive Impact of Endovascular Options for Treating Aneurysm Early; UKSAT, UK Small Aneurysm Trial. (Adapted from Thompson SG, Brown LC, Sweeting MJ, Bown MJ, Kim LG, Glover MJ, et al. Systematic review and meta-analysis of the growth and rupture rates of small abdominal aortic aneurysms: implications for surveillance intervals and their cost-effectiveness. Health Technol Assess 2013;17:1-118.).

Wachstumsgeschwindigkeit von AAA

Prof. **mm/Jahr**inger

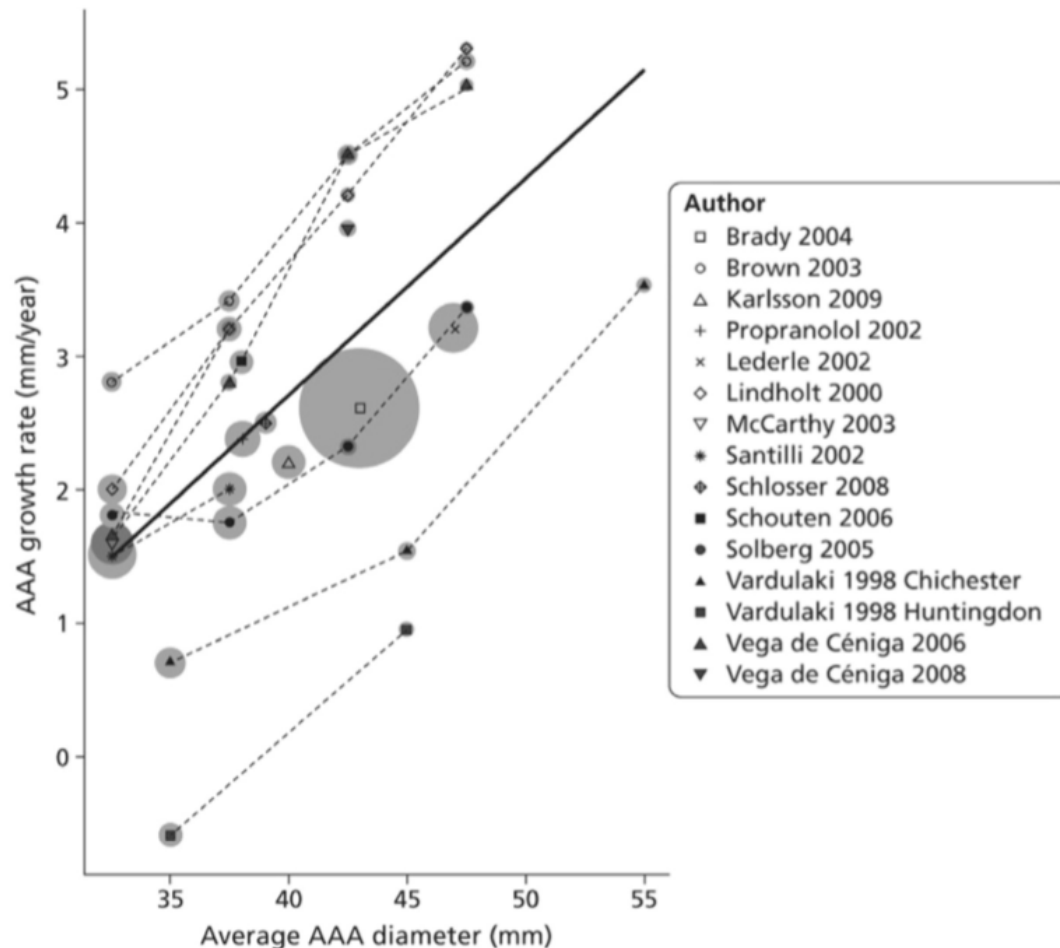


Fig 3. Meta-regression of abdominal aortic aneurysm (AAA) growth rate estimates by aneurysm diameter (see primary source for individual study citations). The *solid line* represents the overall regression, the *dotted line* connects estimates from the same study, and *circles* have diameters that represent amount of information. (Adapted from Thompson SG, Brown LC, Sweeting MJ, Bown MJ, Kim LG, Glover MJ, et al. Systematic review and meta-analysis of the growth and rupture rates of small abdominal aortic aneurysms: implications for surveillance intervals and their cost-effectiveness. *Health Technol Assess* 2013;17:1-118.).

Konservative Therapie

Statine bei AAA

Prof. Dr. C. Bünker

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

... und kardiovaskulärer Komorbidität sollen zur kardiovaskulären Protektion **Statine erhalten**, sofern keine Kontraindikationen bestehen.

EG A/ EvG 2a

Recommendation 21

Blood pressure control, statins and antiplatelet therapy should be considered in all patients with abdominal aortic aneurysm

Class	Level	References
Ila	B	[180,184,181,182,186]

We suggest not administering statins, doxycycline, roxithromycin, ACE inhibitors, or angiotensin receptor blockers for the sole purpose of reducing the risk of AAA expansion and rupture.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

- ... showed that the **five year survival rates** were significantly **improved** for those taking statins (68% vs. 42%), compared with AAA patients not taking these medications.¹⁸⁴

☑ **Überlebensvorteil von >20% nach 5 Jahren**

Periprozedurale Statintherapie

Prof. Dr. C. Büngrer

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018												
... sollte bei Patienten mit einem Gefäßeingriff erwogen werden, idealerweise wenigstens zwei Wochen vor dem Eingriff. EG B/ EvG 2a	<table><tr><th colspan="3">Recommendation 44</th></tr><tr><td colspan="3">Statins are recommended before (if possible, at least 4 weeks) elective abdominal aortic aneurysm surgery to reduce cardiovascular morbidity</td></tr><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>I</td><td>A</td><td>[252,254,253,255]</td></tr></table>	Recommendation 44			Statins are recommended before (if possible, at least 4 weeks) elective abdominal aortic aneurysm surgery to reduce cardiovascular morbidity			Class	Level	References	I	A	[252,254,253,255]	
Recommendation 44														
Statins are recommended before (if possible, at least 4 weeks) elective abdominal aortic aneurysm surgery to reduce cardiovascular morbidity														
Class	Level	References												
I	A	[252,254,253,255]												

☑ 2-4 Wochen vor dem Eingriff beginnen

Thrombozytenaggregationshemmer

Prof. Dr. C. Büniger

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018												
Bei kardiovaskulärer Komorbidität sollten Patienten mit AAA die Therapie mit TAH empfohlen werden. EG B/ EvG 2a	<table border="1"> <tr> <th colspan="3">Recommendation 21</th></tr> <tr> <td colspan="3">Blood pressure control, statins and antiplatelet therapy should be considered in all patients with abdominal aortic aneurysm</td></tr> <tr> <th>Class</th><th>Level</th><th>References</th></tr> <tr> <td>Ila</td><td>B</td><td>[180,184,181,182,186]</td></tr> </table>	Recommendation 21			Blood pressure control, statins and antiplatelet therapy should be considered in all patients with abdominal aortic aneurysm			Class	Level	References	Ila	B	[180,184,181,182,186]	
Recommendation 21														
Blood pressure control, statins and antiplatelet therapy should be considered in all patients with abdominal aortic aneurysm														
Class	Level	References												
Ila	B	[180,184,181,182,186]												
	... showed that the five year survival rates were significantly improved for those <u>taking antiplatelet therapy</u> (64% vs. 40%) compared with AAA patients not taking these medications.¹⁸⁴													

☑ Überlebensvorteil von >20% nach 5 Jahren

Antihypertonika bei AAA

Prof. Dr. C. Büniger

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS
01/2018

Eine Kontrolle des Blutdrucks und **Therapie des Hypertonus** soll bei allen Patienten mit AAA zur Prävention kardiovaskul. Komplikationen durchgeführt werden.

EG A/ EvG 1a

Recommendation 21

Blood pressure control, statins and antiplatelet therapy should be considered in all patients with abdominal aortic aneurysm

Class	Level	References
Ila	B	[180,184,181,182,186]

- ... that the **5y-survival rates** were significantly improved for those taking antihypertensive agents (62% vs. 39%) compared with AAA patients not taking these medications.¹⁸⁴

☑ Überlebensvorteil von >20% nach 5 Jahren

Antiinfektiöse Therapie

Prof. Dr. C. Büniger

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
Die medikamentöse Behandlung kleiner AAA mit Doxycyclin soll nicht durchgeführt werden. EG A/ EvG 2b		We suggest <u>not administering</u> statins, <u>doxycycline</u>, rox- ithromycin, ACE inhibitors, or angiotensin receptor blockers for the sole purpose of reducing the risk of AAA expansion and rupture. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Level of recommendation	2 (Weak)					
Quality of evidence	C (Low)					

Andere Ansätze

Prof. Dr. C. Bünge

S3-Leitlinie
AWMF
07/2018

ESVS 2019

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Recommendation 19

No specific medical therapy has been proven to slow the expansion rate of an abdominal aortic aneurysm, and therefore is not recommended

Class	Level	References
III	A	[172,174]

We suggest not administering beta blocker therapy for the sole purpose of reducing the risk of AAA expansion and rupture.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

- Patients with **diabetes** also have a **slower AAA growth rate** than patients without diabetes, which has recently been suggested to be related to the metformin, used to treat type II diabetes

177,178,91

Recommendation 20

Strategies targetted at a healthy lifestyle, including exercise and a healthy diet, should be considered in all patients with abdominal aortic aneurysm

Class	Level	References
IIa	B	[184,181,182]

Risikoevaluation Begleiterkrankungen

Risikoevaluation

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Bei Patienten mit dialysepflichtiger NI und Patienten mit sauerstoffpflichtiger COPD ist der Nutzen einer elektiven AAA Versorgung **nicht** gesichert.

Recommendation 62

In patients with limited life expectancy, elective abdominal aortic aneurysm repair is not recommended

Class	Level	References
III	B	[52,53,203,204]

Recommendation 26

Patients who initially are not candidates for abdominal aortic aneurysm repair should be considered for continued surveillance, referral to other specialists for optimisation of their fitness status and then reassessed

Class	Level	References
IIa	C	[202-204]

Risikoevaluation

Prof. Dr. C. Büngrer

Table 4.2. Risk factors for cardiac, respiratory, and renal complications after abdominal aortic aneurysm repair, according to ^{221, 222}

Predictors of <u>cardiac</u> complications	Predictors of <u>pulmonary</u> complications	Predictors of <u>renal</u> complications
Age	Age ≥ 60 year	Pre-existing renal insufficiency
History of symptomatic ischaemic heart disease	Pre-existing chronic obstructive lung disease	Congestive heart disease
History of congestive heart failure	Congestive heart failure	Chronic obstructive lung disease
History of symptomatic cerebrovascular disease	Serum albumin level ≤ 35 g/L	Peripheral arterial occlusive disease
Creatinine clearance < 60 mL/min or serum creatinine > 170 μ mol/L	FEV1 $< 70\%$ of expected	Diabetes mellitus
Diabetes mellitus	FVC $< 70\%$ of expected	Arterial hypertension
Functional status in terms of independent living	FEV1/FVC < 0.65	
American Society of Anaesthesiology class 3/4		

FEV1 = forced expiratory volume in 1 s; FVC = forced vital capacity.

Kardiales Risiko

Abschätzung kardiales Risiko bei Aortenchirurgie

Herzinsuffizienz

KHK (Angina pectoris und/oder Z. n. Myokardinfarkt)

Zerebrovaskuläre Insuffizienz (Apoplex oder TIA)

Diabetes mellitus (insulinpflichtig)

Niereninsuffizienz (Kreatinin >2 mg/dl)

GCP zur Abklärung des kardialen Risikos

Prof. Dr. C. Büniger

Abschätzung des kardialen Risikos mit dem Revised Cardiac Risk Index (RCRI)

BNP- bzw. NT-proBNP (N-terminales pro-BNP)

bei kardialen Hochrisikopatienten (Belastbarkeit <4 MET, Revised Cardiac Risk Index (RCRI) >1)

12-Kanal-EKG bei anamnestisch auffälligen oder kardial symptomatischen Patienten

Nichtinvasive kardiale Belastungstests bei Patienten mit ≥ 3 klinischen Risikofaktoren und eingeschränkter (<4 MET) Belastbarkeit

Präoperative Koronarangiographie bei Patienten mit nachgewiesener myokardialer Ischämie

Präoperative Echokardiographie bei neu aufgetretener Dyspnoe unklarer Genese sowie bei bekannter Herzinsuffizienz und Symptomverschlechterung innerhalb der letzten 12 Monate

Präoperative Abklärung/ Optimierung

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Recommendation 27

Routine referral for cardiac work up, coronary angiography and cardiopulmonary exercise testing is not recommended prior to abdominal aortic aneurysm repair

Class	Level	References
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III	C	[213,210]
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Recommendation 29

In patients with stable coronary artery disease, routine coronary revascularisation before elective abdominal aortic aneurysm repair is not recommended

Class	Level	References
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III	B	[213,210,228]
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Präoperative Abklärung/ Optimierung

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Recommendation 28

In patients with poor functional capacity (defined as ≤ 4 metabolic equivalents) or with significant clinical risk factors (such as unstable angina, decompensated heart failure, severe valvular disease, and significant arrhythmia), referral for cardiac work up and optimisation is recommended prior to elective abdominal aortic aneurysm repair

Class	Level	References
I	C	[213,210]

Assessment of medical comorbidities. In patients with active cardiac conditions, including unstable angina, decompensated heart failure, severe valvular disease, and significant arrhythmia, we recommend cardiology consultation before endovascular aneurysm repair (EVAR) or open surgical repair (OSR).

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

In patients with significant clinical risk factors, such as coronary artery disease, congestive heart failure, cerebrovascular disease, diabetes mellitus, chronic renal insufficiency, and unknown or poor functional capacity (metabolic equivalent [MET] < 4), who are to undergo OSR or EVAR, we suggest noninvasive stress testing.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

Metabolische Äquivalente (MET) bestimmter Aktivitäten (modifiziert nach Böhmer et al. 2014)

Prof. Dr. C. Böhmer

MET	Aktivität
1	- Lesen, Fernsehen - Essen, Anziehen
2-3	- Gehen auf ebenem Grund mit ca. 3–4 km/h - Leichte Hausarbeit
4	- Ersteigen weniger Treppenstufen - Gehen auf ebenem Grund mit ca. 6 km/h - Rennen (kurze Strecke) - Schwere Hausarbeit - Mäßiger Ausdauersport (Golf, Tanzen)
 > 10	Anstrengender Ausdauersport (Tennis, Fußball)

Metabolische Äquivalente (MET) bestimmter Aktivitäten (Leitlinie ...)

Prof. Dr. C. Bünge

Table 4.3. Functional capacity estimation based on physical activity, according to Ainsworth et al.²²⁶

Activity level	Example of activity
Poor (MET < 4)	Eating, getting dressed, light housework (washing dishes, cooking, making bed)
Moderate (MET 4–7)	Climbing two flights of stairs, walking up a hill, jogging < 10 min, heavy housework (scrubbing floor or moving furniture), hand mowing lawn, shovelling snow by hand
Good (MET 7–10)	Tennis, bicycling at moderate pace, leisure swimming, jogging > 10 min
Excellent (MET > 10)	Strenuous sports such as uphill mountain bicycling, football, basketball, karate, running 10 km/h or more

MET = metabolic equivalent.

Table IV. Functional capacity estimation from an assessment of physical activity

Activity level	Examples of activity level
Poor (1-3 METs)	Eating, walking at 2-3 mph, getting dressed, light housework (washing dishes)
Moderate (4-7 METs)	Climbing a flight of stairs or walking up a hill, running a short distance, heavy housework (scrubbing floors or moving furniture)
Good (7-10 METs)	Doubles tennis, calisthenics without weights, golfing without cart
Excellent (>10 METs)	Strenuous sports such as football, basketball, singles tennis, karate, jogging 10-minute mile or more, chopping wood

METs, Metabolic equivalents (1 MET = 3.5 mL kg⁻¹ min⁻¹ oxygen uptake).

From Chaikof EL, Brewster DC, Dalman RL, Makaroun MS, Illig KA, Sicard GA, et al. The care of patients with an abdominal aortic aneurysm: the Society for Vascular Surgery practice guidelines. J Vasc Surg 2009;50(Suppl):S2-49; originally adapted from Hlatky MA, Boineau RE, Higginbotham MB, Lee KL, Mark DB, Califf RM, et al. A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). Am J Cardiol 1989;64:651-4.

Präoperative Abklärung/ Optimierung

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018																
		We recommend a preoperative resting <u>12-lead electrocardiogram (ECG) in all patients</u> undergoing EVAR or OSR within 30 days of planned treatment. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>B (Moderate)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	B (Moderate)												
Level of recommendation	1 (Strong)																	
Quality of evidence	B (Moderate)																	
		We recommend <u>echocardiography</u> before planned operative repair <u>in patients with dyspnea</u> of unknown origin or worsening dyspnea. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)												
Level of recommendation	1 (Strong)																	
Quality of evidence	A (High)																	
	<table><tr><td colspan="3">Recommendation 43</td></tr><tr><td colspan="3"><u>Commencement of beta blockers is not recommended prior to abdominal aortic aneurysm repair</u></td></tr><tr><td>Class</td><td>Level</td><td>References</td></tr><tr><td>III</td><td>A</td><td>[249,251,250]</td></tr></table>	Recommendation 43			<u>Commencement of beta blockers is not recommended prior to abdominal aortic aneurysm repair</u>			Class	Level	References	III	A	[249,251,250]	We suggest <u>continuation of beta blocker</u> therapy during the perioperative period if it is part of an established medical regimen. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>B (Moderate)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	B (Moderate)
Recommendation 43																		
<u>Commencement of beta blockers is not recommended prior to abdominal aortic aneurysm repair</u>																		
Class	Level	References																
III	A	[249,251,250]																
Level of recommendation	2 (Weak)																	
Quality of evidence	B (Moderate)																	
		If a decision was made to <u>start beta blocker</u> therapy (because of the presence of <u>multiple risk factors</u>, such as coronary artery disease, renal insufficiency, and diabetes), we suggest initiation <u>well in advance</u> of surgery to allow sufficient time to assess safety and tolerability. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>B (Moderate)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	B (Moderate)												
Level of recommendation	2 (Weak)																	
Quality of evidence	B (Moderate)																	

Kardiale Abklärung/ Optimierung

S3-Leitlinie AWMF
07/2018

ESVS 2019

SVS 01/2018

Recommendation 31

In patients with moderate to severe heart failure, pharmacological optimisation of heart failure under expert guidance should be considered before elective abdominal aortic aneurysm repair

Class	Level	References
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IIa	C	[230]
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Recommendation 32

In patients with severe aortic valve stenosis, evaluation for aortic valve replacement prior to elective abdominal aortic aneurysm repair is recommended

Class	Level	References
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I	B	[213,210,231,228]
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Recommendation 33

In patients on dual antiplatelet therapy after interventional coronary revascularisation, delaying abdominal aortic aneurysm repair until reduction to monotherapy, may be considered. Alternatively, if AAA repair becomes necessary, EVAR may be considered under dual antiplatelet therapy

Class	Level	References
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IIb	C	[229]
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Präoperative Koronarrevaskularisation

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

**Instabile Angina,
stabile Angina mit
Erkrankung des linken
Hauptstamms,
3-Gefäßerkrankung
akuter Herzinfarkt
EG B/ EvG 2b**

Recommendation 30

In patients with unstable coronary artery disease or considered to be at high risk of cardiac events following abdominal aortic aneurysm repair, prophylactic pre-operative coronary revascularisation should be considered

Class	Level	References
Ila	B	[213,210,228]

We suggest coronary revascularization before aneurysm repair in patients with acute ST-segment or non-ST-segment elevation myocardial infarction (MI), unstable angina, or stable angina with left main coronary artery or three-vessel disease.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

We suggest coronary revascularization before aneurysm repair in patients with stable angina and two-vessel disease that includes the proximal left descending artery and either ischemia on noninvasive stress testing or reduced left ventricular function (ejection fraction < 50%).

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

In patients who may need aneurysm repair in the subsequent 12 months and in whom percutaneous coronary intervention is indicated, we suggest a strategy of balloon angioplasty or bare-metal stent placement, followed by 4 to 6 weeks of dual antiplatelet therapy.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

Präoperative Koronarrevaskularisation

Prof. Dr. C. Böhm

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		We suggest <u>deferring elective aneurysm repair for 30 days</u> after bare-metal stent placement or coronary artery bypass surgery if clinical circumstances permit. As an alternative, <u>EVAR</u> may be performed with uninterrupted continuation of <u>dual antiplatelet therapy</u>. Level of recommendation 2 (Weak) Quality of evidence B (Moderate)
		We suggest <u>deferring</u> open aneurysm repair for at least <u>6 months</u> after drug-eluting coronary stent placement or, alternatively, performing <u>EVAR with continuation of dual antiplatelet therapy</u>. Level of recommendation 2 (Weak) Quality of evidence B (Moderate)
		In patients with a drug-eluting coronary stent requiring open aneurysm repair, we recommend <u>discontinuation of P2Y₁₂ platelet receptor inhibitor</u> therapy 10 days preoperatively with continuation of aspirin. The P2Y₁₂ inhibitor should be restarted as soon as possible after surgery. The relative risks and benefits of perioperative bleeding and stent thrombosis should be discussed with the patient. Level of recommendation 1 (Strong) Quality of evidence B (Moderate)

Pulmonales Risiko

Pulmonales Risiko

S3-Leitlinie AWMF
07/2018

ESVS 2019

SVS 01/2018

Eine präprozedurale Lufu sollte bei V.a. auf pulmonale Erkrankung durchgeführt werden.
EG B/ EvG 3b

Recommendation 34

In all patients, pulmonary function testing with spirometry prior to elective abdominal aortic aneurysm repair should be considered

Class	Level	References
Ila	C	[214]

We recommend smoking cessation for at least 2 weeks before aneurysm repair.

Level of recommendation	1 (Strong)
Quality of evidence	C (Low)

Recommendation 35

In patients with risk factors for pulmonary complications or a recent decline in respiratory function, specialist referral for respiratory work up and optimisation is recommended prior to elective abdominal aortic aneurysm repair

Class	Level	References
I	C	[214,215]

We suggest preoperative pulmonary function studies, including room air arterial blood gas determinations, in patients with a history of symptomatic chronic obstructive pulmonary disease (COPD), long-standing tobacco use, or inability to climb one flight of stairs.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Recommendation 36

Routine chest Xray prior to abdominal aortic aneurysm repair is not recommended

Class	Level	References
III	C	[214,215]

We suggest administration of pulmonary bronchodilators for at least 2 weeks before aneurysm repair in patients with a history of COPD or abnormal results of pulmonary function testing.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Renales Risiko

Renales Risiko

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

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Recommendation 37

In patients undergoing abdominal aortic aneurysm repair, assessment of pre-operative kidney function by measuring serum creatinine and estimating GFR is recommended, and those with severe renal impairment (estimated Glomerular Filtration Rate <30 mL/min/1.73 m²) should be referred to a renal physician

Class	Level	References
I	C	[238,211,239]

We suggest holding angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor antagonists on the morning of surgery and restarting these agents after the procedure once euolemia has been achieved.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Eine prä- und postinterventionelle **Hydrierung** soll bei NI und EVAR insbesondere zur Vermeidung einer kontrastmittelbedingten Nephropathie erfolgen.
EG A/ EvG 1b

Recommendation 38

Patients with renal impairment should be adequately hydrated before elective abdominal aortic aneurysm repair, and estimated glomerular filtration rate, fluid input, and urine output should be monitored after abdominal aortic aneurysm repair to recognise and manage reduced kidney function

Class	Level	References
I	C	[211]

We recommend preoperative hydration in nondialysis-dependent patients with renal insufficiency before aneurysm repair.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

We recommend preprocedure and postprocedure hydration with normal saline or 5% dextrose/sodium bicarbonate for patients at increased risk of contrast-induced nephropathy (CIN) undergoing EVAR.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Renales Risiko

Prof. Dr. C. Bünge

Bei allen Patienten mit AAA sollten präoperativ Serumkreatinin und GFR bestimmt werden. Alle Patienten mit einer GFR von $< 45 \text{ mL/min/1,73 m}^2$ (das heißt ab CKD-Stadium 3b) oder mit einer GFR von $< 60 \text{ mL/min/1,73 m}^2$ (das heißt ab CKD-Stadium 3a) und gleichzeitigem Auftreten eines der Kriterien Proteinurie, Hämaturie, Hypertonie, morphologische Veränderungen, nierenspezifische Komorbiditäten sollten einem Nephrologen vorgestellt werden (Galle 2016) mit der Frage der Optimierung der Medikation vor Aneurysmaversorgung (Moll et al. 2011).

Renales Risiko

Prof. Dr. C. Bünge

Die wichtigste Maßnahme, eine Kontrastmittel-induzierte Nephropathie zu vermeiden, ist eine ausreichende Hydrierung des Patienten vor Operation, dies gilt speziell für EVAR. Hierzu wird empfohlen, dem Patienten für 12 Stunden vor dem Eingriff und bis zu 24 Stunden nach dem Eingriff eine 0,9% Kochsalzlösung mit einer Rate von 1-1,5 ml/kg/ Stunde i. v. zu verabreichen (Rear et al. 2016). Mit einer nephrotoxischen Medikation sollte rechtzeitig / ausreichend lange peri-KM-Exposition pausiert werden.

Renales Risiko

Prof. Dr. C. Bunger

Die Leitlinien der European Society of Cardiology (ESC) und der European Association for Cardio-Thoracic Surgery (EACTS) (Windecker et al. 2014) empfehlen, dass speziell wenn die GFR $< 40 \text{ mL / Min/ } 1,73 \text{ m}^2$ liegt, alle Patienten vor einer diagnostischen Katheterisierung eine preventive Hydrierung mit isotoner Kochsalzlosung erhalten sollen, beginnend ungefahr 12 Stunden vor Angiographie und fortgefuhrt fur wenigstens 24 Stunden danach (Klasse I-Empfehlung, Evidenzlevel A). Des Weiteren sei auf die Leitlinien der European Society of Urogenital Radiology (ESUR) verwiesen, die bereits bei einer GFR $< 60 \text{ mL / Min/ } 1,73 \text{ m}^2$ eine ausreichende Hydrierung fur 6 Stunden vor und 6 Stunden nach Kontrastmittelgabe empfehlen (Thomsen und Webb 2014).

Renales Risiko

Prof. Dr. C. Bünge

Eine exzessive Hydrierung kann aber nicht empfohlen werden (Liu et al. 2016). Bei Patienten mit offener Versorgung eines AAA konnte darüber hinaus in einer randomisierten Studie gezeigt werden, dass die präoperative Hydrierung mit 0,9% Kochsalzlösung keinen Einfluss auf die postoperative akute Nierenschädigung hat (Serrano et al. 2016). Für intraoperative Maßnahmen, die Nierenfunktion zu schützen, liegt laut einem Cochrane Review keine Evidenz vor (Zacharias et al. 2013).

In den Empfehlungen der genannten Leitlinien wird eine präoperative Hydrierung mit isotoner Kochsalzlösung empfohlen, Studien mit anderen Lösungen liegen nicht vor. Die S3-Leitlinie „Intravasale Volumentherapie beim Erwachsenen“ (DGAI 2014) empfiehlt nun generell, isotone Kochsalzlösung zum peri-interventionellen Volumenersatz mit Blick auf die Beeinflussung des Säure-Basen-Haushaltes nicht zu verwenden (Grad A-Empfehlung). Stattdessen wird empfohlen (Grad A), balanzierte kristalloide isotone Vollelektrolyt-Lösungen peri-interventionell zum Volumenersatz einzusetzen. Andererseits schränkt diese Leitlinie ihre Gültigkeit auf die peri-interventionelle Phase ein und sagt dezidiert aus, dass sie aufgrund ihrer Methodik zur prä-interventionellen Flüssigkeitstherapie in der Nüchternphase vor Operation keine Empfehlungen abgeben kann und will.

Renales Risiko

Prof. Dr. C. Bunger

Die ESUR-Leitlinien nehmen auch zu Patienten Stellung, die **Metformin** einnehmen. Danach konnen Patienten mit einer GFR gleich oder groer 60 ml/min/1,73 m² (CKD 1 und 2) mit der Metformineinnahme normal fortfahren. Dies gilt auch fur Patienten mit GFR > 45 ml/min/1,73 m², bei denen Kontrastmittel intravenos verabreicht werden. Hingegen sollten Patienten mit einer GFR von 30 bis 59 ml/min/1,73 m² (CKD 3), die intraarteriell Kontrastmittel erhalten und solche mit einer GFR von 30 bis 44 ml/min/1,73 m², die intravenos Kontrastmittel erhalten, mit der Metformineinnahme 48 Stunden vor Kontrastmittelgabe pausieren und die Medikation erst 48 Stunden danach wiederaufnehmen, wenn sich die Nierenfunktion nicht verschlechtert hat. Nach diesen Leitlinien ist bei Patienten mit einer GFR < 30 ml/min/1,73 m² (CKD 4 und 5) Metformin kontraindiziert und Jod-basierte Kontrastmittel sollten vermieden werden.

Renales Risiko

Prof. Dr. C. Büngrer

Auf weitere Arzneimittelinteraktionen mit den applizierten Kontrastmitteln und ihre Handhabung sei ebenfalls auf die ESUR-Leitlinie verwiesen. Die DGAI/DGCH/DGIM-Empfehlungen (2017) sind nicht so detailliert. Dort wird darauf hingewiesen, dass Metformin bei Kumulation (z.B. Niereninsuffizienz) in seltenen Fällen zu einer lebensbedrohlichen Laktazidose führen kann, so dass in der Fachinformation ein Absetzen 48 Stunden vor dem Eingriff empfohlen wird, im direkt perioperativen Bereich scheint das Risiko der Laktazidose jedoch äußerst gering zu sein. Bei geplanter intravenöser Gabe von Kontrastmittel sollte allerdings die Metformingabe 24-48h vor dem Eingriff pausiert werden.

Diabetes mellitus, Enhrungsstatus

Ernährungsstatus

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Recommendation 39

In patients undergoing elective abdominal aortic aneurysm repair, assessment of pre-operative nutritional status by measuring serum albumin is recommended, with an albumin level of <2.8 g/dL as a threshold for pre-operative correction

Class	Level	References
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I	C	[244]
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We recommend parenteral nutrition if a patient is unable to tolerate enteral support 7 days after aneurysm repair.

Level of recommendation	1 (Strong)
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Quality of evidence	A (High)
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Ernährungsstatus

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
		We recommend <u>holding metformin</u> at the time of administration of contrast material among patients with an <u>estimated glomerular filtration rate (eGFR)</u> of <60 mL/min or up to 48 hours before administration of contrast material if the eGFR is <45 mL/min. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	C (Low)
Level of recommendation	1 (Strong)					
Quality of evidence	C (Low)					
		We recommend <u>restarting metformin no sooner than 48 hours</u> after administration of contrast material as long as renal function has remained stable (<25% increase in creatinine concentration above baseline). <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	C (Low)
Level of recommendation	1 (Strong)					
Quality of evidence	C (Low)					
		Nasogastric decompression and perioperative nutrition. We recommend optimization of preoperative nutritional status before elective open aneurysm repair if repair will not be unduly delayed. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Level of recommendation	1 (Strong)					
Quality of evidence	A (High)					

Carotis-Stenose

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

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- ... SMART study (n = 2,274, in which 147 were diagnosed with AAA) **8.8%** of all AAA patients had an asymptomatic internal carotid artery stenosis of at least 70%.²⁴⁵

Patienten mit AAA sollten präprozedural duplexsonographisch auf das Vorliegen einer Stenose der **A. carotis interna untersucht** werden.
EG B/ EvG 4

Recommendation 40

Routine screening for asymptomatic carotid stenosis prior to abdominal aortic aneurysm repair is not recommended

Class	Level	References
III	C	[247,248]

Recommendation 42

Routine prophylactic carotid intervention for asymptomatic carotid stenosis prior to abdominal aortic aneurysm repair is not recommended

Class	Level	References
III	C	[248]

Recommendation 41

Patients with abdominal aortic aneurysms and concomitant symptomatic carotid stenosis within the last 6 months should be considered for carotid intervention before aneurysm repair

Class	Level	References
IIa	A	[248]

Risiko-Score

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
Für die präprozedurale Risikoabschätzung EVAR versus OR kann der BAR-Score genutzt werden. EG 0/ EvG 3b		Assessment of operative risk and life expectancy. We suggest informing patients contemplating open repair or EVAR of their Vascular Quality Initiative (VQI) perioperative mortality risk score. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Level of recommendation	2 (Weak)					
Quality of evidence	C (Low)					
		Role of elective EVAR in the high-risk and unfit patient. We suggest informing high-risk patients of their VQI perioperative mortality risk score for them to make an informed decision to proceed with aneurysm repair. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Level of recommendation	2 (Weak)					
Quality of evidence	C (Low)					

(www.britishaneurysmrepairscore.com)

Risiko-Score

Prof. Dr. C. Bünge

Table VI, A. Mortality risk scoring scheme for patients undergoing repair of an abdominal aortic aneurysm (AAA)

Parameter	Points
Treatment	
EVAR	0
OAR (infrarenal)	2
OAR (suprarenal)	4
Aneurysm size, mm	
<65	0
≥65	2
Age, years	
≤75	0
>75	1
Gender	
Male	0
Female	1
Comorbidities	
Myocardial disease	1
Cerebrovascular disease	1
Chronic obstructive pulmonary disease	2
Laboratory value	
Creatinine, mg/dL	
<1.5	0
1.5 to <2	2
≥2	2

EVAR, Endovascular aneurysm repair; OAR, open aneurysm repair.
 From Eslami MH, Rybin D, Doros G, Kalish JA, Farber A; Vascular Study Group of New England. Comparison of a Vascular Study Group of New England risk prediction model with established risk prediction models of in-hospital mortality after elective abdominal aortic aneurysm repair. J Vasc Surg 2015;62:1125-33.e2.

Table VI, B. Risk categorization based on mortality risk scoring scheme (Table VI, A) for patients undergoing repair of an abdominal aortic aneurysm (AAA)

Points	Probability of mortality, %	Proposed risk designation
0	0.12	Low-risk group
1	0.20	
2	0.34	
3	0.59	Medium-risk group
4	1.00	
5	1.71	
6	2.91	High-risk group
7	4.90	
8	8.14	
9	13.2	Prohibitive high-risk group
10	20.75	
11	31.05	
12	43.63	
13	57.10	
14	69.59	

From Eslami MH, Rybin D, Doros G, Kalish JA, Farber A; Vascular Study Group of New England. Comparison of a Vascular Study Group of New England risk prediction model with established risk prediction models of in-hospital mortality after elective abdominal aortic aneurysm repair. J Vasc Surg 2015;62:1125-33.e2.

Indikationsstellung invasive Therapie asymptomatisches AAA

Fusiformes AAA beim Mann

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018																
<u>DM 4,0 bis 5,4 cm:</u> Surveillance EG A/ EvG 1a		In patients with a small aneurysm (4.0-5.4 cm) who will require chemotherapy, radiation therapy, or solid organ transplantation, we suggest a shared decision-making approach to decide about treatment options. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)												
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	
<u>DM 5,0 bis 5,4 cm:</u> AAA-Versorgung kann erwogen werden EG 0/ EvG 3b																		
	<table><tr><td colspan="3">Recommendation 22</td></tr><tr><td colspan="3">In men, the threshold for considering elective abdominal aortic aneurysm repair is recommended to be ≥ 5.5 cm diameter</td></tr><tr><td>Class</td><td>Level</td><td>References</td></tr><tr><td>I</td><td>A</td><td>[189]</td></tr></table>	Recommendation 22			In men, the threshold for considering elective abdominal aortic aneurysm repair is recommended to be ≥ 5.5 cm diameter			Class	Level	References	I	A	[189]	We recommend elective repair for the patient at low or acceptable surgical risk with a fusiform AAA that is ≥ 5.5 cm. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Recommendation 22																		
In men, the threshold for considering elective abdominal aortic aneurysm repair is recommended to be ≥ 5.5 cm diameter																		
Class	Level	References																
I	A	[189]																
Level of recommendation	1 (Strong)																	
Quality of evidence	A (High)																	
<u>Größenzunahme von >10 mm /Jahr:</u> Indikation zur konventionellen OP oder EVAR unabhängig vom DM EG A/ EvG 1 a	<table><tr><td colspan="3">Recommendation 24</td></tr><tr><td colspan="3">When rapid abdominal aortic aneurysm growth is observed (≥ 1 cm/year), fast track referral to a vascular surgeon with additional imaging should be considered</td></tr><tr><td>Class</td><td>Level</td><td>References</td></tr><tr><td>IIa</td><td>C</td><td>[194,195]</td></tr></table>	Recommendation 24			When rapid abdominal aortic aneurysm growth is observed (≥ 1 cm/year), fast track referral to a vascular surgeon with additional imaging should be considered			Class	Level	References	IIa	C	[194,195]					
Recommendation 24																		
When rapid abdominal aortic aneurysm growth is observed (≥ 1 cm/year), fast track referral to a vascular surgeon with additional imaging should be considered																		
Class	Level	References																
IIa	C	[194,195]																

Fusiformes AAA bei der Frau

Prof. Dr. C. Bünner

S3-Leitlinie AWMF
07/2018

ESVS 2019

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Frauen: invasive
Versorgung, wenn
der maximale DM
5,0 cm erreicht hat.
EG B/ EvG 3b

Recommendation 23

In women with acceptable surgical risk the threshold for considering elective abdominal aortic aneurysm repair may be considered to be ≥ 5.0 cm diameter

Class	Level	References
IIb	C	[199,171,91,198,200]

We suggest repair in women with AAA between 5.0 cm and 5.4 cm in maximum diameter.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

Inflammatorisches Aneurysma

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

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Indikation zu OAR und EVAR nach den **gleichen Kriterien** wie bei nichtinflammatorisch EVAR zeigt gering. 1-Jahressterblichkeit, jedoch kann bei Patienten mit Hydronephrose und geringem Op-Risiko OAR von Vorteil sein.

EG A/ EvG 4

Recommendation 111

All patients with symptomatic inflammatory abdominal aortic aneurysms should be considered for medical anti-inflammatory treatment

Class	Level	References
IIa	C	[717,719,738,732]

Recommendation 112

In patients with inflammatory abdominal aortic aneurysm with a threshold diameter of 5.5 cm and suitable anatomy, endovascular repair should be considered as a first option

Class	Level	References
IIa	C	[739,738,720]

OSR. We recommend a retroperitoneal approach for patients requiring OSR of an inflammatory aneurysm, a horseshoe kidney, or an aortic aneurysm in the presence of a hostile abdomen.

Level of recommendation	1 (Strong)
Quality of evidence	C (Low)

AAA und Hufeisenniere

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

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Recommendation 124

A retroperitoneal approach for patients requiring open surgical repair or endovascular repair if anatomically feasible may be considered as preferred options for the surgical treatment of abdominal aortic aneurysm with a co-existing horseshoe kidney

Class	Level	References
IIb	C	[788,787,789]

OSR. We recommend a retroperitoneal approach for patients requiring OSR of an inflammatory aneurysm, a horseshoe kidney, or an aortic aneurysm in the presence of a hostile abdomen.

Level of recommendation	I (Strong)
Quality of evidence	C (Low)

Recommendation 125

Preservation of the renal isthmus and anomalous renal arteries >3 mm in diameter should be considered during both open and endovascular repair of abdominal aortic aneurysm with a co-existing horseshoe kidney

Class	Level	References
IIa	C	[788,786,789]

Transperitoneal vs Retroperitoneal

Prof. Dr. C. Büngrer

Table VII. Surgical approaches for open aneurysm repair

	Transperitoneal	Retroperitoneal
Advantages	• Most rapid, greatest versatility • Provides widest access • Enables evaluation and treatment of concomitant intra-abdominal disease	• Avoids hostile abdomen • Facilitates suprarenal exposure and control • Potential reduction of postoperative ileus • Obesity • Inflammatory AAA • Horseshoe kidney
Disadvantages	• Longer postoperative ileus • Potential for greater fluid losses • Difficulty with exposure and control for suprarenal aneurysms • Higher incidence of incisional hernia	• Poor access to right renal and iliac arteries • Cannot evaluate intra-abdominal disease • Flank bulge

AAA, Abdominal aortic aneurysm.

Adapted from Chaikof EL, Brewster DC, Dalman RL, Makaroun MS, Illig KA, Sicard GA, et al. The care of patients with an abdominal aortic aneurysm: the Society for Vascular Surgery practice guidelines. J Vasc Surg 2009;50(Suppl):S2-49.

Sacciformes AAA

Prof. Dr. C. Bünner

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07/2018

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Recommendation 116

Early treatment may be considered for saccular abdominal aortic aneurysms, with a lower threshold for elective repair than for standard fusiform abdominal aortic aneurysms

Class	Level	References
IIb	C	[750,751]

We suggest elective repair for the patient who presents with a saccular aneurysm.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

PAU, Dissektion, IMH

Prof. Dr. C. Bünner

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07/2018

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Recommendation 113

In all patients with penetrating aortic ulcer, isolated abdominal aortic dissection, aortic pseudoaneurysm, or intramural haematoma, medical treatment, including blood pressure control, is recommended

Class	Level	References
I	C	[749,745,617]

Recommendation 114

In uncomplicated penetrating aortic ulcer, dissection, or intramural haematoma of the abdominal aorta, serial imaging surveillance is recommended

Class	Level	References
I	C	[745,617]

Recommendation 115

In patients with complicated penetrating aortic ulcer, dissection, or intramural haematoma, and in pseudoaneurysm in the abdominal aorta, repair is recommended

Class	Level	References
I	C	[745,617]

Recommendation 117

In patients with complicated penetrating aortic ulcer, dissection, intramural haematoma, or pseudoaneurysm of the abdominal aorta, endovascular repair should be considered as a first option

Class	Level	References
IIa	C	[741,743,744,749,745,746]

AAA bei Tumorerkrankung

Prof. Dr. C. Böhm

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07/2018

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- The reported incidence of concomitant malignant diseases and AAA is **5.4 to 6.7%**.^{757,758}
- “treat what is most threatening or symptomatic first”** (large AAA, obstructing colonic cancer, bleeding gastric cancer, etc.)^{764,765}

Recommendation 118

Patients with abdominal aneurysm and concomitant cancer are not recommended prophylactic aneurysm repair on a different indication (diameter threshold) from patients without cancer, including cases of chemotherapy

Class	Level	References
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III	C	[769,760]
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Recommendation 119

In patients with concomitant malignancy, a staged surgical approach, with endovascular repair of a large or symptomatic abdominal aortic aneurysm first, to allow for treatment of malignancy with minimal delay, is recommended

Class	Level	References
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I	C	[764,765,757]
---	---	---------------

Recommendation 120

In patients with concomitant cancer, prolonged low molecular weight heparin prophylaxis up to four weeks after abdominal aortic aneurysm repair should be considered

Class	Level	References
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IIa	C	[771,757]
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Bindegewebserkrankungen (Marfan, LDS, ED)

Prof. Dr. C. Büniger

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AAA bei angeborenen Bindegewebserkrankungen sind eine Rarität. Wenn eine Intervention indiziert ist, sollte in Fällen von Marfan-Syndrom und anderen hereditären Bindegewebsschwächen der **offene chirurgische Eingriff** als Erstoption indiziert werden. Die Sekundärtherapie kann endovaskulär erfolgen.
EG B/ EvG 4

Recommendation 121

In patients with abdominal aortic aneurysm in whom the disease cannot be solely explained by a non-genetic cause, such as patients <60 years or in patients with a positive family history, genetic counselling is recommended prior to genetic testing

Class	Level	References
I	C	[774,780,781]

Recommendation 122

Referral to a multidisciplinary aortic team at a highly specialised centre is recommended to manage patients with an aortic disorder suspected of having an underlying genetic cause

Class	Level	References
I	C	[775,782-784]

Recommendation 123

In young patients with suspected connective tissue disorders and abdominal aortic aneurysms, open surgical repair is recommended as first option

Class	Level	References
I	C	[785,782]

Mykotisches AAA

Prof. Dr. C. Bünner

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Table 9.1. Suggested diagnostic criteria of mycotic aortic aneurysm.⁶⁸⁸

Combination of the following factors:

Clinical presentation	Abdominal/back pain Fever Sepsis/shock
Laboratory and culture	C-reactive protein ↑ Leucocytes ↑ Positive blood culture or aortic tissue culture
Radiologic findings on CT	Saccular/multi-lobular/eccentric Peri-aortic gas/soft tissue mass Rapid expansion (days) and/or rupture Atypical location (e.g. para-visceral) or multiple aneurysms in different locations

Recommendation 106

It is recommended that the diagnosis of a mycotic aortic aneurysm is based on a combination of clinical, laboratory, and imaging parameters

Class	Level	References
I	C	[692,689,690]

Recommendation 107

Treatment of patients with a suspected mycotic aortic aneurysm with intravenous antibiotics is recommended; empirical antibiotic treatment against *Staphylococcus aureus* and Gram negative rods should be initiated as soon as cultures have been secured, and continued in those with negative cultures

Class	Level	References
I	C	[701,698,690]

Mykotisches AAA

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Recommendation 108

Mycotic aneurysm repair is recommended irrespective of aneurysm size

Class	Level	References
I	C	[710,690]

Recommendation 109

Surgical techniques used in mycotic aneurysm repair should be considered based on patient status, local routines, and team experience, with endovascular repair being an acceptable alternative to open repair

Class	Level	References
IIa	C	[702,698,694,690]

Recommendation 110

Long-term post-operative antibiotic treatment (6–12 months or lifelong) and surveillance should be considered after mycotic aneurysm repair

Class	Level	References
IIa	C	[702,690]

...in Abhängigkeit vom Zustand des Patienten und der Erfahrung des Behandlungsteams **offen** oder **endovaskulär** angegangen werden.
EG B/ EvG 4

AAA mit Aortocavaler Fistel

Prof. Dr. C. Büngrer

A ruptured aneurysm associated with an aortocaval fistula has been reported in 0.22% to 6% of patients.⁵²⁰ The triad of abdominal pain, pulsatile mass, and abdominal “machinery” bruit is present in up to 80% of cases.⁵²¹⁻⁵²⁴ Patients presenting with an abdominal aneurysm and high-output heart failure or a para- doxical pulmonary embolism should also be suspected of having an aortocaval fistula.⁵²⁵⁻⁵²⁹ Duplex ultrasound im- aging will reveal an arterial flow pattern in the inferior vena cava, and CT imaging will demonstrate contrast material in the inferior vena cava during the arterial phase.⁵³⁰⁻⁵³³ EVAR is preferred,⁵³⁴⁻⁵⁴⁰ with expected resolution of pre- operative heart failure and other physiologic distur- bances.⁵⁴¹⁻⁵⁴⁴ If open repair is required, venous bleeding should be anticipated and care taken to minimize the risk of pulmonary air embolism or embolism of thrombotic debris by placement of sponge sticks proximal and distal to the aortocaval fistula for control, followed by direct su- ture repair of the defect.^{545,546}

Since 2013, an additional 53 patients presenting with an aortocaval fistula have been added to the previously reported 250 cases.⁵⁴⁷ The majority have been success- fully treated with EVAR alone, with occasional use of an Amplatzer plug⁵⁴⁸ or additional placement of a covered stent in the inferior vena cava.⁵⁴⁹⁻⁵⁵²

Indikationsstellung invasive Therapie symptomatisches AAA

Symptomatisches AAA

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018										
	Recommendation 25 Emergency <u>referral to a vascular surgeon</u> of patients with symptomatic abdominal aortic aneurysm is recommended <table><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>I</td><td>C</td><td>[196,197]</td></tr></table>	Class	Level	References	I	C	[196,197]	We recommend a <u>CT scan to evaluate</u> patients thought to have AAA presenting with recent-onset abdominal or back pain, particularly in the presence of a pulsatile epigastric mass or significant risk factors for AAA. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>B (Moderate)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	B (Moderate)
Class	Level	References										
I	C	[196,197]										
Level of recommendation	1 (Strong)											
Quality of evidence	B (Moderate)											
Patienten mit symptomatischem AAA sollen zum nächstmöglichen Elektivtermin invasiv behandelt werden. EG A/ EvG 2b		We recommend repair for the patient who presents with an AAA and abdominal or back pain that is likely to be attributed to the aneurysm. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	C (Low)						
Level of recommendation	1 (Strong)											
Quality of evidence	C (Low)											
Patienten mit symptomatischem AAA sollten - falls technisch geeignet - endovaskulär behandelt werden. EG B/ EvG 2b		Should repair of a symptomatic AAA be delayed to optimize coexisting medical conditions, we recommend that the patient be monitored in an intensive care unit (<u>ICU</u>) setting with blood products available. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	C (Low)						
Level of recommendation	1 (Strong)											
Quality of evidence	C (Low)											

Indikationsstellung invasive Therapie rupturiertes AAA

Rupturiertes AAA

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
Das rAAA stellt einen Notfall dar, der sofort invasiv behandelt werden soll. EG A/ EvG 2b		Timing for intervention. We recommend immediate repair for patients who present with a ruptured aneurysm. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Level of recommendation	1 (Strong)					
Quality of evidence	A (High)					
Auch bei Patienten mit erfolgreich therapiertem Herzstillstand (Resuscitation of Spontaneous Circulation, ROSC) kann ein Behandlungsversuch gerechtfertigt sein. EG 0/ EvG 4						

Infrastruktur

Versorgung in Zentren

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
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Die Versorgung des AAA soll in spezialisierten Zentren erfolgen.
EG A/ EvG 2a

We suggest referral to a vascular surgeon at the time of initial diagnosis of an aortic aneurysm.

Level of recommendation Good Practice Statement

Quality of evidence Ungraded

Recommendation 1

Centres performing aortic surgery are recommended to enter cases in a validated prospective registry to allow for monitoring of changes in practice and outcomes

Class	Level	References
I	C	[7,6,10,8,20]

We suggest that patients with ruptured AAA who require transfer for repair be referred to a facility with an established rupture protocol and suitable endovascular resources.

Level of recommendation Good Practice Statement

Quality of evidence Ungraded

Recommendation 3

Abdominal aortic aneurysm repair should only be considered in centres with a minimum yearly caseload of 30 repairs

Class	Level	References
IIa	C	[32,34,47,35]

Perioperative outcomes of elective EVAR. We suggest that elective EVAR be performed at centers with a volume of at least 10 EVAR cases each year and a documented perioperative mortality and conversion rate to OSR of 2% or less.

Level of recommendation 2 (Weak)

Quality of evidence C (Low)

Recommendation 4

Abdominal aortic aneurysm repair should not be performed in centres with a yearly caseload <20

Class	Level	References
III	B	[40,48,39,44,49,27,42,38,43]

Perioperative outcomes of open AAA repair. We suggest that elective OSR for AAA be performed at centers with an annual volume of at least 10 open aortic operations of any type and a documented perioperative mortality of 5% or less.

Level of recommendation 2 (Weak)

Quality of evidence C (Low)

Versorgung in Zentren

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

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rAAA: ...möglichst in **spezialisierten Zentren** mit hoher Strukturqualität versorgt werden. Die große Varianz in den geographischen Bedingungen und damit Transportzeiten, in lokaler Praxis und Expertise macht es jedoch unmöglich, generell die Weiterleitung von Patienten mit rAAA in ein Schwerpunktzentrum zu fordern.

EG A/ EvG 2a

Recommendation 6

An established protocol for the management of aortic aneurysm emergencies is recommended

Class	Level	References
I	C	[67,57-59,62]

An established protocol for the management of ruptured AAA is essential for optimal outcomes.

Level of recommendation	Good Practice Statement
Quality of evidence	Ungraded

Recommendation 2

It is recommended that centres or networks of collaborating centres treating patients with abdominal aortic aneurysms can offer both endovascular and open aortic surgery at all times

Class	Level	References
I	B	[21–31]

The patient with a ruptured aneurysm. We suggest a door-to-intervention time of <90 minutes, based on a framework of 30-30-30 minutes, for the management of the patient with a ruptured aneurysm.

Level of recommendation	Good Practice Statement
Quality of evidence	Ungraded

Bildgebung

Bildgebende Diagnostik

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018												
... präprozedurale bildgebende Diagnostik ... CTA als Methode der Wahl eingesetzt werden EG A/ EvG 3a	<table> <tr> <th colspan="3">Recommendation 9</th></tr> <tr> <td colspan="3">In patients with abdominal aortic aneurysms computed tomography angiography is recommended for therapeutic decision making and treatment planning, and for the diagnosis of rupture</td></tr> <tr> <th>Class</th><th>Level</th><th>References</th></tr> <tr> <td>I</td><td>C</td><td>[120,103,113]</td></tr> </table>	Recommendation 9			In patients with abdominal aortic aneurysms computed tomography angiography is recommended for therapeutic decision making and treatment planning, and for the diagnosis of rupture			Class	Level	References	I	C	[120,103,113]	
Recommendation 9														
In patients with abdominal aortic aneurysms computed tomography angiography is recommended for therapeutic decision making and treatment planning, and for the diagnosis of rupture														
Class	Level	References												
I	C	[120,103,113]												
Die MRA ohne KM Alternative zur CTA, speziell bei NI. ... soll die MR-Kompatibilität der Implantate überprüft werden. EG A/ EvG 3a														
	<table> <tr> <th colspan="3">Recommendation 10</th></tr> <tr> <td colspan="3">Aortic diameter measurement with computed tomography angiography should be considered using dedicated post-processing software analysis in three perpendicular planes with a consistent calliper placement</td></tr> <tr> <th>Class</th><th>Level</th><th>References</th></tr> <tr> <td>IIa</td><td>C</td><td>[114]</td></tr> </table>	Recommendation 10			Aortic diameter measurement with computed tomography angiography should be considered using dedicated post-processing software analysis in three perpendicular planes with a consistent calliper placement			Class	Level	References	IIa	C	[114]	
Recommendation 10														
Aortic diameter measurement with computed tomography angiography should be considered using dedicated post-processing software analysis in three perpendicular planes with a consistent calliper placement														
Class	Level	References												
IIa	C	[114]												

CTA

Prof. Dr. C. Bünge

Die CT-Angiographie (CTA) einschließlich 3D Rekonstruktion der Gefäße stellt die bildgebende Methode der Wahl für eine genaue präoperative Planung dar (Corriere et al. 2014).

Die CT-Angiographie soll von Kopf bis unterhalb der Leiste als Dünnschicht-CT (Schichtdicke ≤ 1 mm) durchgeführt werden, um Begleitaneurysmata und die Zugangswege darzustellen.

Die CTA zeigt auch die höchste Treffsicherheit bei Verdacht auf Ruptur eines AAA (Biancari et al. 2013).

Die Computertomographie zeigt besser als jede andere bildgebende Modalität das Ausmaß der Wandverkalkungen. Ferner lassen sich parietale Thrombosierungen sehr exakt abgrenzen. Darüber hinaus können aberrante Viszeralarterien in der Regel eindeutig identifiziert werden. Ferner lassen sich durch die Computertomographie bereits früher eingebrachte Implantate (z.B. Metallstents im Becken) exakt abbilden.

Entsprechende Implantate könnten im Rahmen der Stentgraft- Einbringung disloziert werden. Ebenso finden sich in der Computertomographie nicht selten Zusatzbefunde (basaler Lungenrundherd, solider Nierentumor), die für die Patientenprognose relevant sind bzw. eine weitere Abklärung erfordern.

Nachteilig ist die Kontrastmittelgabe bei Patienten mit eingeschränkter Nierenfunktion, Jod-Kontrast- Allergie oder Hyperthyreose.

MR MRA

Prof. Dr. C. Büngrer

MRT und MRA können ebenfalls für die präoperative Planung genutzt werden. Dabei ist für eine ausreichende Präzision die Kontrastmittelgabe nicht erforderlich, so dass die nicht-verstärkte MRA bei fehlender Strahlenbelastung als Alternative zur CTA speziell auch bei Patienten mit eingeschränkter Nierenfunktion gilt (Saida et al. 2012; Goshima et al. 2013). Saida et al. (2012) verglichen in ihrer Studie prospektiv die Aussagekraft der MRT und der Computertomographie vor einer möglichen endovaskulären Versorgung eines AAA. Die Autoren fanden eine hohe Übereinstimmung zwischen den Methoden und kamen zu dem Schluss, dass die Computertomographie weiterhin als Goldstandard für die präoperative Abklärung eines AAAs anzusehen sei, dass aber bei Patienten, die Kontraindikationen für eine CT- Untersuchung aufweisen, alternativ in der präoperativen Abklärung eine MRT- Untersuchung erfolgen kann.

Zu bedenken ist, dass es bei der Magnetresonanztomographie durch Metallimplantate zu Beeinträchtigungen der Bildqualität kommen kann.

Sonografie, FKDS, KM-Sonografie

Prof. Dr. C. Bünge

Die Duplexsonographie ist die Methode der Wahl bei Screening und Überwachung asymptomatischer AAA, bei der präprozeduralen Planung ist sie jedoch hinsichtlich der Genauigkeit der CTA unterlegen. Wegen der geringeren Untersucherabhängigkeit und geringeren Fehleranfälligkeit durch schlechte Untersuchungsbedingungen wird allgemein die CT-A als Goldstandard angesehen (Foo et al. 2011; Gray et al. 2014; Scaife et al. 2016).

Die 3D-Duplexsonographie wird als Verbesserung der Sonographie gewertet (Bredahl et al. 2015), inwieweit sie aber ein CTA bei der präoperativen Bildgebung ersetzen kann, ist offen, die Technik gilt nicht als Routinemethode (Lowe et al. 2016 und 2017).

Die kontrastmittelverstärkte Sonographie kann die CTA bei der präprozeduralen Planung nicht ersetzen, wird aber für die Kontrolluntersuchungen nach EVAR und die Entdeckung von Endoleaks empfohlen (Gürtler et al. 2013; Piscaglia et al. 2012). Die Implantation einer endovaskulären Aortenprothese mittels Ultraschall wurde beschrieben (Kopp et al. 2010).

Die DSA stellt das wahre Lumen des Gefäßes dar, die tatsächliche Größe von Gefäß und Aneurysma kann jedoch bei thrombosiertem AAA unterschätzt werden. Hinzu kommt: die DSA ist invasiv und benötigt jodhaltige Kontrastmittel. Die DSA wird deshalb nicht mehr als präprozedurale Routineuntersuchung bei AAA empfohlen. Die DSA kann jedoch bei atypischen Viszeralarterien, z.B. wie sie bei Hufeisennieren auftreten, wesentliche Zusatzinformationen präoperativ liefern. Ferner wird sie nach wie vor bei der Klassifikation und Behandlung von Endoleaks eingesetzt. So lassen sich einzelne Stentgraft- Abschnitte selektiv in der Katheterangiographie darstellen. Dies erlaubt eine exakte Lokalisation der Endoleckage.

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Die CO₂ - DSA wird lediglich in zwei Studien als Alternative zur Standard-Kontrastangiographie bei intraprozeduraler Endoleak-Kontrolle (mit ausreichender Detektionsrate) für Patienten empfohlen, die ein erhöhtes Risiko für eine Kontrastmittel-assoziierte Nierenschädigung aufweisen (Huang et al. 2013; Sueyoshi et al. 2015).

IVUS

Prof. Dr. C. Büngrer

Zum intravaskulären Ultraschall (IVUS) liegen nur sehr wenige Studien vor, zur präprozeduralen Bildgebung wird er nicht empfohlen. Garret et al. (2003) fanden IVUS hilfreich, intraprozedural die nach dem CT geplante Größe des Stentgrafts zu korrigieren, womit sich in einer Serie von 78 Patienten ein Endoleak Typ I vermeiden ließ. IVUS war in dieser Serie in Einzelfällen die genaueste Methode, den Durchmesser des proximalen Aneurysmahalses zu bestimmen. In einer weiteren Machbarkeitsstudie wurde bei 13 EVAR-Patienten eine gute Übereinstimmung zwischen präinterventioneller CT-Bestimmung des Durchmessers des Aneurysmahalses und der IVUS-Messung gesehen (Eriksson et al. 2009). Es wurde vermutet, dass sich mit der intraprozeduralen Anwendung von IVUS eventuell eine präprozedurale CTA vermeiden ließe und intraprozedural Kontrastmittel eingespart werden könnte, was speziell die Gefahr der Nierenschädigung verringern sollte. Tatsächlich liegen Ergebnisse mit einem Protokoll vor, bei dem bei Patienten mit chronischer Niereninsuffizienz EVAR intraprozedural mittels CO₂ - Angiographie und IVUS kontrolliert wurde. Die intraprozedural verabreichte Kontrastmittelmenge ließ sich so reduzieren, die Nierenfunktion der Patienten war nicht schlechter als bei offenem Vorgehen (Haga et al. 2016).

PET/CT

Prof. Dr. C. Bünker

Das 18F-FDG PET-CT (18F-fluoro-deoxy-glucose positron emission tomography) hat in der Routine der präprozeduralen bildgebenden Diagnostik aktuell keinen Stellenwert, kann aber chronische entzündliche Prozesse in der Aortenwand mit nachfolgendem proteolytischem Abbau darstellen (McBride et al. 2016). Inwieweit damit das PET-CT in der Lage ist, Aneurysmawachstum und Rupturgefahr vorherzusagen, wurde in einer systematischen Literaturübersicht überprüft (Jalalzadeh et al. 2016). Demnach liegen bisher zu dieser Fragestellung nur wenige Arbeiten mit kleinen Fallzahlen vor, mit widersprüchlichen Aussagen darüber, ob die PET-CT-Befunde mit dem Aneurysmawachstum korrelieren oder nicht. Im Moment kann das PET-CT nicht als Hilfsmittel in der täglichen Praxis verwendet werden, Aneurysmawachstum oder Ruptur vorherzusagen. Eine hohe Bedeutung hat das PET/CT bei fraglichen Prothesen- oder Stentgraft-Infektionen, selbst bei negativen Abstrichen oder Blutkulturen (Capoccia et al. 2014). Hier wird es als Verfahren mit der höchsten Sensitivität und Spezifität angesehen. Ferner lassen sich weitere Entzündungsherde mit dieser Methode darstellen (z. B. Endokarditis). Die Methode wurde daher in die europäische Leitlinie zur Endokarditis-Diagnostik aufgenommen.

Bildgebende Rupturrisikobestimmung (Speckle-Tracking, Finite Elements)

Prof. Dr. C. Bünker

Die Finite-Element-Analyse (FEA) zielt darauf ab, anhand von CT-Modellen den Wandstress des AAA zu erfassen und so das Rupturrisiko unabhängig vom Aneurysmadurchmesser zu kalkulieren. Die Methode kann als klinisch experimentell gelten, sie hat noch keinen Platz in der klinischen Routine (Schmitz-Rixen et al. 2016). Ähnliches gilt für den Speckle-Tracking-Ultraschall, der versucht, über Wandbewegung und Elastizität eine Aussage über das Rupturrisiko zu machen (Derwich et al. 2016).

Abklärung Begleitaneurysmata

Prof. Dr. C. Bünner

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Patienten mit nachgewiesenem AAA sollen <u>duplexsonographisch</u> auf das Vorliegen eines Popliteaaneurysmas untersucht werden. EG A/ EvG 4		Physical examination. In patients with a suspected or known abdominal aortic aneurysm (AAA), we recommend performing physical examination that includes an assessment of femoral and popliteal arteries. In patients with a popliteal or femoral artery aneurysm, we recommend evaluation for an AAA. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Level of recommendation	1 (Strong)					
Quality of evidence	A (High)					

Femoralarterienaneurysmen und **Aneurysmen der A. poplitea** kommen bei Patienten mit AAA gehäuft vor. Diwan et al. (2000) gaben die Prävalenz von Femoral- und Popliteaaneurysmen bei Patienten mit AAA mit 12%, bei Männern mit 14% an, wobei nur 10/51 Aneurysmen palpabel waren. 10% der Männer hatten ausschließlich ein Popliteaaneurysma (PAA). In einer weiteren Untersuchung wurde die Prävalenz von PAA bei Patienten mit AAA in Abhängigkeit von der Definition mit 28% (Durchmesser > 10,5 mm) bzw. 11% (PAA > 15 mm) angegeben (Tuveson et al. 2016). Auch in dieser Studie erwies sich die klinische Untersuchung allein als ungenügend, ein PAA zu entdecken. Bei dem Krankheitswert eines PAA ergibt sich aus diesen Daten die Empfehlung, Patienten mit AAA routinemäßige auf das Vorkommen eines PAA mittels Duplexsonographie zu untersuchen.

Abklärung Thorax- und Lungenbefunden

Prof. Dr. C. Bünner

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Bei etwa jedem 20. Patienten, der zur Versorgung eines AAAs ansteht, findet sich als Koinzidenz ein Malignom. EvG 2b		
Patienten mit einem AAA sollen <u>vor einer invasiven Versorgung</u> eine bildgebende Diagnostik unter Einschluß des Thorax erhalten (vorzugsweise CT). EG A/ EvG 2b		

Diagnostik des rAAA

Prof. Dr. C. Bünner

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We recommend a CT scan to evaluate patients thought to have AAA presenting with recent-onset abdominal or back pain, particularly in the presence of a pulsatile epigastric mass or significant risk factors for AAA.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Bei **hämodynamisch stabilen** Patienten mit Zeichen der Ruptur eines AAA soll ein **Notfall-CT** angestrebt werden.

EG A EvG 3b /

Recommendation 63

In haemodynamically stable patients with suspected ruptured abdominal aortic aneurysm, prompt thoraco-abdominal computed tomography angiography is recommended as the imaging modality of choice

Class	Level	References
I	B	[366,367,187,368,59]

Hämodynamisch instabile Patienten mit gesicherter Ruptur eines AAA sollen **unmittelbar in den (Hybrid)-OP** gebracht werden.

EG A/ EvG 3b

Recommendation 64

In haemodynamically unstable patients with suspected ruptured abdominal aortic aneurysm, prompt thoraco-abdominal computed tomography angiography, allowing assessment for endovascular repair, should be considered before transferring the patient to the operating room

Class	Level	References
Ila	B	[366,26,367,368]

Invasive Therapiewahl- Intaktes AAA

Invasive Therapiewahl- Intaktes AAA Studienlage

Therapiewahl - Studienlage

Prof. Dr. C. Büniger

Table 4.5. Summary of randomised controlled trials comparing elective endovascular and open repair for abdominal aortic aneurysm.

Study	Country	Recruitment period	<i>n</i> of pts	Main findings
EVAR 1, ²³	UK	1999–2003	1082	Better peri-operative survival after EVAR (1.7% vs. 4.7%) Early survival benefit lost after 2 years, with similar long-term survival Higher aneurysm related mortality in the EVAR group after 8 years, mainly attributable to secondary aneurysm sac rupture Higher re-intervention rate after EVAR
DREAM, ³⁴²	The Netherlands and Belgium	2000–2003	351	Better peri-operative survival after EVAR (1.2% vs. 4.6%) Early survival benefit was lost by the end of the first year, with similar long-term survival Higher re-intervention rate after EVAR
OVER, ³⁴³	USA	2002–2008	881	Better peri-operative survival after EVAR (0.5% vs. 3%) Early survival benefit sustained to 3 years but not thereafter No difference in re-intervention rate No difference in quality of life No difference in cost and cost effectiveness
ACE, ²¹	France	2003–2008	316	No difference in peri-operative survival (1.3% vs. 0.6%) No difference in long-term survival up till 3 years Higher re-intervention rate after EVAR

UK = United Kingdom; USA = United States of America; EVAR = endovascular aneurysm repair.

Langzeit-Ergebnisse

Prof. Dr. C. Bünge

EVAR-1 Studie

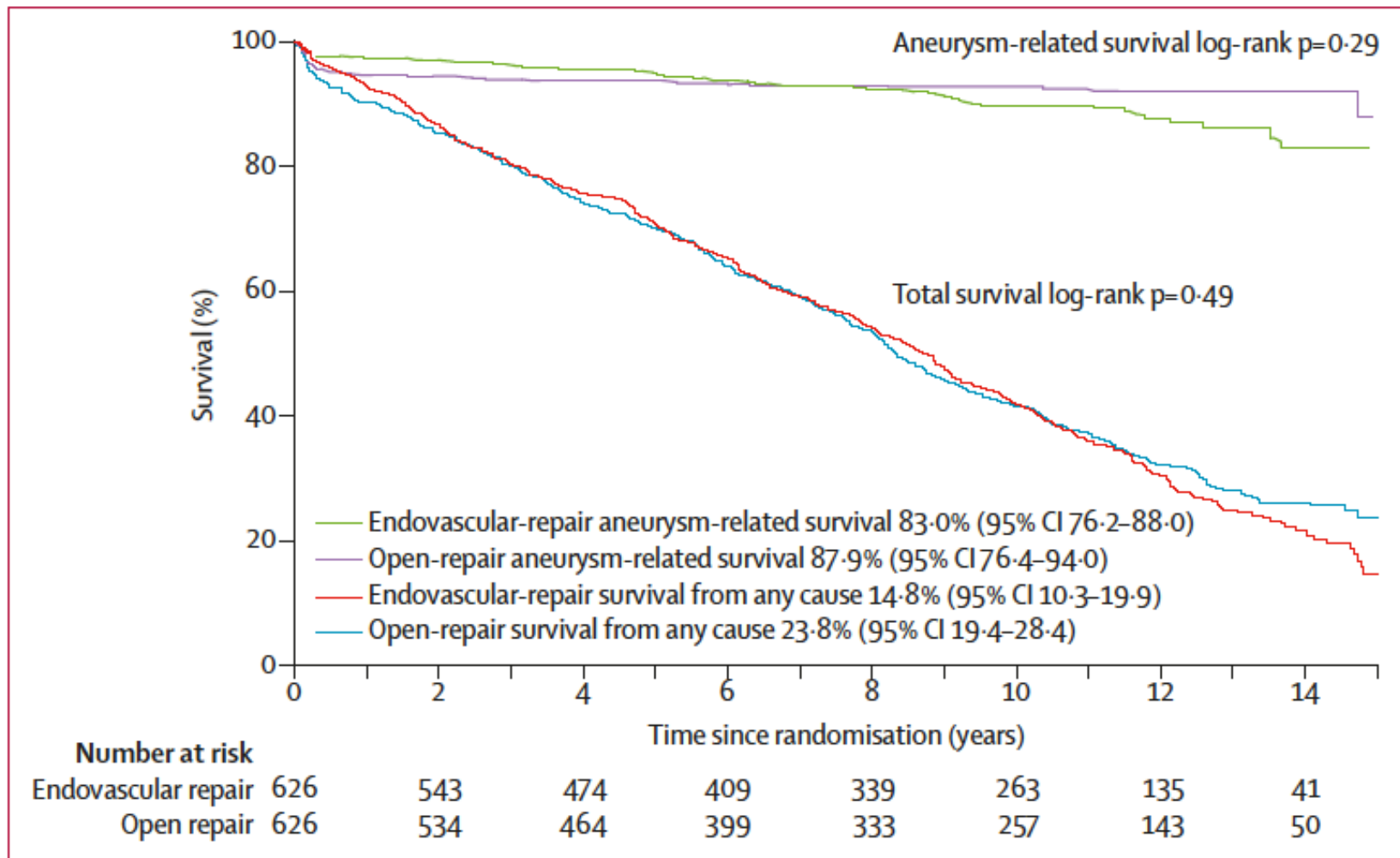


Figure 2: Kaplan-Meier estimates for total survival and aneurysm-related survival up to 15 years of follow-up
 The hazard ratio is 1.05 (95% CI 0.92–1.19) for total mortality, and is 1.24 (0.84–1.83) for aneurysm-related mortality.

Langzeit-Ergebnisse

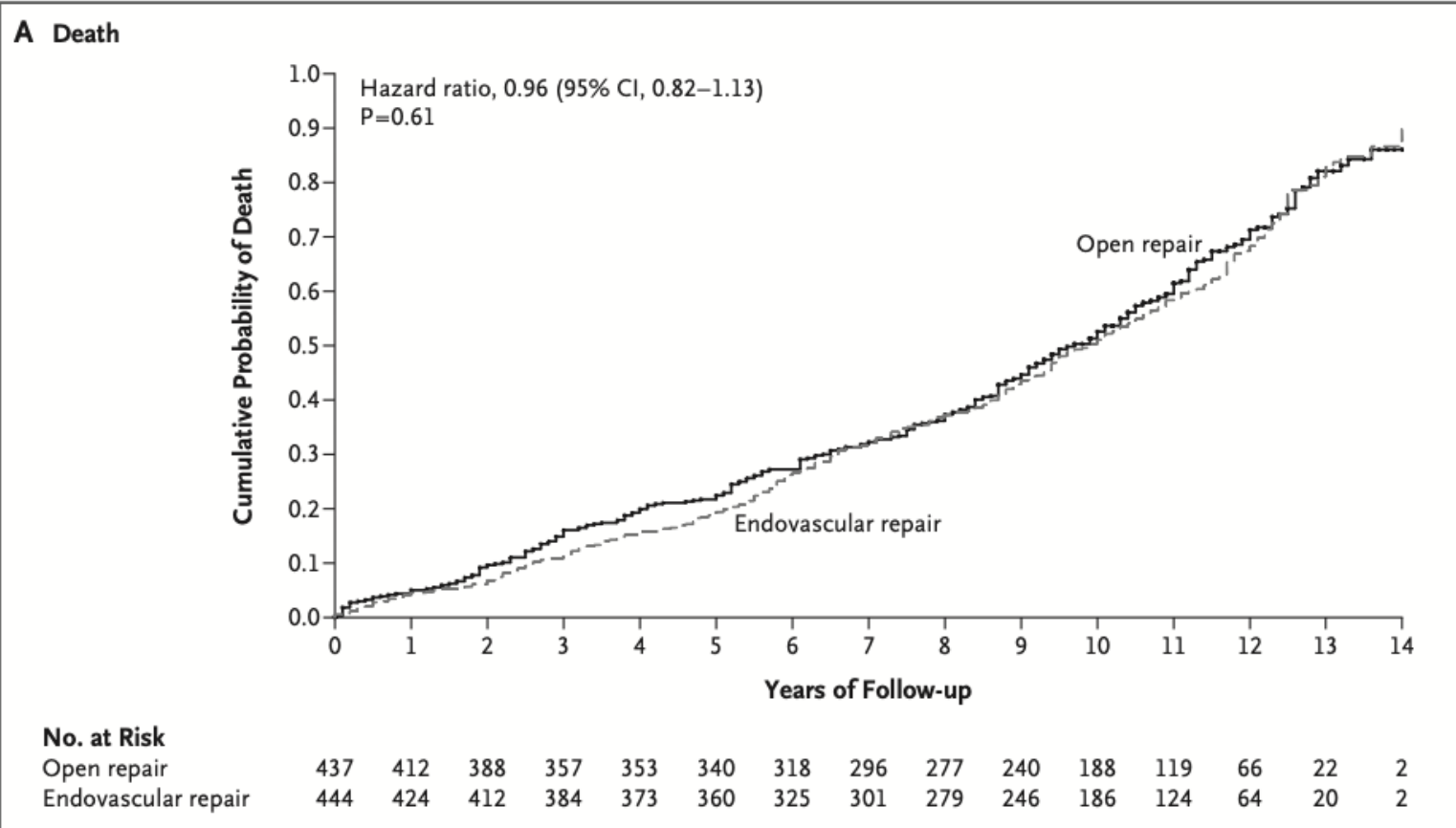


Figure 2. Kaplan–Meier Plots of the Cumulative Probability of Death

Panel A shows the cumulative probability of death from any cause from the time of randomization among patients with an abdominal aortic aneurysm who underwent endovascular repair or open repair.

At the end of 14 years, 608 of 693 patients had died, and 575 of 691 patients had either undergone a secondary therapeutic procedure or had died.

OVER-Studie

Therapiewahl - Studienlage

Prof. Dr. C. Bünner

Stather, 2013 ¹¹ Coughlin, 2013 ¹²	Open vs endovascular repair	• EVAR had lower 30-day or in-hospital mortality rate (high) • Reduction in quality of life at 3 months was more pronounced with open repair • At 2 and 4 years, no difference in mortality (low) • EVAR required more reinterventions and was associated with increased late rupture (high)
Biancari, 2011 ¹³	Open vs endovascular repair (age >80 years)	• Elective EVAR was associated with lower immediate postoperative mortality and morbidity (low, observational data)
Kontopodis, 2015 ¹⁴	Open vs endovascular repair (age <70 years)	• EVAR was associated with a decreased risk of 30-day mortality and 30-day morbidity and shorter length of hospitalization (moderate); long-term survival and the need for reintervention were similar (low)
Saeton, 2015 ¹⁵	Open vs endovascular repair (obese patients)	• EVAR had lower 30-day postoperative mortality and fewer early postoperative complications (MI, chest infection, renal failure, wound infection); risks of postoperative bowel ischemia and stroke were similar (low)
Rayet, 2008 ¹⁶ Sweeting, 2015 ¹⁷ Antoniou, 2013 ¹⁸ Antoniou, 2015 ¹⁹ Badger, 2016 ²⁰ Li, 2016 ²¹ Luebke, 2015 ²²	Open vs endovascular repair (ruptured AAA)	• EVAR had lower mortality in 31 studies that was insignificant in pooled analysis of three recent trials or in an adjusted analysis (low)

Therapiewahl - Studienlage

Prof. Dr. C. Bünner

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Für Patienten mit akzeptablem periprozeduralem Risiko sollen **EVAR und OR in gleicher Weise** empfohlen werden, anatomische Machbarkeit von EVAR vorausgesetzt.
EG A/ EvG 1a

Recommendation 60

In most patients with suitable anatomy and reasonable life expectancy, endovascular abdominal aortic aneurysm repair should be considered as the preferred treatment modality

Class	Level	References
Ila	B	[7,22,341,293,352,52,53,359,23,357,343,28,345,11,361,29,344,30,342,360,350,203,204,351]

Recommendation 61

In patients with long life expectancy, open abdominal aortic aneurysm repair should be considered as the preferred treatment modality

Class	Level	References
Ila	B	[21,22,341,23,343,28,345,29,344,30,342]

Therapiewahl - Studienlage

Prof. Dr. C. Bünner

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Bei der Auswahl des Eingriffsverfahrens soll die <u>Patientenpräferenz</u> berücksichtigt werden, wobei auf <u>Unterschiede</u> zwischen EVAR und OR im periprozeduralen Verlauf, der Reinterventionshäufigkeit, der Nachsorge und der aneurysmabezogenen Langzeitsterblichkeit <u>hingewiesen</u> werden soll. EG A/ EvG 1a		

Therapiewahl - Laparoskopisch

Prof. Dr. C. Bünner

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Der Stellenwert der laparoskopischen AAA-Versorgung ist **ungeklärt**.

EvG 4

Recommendation 59

Laparoscopic abdominal aortic aneurysm repair is not recommended in routine clinical practice, outside highly specialised centres, registries or trials

Class	Level	References
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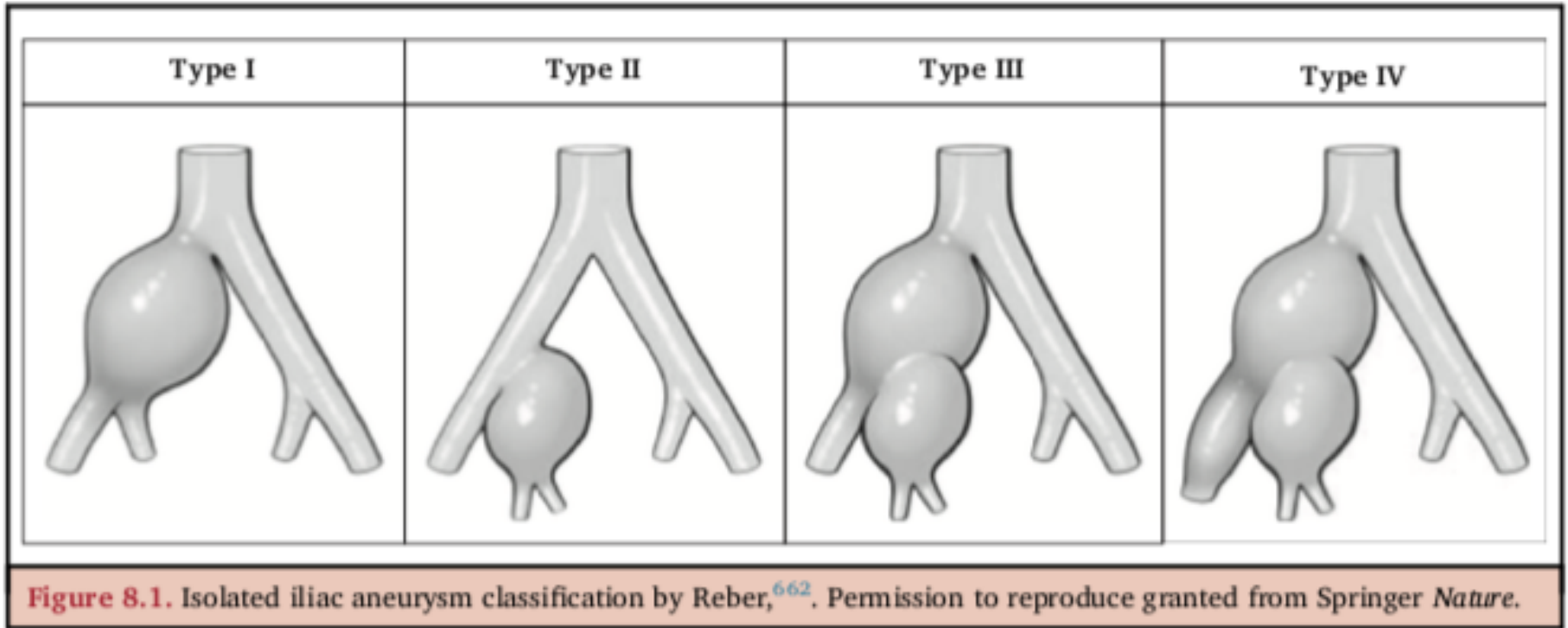
III	C	[339,340]
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Iliacales Aneurysma

Iliakales Aneurysma

Prof. Dr. C. Bunger

ESVS 2019



Iliakale Begleitaneurysmen

Prof. Dr. C. Bünner

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Iliakale Begleitaneurysmen
> **3,0 cm** stellen bei
behandlungsbedürftigem
AAA eine Erweiterung des
Eingriffs dar.
EG A/ EvG 4

Recommendation 102

The threshold for elective repair of isolated iliac artery aneurysm (common iliac artery, internal iliac artery and external iliac artery, or combination thereof) may be considered at a minimum of 3.5 cm diameter

Class	Level	References
IIb	C	[665,671-673,659,658]

Recommendation 103

In patients with iliac artery aneurysm endovascular repair may be considered as first line therapy

Class	Level	References
IIb	B	[674,665,677,678]

We recommend using Food and Drug Administration (FDA)-approved branch endograft devices in anatomically suitable patients to maintain perfusion to at least one internal iliac artery.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Iliakale Begleitaneurysmen

Prof. Dr. C. Bünner

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Im Vergleich zur einseitigen oder beidseitigen Okklusion der A. iliaca interna stellen der **Internaerhalt**, mehrheitlich unter Verwendung einer gebrannten Prothese, eine deutliche Verbesserung in der Behandlung aortoiliakler Aneurysmen mit EVAR dar. Sie sollen bevorzugt werden.

EG A/ EvG 2c

Recommendation 104

Preserving blood flow to at least one internal iliac artery during open surgical and endovascular repair of iliac artery aneurysms is recommended

Class	Level	References
I	B	[683]

EVAR. We recommend preservation of flow to at least one internal iliac artery.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Recommendation 105

In patients where internal iliac artery embolisation or ligation is necessary, occlusion of the proximal main stem of the vessel is recommended if technically feasible, to preserve distal collateral circulation to the pelvis

Class	Level	References
I	C	[683]

We recommend staging bilateral internal iliac artery occlusion by at least 1 to 2 weeks if required for EVAR.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Invasive Therapiewahl- Intaktes AAA

Perioperatives Vorgehen

Antibiotikaprophylaxe

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OAR: systemische perioperative Antibiotikaprophylaxe mit Aktivität gegen Staphylokokken und gramnegative Bakterien.

EG A/ EvG 2a

EVAR: Einmalgabe eines Cephalosporins

EG A/ EvG 5

Recommendation 46

In all patients undergoing open or endovascular abdominal aortic aneurysm repair, peri-operative systemic antibiotic prophylaxis is recommended

Class	Level	References
I	A	[263]

Antibiotic prophylaxis. We recommend intravenous administration of a first-generation cephalosporin or, in the event of penicillin allergy, vancomycin within 30 minutes before OSR or EVAR. Prophylactic antibiotics should be continued for no more than 24 hours.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

30 min vor Hautschnitt, unter Berücksichtigung der Halbwertszeit von beispielsweise Cefuroxim (ca. 70 min) empfohlen, bei langer Operationsdauer nach 3 h sowie bei Blutverlust von mehr als 1500 ml die Antibiotikagabe zu wiederholen.

Thrombozytenaggregationshemmer

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Bei Patienten mit AAA soll perioperativ die Gabe von **ASS** im Rahmen der Sekundärprävention fortgesetzt werden. Ein Absetzen erfolgt nur aufgrund individueller Risikoabwägung.
EG A/ EvG 3a

Recommendation 45

An established monotherapy with aspirin or thienopyridines (e.g. clopidogrel) is recommended to be continued during the peri-operative period after open and endovascular abdominal aortic aneurysm repair

Class	Level	References
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I	B	[258,260-262]
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Perioperative Heparin

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018												
	<table><tr><th colspan="3">Recommendation 50</th></tr><tr><td colspan="3">Intravenous heparin (50–100 IU/kg) is recommended before aortic cross clamping</td></tr><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>I</td><td>C</td><td>[299]</td></tr></table>	Recommendation 50			Intravenous heparin (50–100 IU/kg) is recommended before aortic cross clamping			Class	Level	References	I	C	[299]	
Recommendation 50														
Intravenous heparin (50–100 IU/kg) is recommended before aortic cross clamping														
Class	Level	References												
I	C	[299]												
		We recommend a thrombin inhibitor, such as bivalirudin or <u>argatroban</u>, as an alternative to heparin for patients with a <u>history of heparin-induced thrombocytopenia</u>. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>B (Moderate)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	B (Moderate)								
Level of recommendation	1 (Strong)													
Quality of evidence	B (Moderate)													

Körpertemperatur

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
Eine perioperative Hypothermie kann das Operationsergebnis und den postoperativen Verlauf negativ beeinflussen und soll aktiv vermieden werden. EG A/ EvG 2a		Maintenance of body temperature. We recommend maintaining core body temperature at or above 36°C during aneurysm repair. <table><tr><td>Levels of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Levels of recommendation	1 (Strong)	Quality of evidence	A (High)
Levels of recommendation	1 (Strong)					
Quality of evidence	A (High)					

Etwa 25–90 % aller elektiv operierten Patienten erleiden eine **unbeabsichtigte postoperative Hypothermie**, die als Körperkerntemperatur < 36 °C definiert ist. Die Hypothermie ist mit einem relativen Risiko von 3,25 für postoperative Wundinfektionen, 4,49 für kardiale Komplikationen und 1,33 für Bluttransfusionen im Vergleich zu normothermen Patienten assoziiert (Torossian et al. 2015).

Nierenprotektion und Nierenversagen

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Evidenzgesicherte intraoperative medikamentöse Protektionsmaßnahmen zur Verbesserung der Nierenfunktion postoperativ sind nicht bekannt. Bei offener Versorgung eines AAA sollen kurze renale Ischämiezeiten und ein Erhalt der linken Nierenvene angestrebt werden. EG A/ EvG 4		

Patient Blood Management intraprozedural

Prof. Dr. C. Rüger

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...**Blood Management-Konzept** implementiert werden, incl. der maschinellen Autotransfusion, wenn von einem größeren Blutverlust ausgegangen wird.
EG A/ EvG 2a

Recommendation 49

Intra-operative cell salvage and re-transfusion should be considered during open abdominal aortic aneurysm repair

Class	Level	References
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IIa	B	[287,288]
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Intraoperative fluid resuscitation and blood conservation. We recommend using cell salvage or an ultrafiltration device if large blood loss is anticipated.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

= 4,35 mmol/l

We recommend perioperative transfusion of packed red blood cells if the hemoglobin level is <7 g/dL.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

If the intraoperative hemoglobin level is <10 g/dL and blood loss is ongoing, we recommend transfusion of packed blood cells along with fresh frozen plasma and platelets in a ratio of 1:1:1.

= 6,21 mmol/l

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

We suggest hematologic assessment if the preoperative platelet count is <150,000/ μ L.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Invasive Therapiewahl- Intaktes AAA

Postoperatives Vorgehen

Postoperative Überwachung

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		We recommend postoperative <u>ST-segment monitoring</u> for all patients undergoing open aneurysm repair and for those patients undergoing EVAR who are at high cardiac risk. Level of recommendation 1 (Strong) Quality of evidence B (Moderate)
		We recommend <u>postoperative troponin measurement</u> for all patients with electrocardiographic changes or chest pain after aneurysm repair. Levels of recommendation 1 (Strong) Quality of evidence A (High)
		Role of the ICU. We recommend <u>postoperative management in an ICU</u> for the patient with significant cardiac, pulmonary, or renal disease as well as for those requiring postoperative mechanical ventilation or who developed a significant arrhythmia or hemodynamic instability during operative treatment. Level of recommendation 1 (Strong) Quality of evidence A (High)

Thromboseprophylaxe

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018				
		Prophylaxis for deep venous thrombosis. We recommend <u>thromboprophylaxis</u> that includes intermittent pneumatic compression and early ambulation for all patients undergoing OSR or EVAR. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Level of recommendation	1 (Strong)					
Quality of evidence	A (High)					
		We suggest thromboprophylaxis with unfractionated or <u>low-molecular-weight heparin</u> for patients undergoing aneurysm repair at moderate to high risk for venous thromboembolism and low risk for bleeding. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Level of recommendation	2 (Weak)					
Quality of evidence	C (Low)					

Patient Blood Management postprozedural

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Umrechnen in mmol...		Postoperative blood transfusion. In the absence of ongoing blood loss, we suggest a threshold for blood transfusion during or after aneurysm repair at a hemoglobin concentration of 7 g/dL or below. Level of recommendation 2 (Weak) Quality of evidence C (Low)

Fast Track Konzept

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Fast-Track-Protokolle verkürzen die stationäre Liegezeit. EvG 3b		

Fast Track Konzept

Prof. Dr. C. Büniger

1.	Mündliche und schriftliche Beratung und Information vor stationärer Aufnahme.
2.	Keine routinemäßige präoperative Darmvorbereitung.
3.	Verkürzte Nüchternheitsperiode und Kohlenhydrat-Zufuhr.
4.	Kurzwirksame Prämedikation vor Anästhesie.
5.	Thromboembolieprophylaxe.
6.	Antibiotikaprophylaxe.
7.	Kurzwirksame Opioide / Epiduralanästhesie.
8.	Vorbeugung und Behandlung von postoperativer Übelkeit und Erbrechen.
9.	Weniger invasive chirurgische Inzisionen.
10.	Vorbeugung von intraoperativer Hypothermie.
11.	Standardisierung der perioperativen Flüssigkeitszufuhr
12.	Vernünftiger Gebrauch von Drains und Kathetern.
13.	Vorbeugung vor postoperativem Ileus.
14.	Postoperative Ernährungsbehandlung.
15.	Frühe Mobilisation.

EVAR:

- perkutaner bilateraler Zugang
- grundsätzlich keine Allgemeinnarkose, sondern Lokalanästhesie (bei zusätzlicher Sedierung)
- kein postoperativer Aufenthalt auf der Intensivstation
- Entlassung des Patienten im Mittel nach 1 Tag angestrebt.

Postoperative Betreuung

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Recommendation 75

In all patients after abdominal aortic aneurysm repair, cardiovascular risk management, with blood pressure and lipid control as well as antiplatelet therapy, is recommended

Class	Level	References
I	B	[180,478,183,486,491,487,482,488]

Prophylaxe Prothesen-Infektion

Prof. Dr. C. Bünner

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We recommend that any potential sources of dental sepsis be eliminated at least 2 weeks before implantation of an aortic prosthesis.

Level of recommendation	Good Practice Statement
Quality of evidence	Ungraded

Recommendation 80

In patients with previous abdominal aortic aneurysm repair routine use of antibiotic prophylaxis in conjunction with dental or other surgical procedures for prevention of graft infection is not recommended

Class	Level	References
III	C	[535,380,536]

We recommend antibiotic prophylaxis to prevent graft infection before any dental procedure involving the manipulation of the gingival or periapical region of teeth or perforation of the oral mucosa, including scaling and root canal procedures, for any patient with an aortic prosthesis, whether placed by OSR or EVAR.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Recommendation 81

In patients with previous abdominal aortic aneurysm repair antibiotic prophylaxis should be considered in conjunction with high risk infectious procedures, including abscess drainage, dental procedures requiring manipulation of the gingival or peri-apical region of the teeth or breaching the oral mucosa, as well as in immuno-compromised patients undergoing surgical or interventional procedures

Class	Level	References
IIa	C	[535,380,536]

We suggest antibiotic prophylaxis before respiratory tract procedures, gastrointestinal or genitourinary procedures, and dermatologic or musculoskeletal procedures for any patient with an aortic prosthesis if the potential for infection exists or the patient is immuno-compromised.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Invasive Therapiewahl- Intaktes AAA

Spezielles Vorgehen bei OAR

Anästhesie-Verfahren

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018										
OAR in Kombination von Allgemein-anästhesie mit Epiduralanästhesie kann auf Basis einer individuellen Nutzen-Risiko Bewertung erwogen werden. EG 0/ EvG 3a		Choice of anesthetic technique and agent. We recommend general endotracheal anesthesia for patients undergoing open aneurysm repair. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)						
Level of recommendation	1 (Strong)											
Quality of evidence	A (High)											
	Recommendation 47 In patients undergoing open abdominal aortic aneurysm repair, peri-operative epidural analgesia should be considered, to maximise pain relief and minimise early post-operative complications <table><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>IIa</td><td>B</td><td>[265]</td></tr></table>	Class	Level	References	IIa	B	[265]	Perioperative pain management. We recommend multimodality treatment, including epidural analgesia, for postoperative pain control after OSR of an AAA. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)
Class	Level	References										
IIa	B	[265]										
Level of recommendation	1 (Strong)											
Quality of evidence	A (High)											
		We recommend using nasogastric decompression intraoperatively for all patients undergoing open aneurysm repair but postoperatively only for those patients with nausea and abdominal distention. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>A (High)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	A (High)						
Level of recommendation	1 (Strong)											
Quality of evidence	A (High)											

Schnittführung und Zugang

Prof. Dr. C. Bünner

S3-Leitlinie AWMF Deutschland	ESVS 2019					
Zur Vermeidung von Narbenhernien kann der quere Zugang vor dem vertikalen bei OR erwogen werden. EG 0/ EvG 3b						
Die Wahl des operativen Zugangs soll der Präferenz des Chirurgen überlassen bleiben. Bei <u>inflammatorisch. Aneurysmen, Patienten mit Hufeisenniere, und Aneurysmen bei Verwachsungsbauch</u> empfehlen wir einen retroperitonealen Zugang. EG A/ EvG 4		OSR. We recommend a retroperitoneal approach for patients requiring OSR of an inflammatory aneurysm, a horseshoe kidney, or an aortic aneurysm in the presence of a hostile abdomen. <table><tr><td>Level of recommendation</td><td>1 (Strong)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	1 (Strong)	Quality of evidence	C (Low)
Level of recommendation	1 (Strong)					
Quality of evidence	C (Low)					

Schnittführung und Zugang

Prof. Dr. C. Bünner

S3-Leitlinie AWMF Deutschland	ESVS 2019							
		We suggest a <u>retroperitoneal exposure</u> or a transperitoneal approach with a transverse abdominal incision for patients with <u>significant pulmonary disease</u> requiring OSR. Level of recommendation 2 (Weak) Quality of evidence C (Low)						
Die präventive Netzverstärkung ... in Sublaytechnik ... ist sicher und verhindert effektiv die mit hoher Prävalenz auftretende Bildung einer Hernie. Sie sollte vorgenommen werden. EG B/ EvG 1b	Recommendation 54 In patients treated for abdominal aortic aneurysm by open repair, <u>prophylactic use of mesh reinforcement of midline laparotomies</u> may be considered for patients at high risk of incisional hernia <table><thead><tr><th>Class</th><th>Level</th><th>References</th></tr></thead><tbody><tr><td>IIb</td><td>A</td><td>[316,317]</td></tr></tbody></table>	Class	Level	References	IIb	A	[316,317]	
Class	Level	References						
IIb	A	[316,317]						

Schnittführung und Zugang

Prof. Dr. C. Bünker

Ma, 2016 ²³	Transperitoneal vs retroperitoneal approach for elective open AAA repair	• No difference in mortality (low) • Retroperitoneal approach may reduce blood loss, hospital stay, and ICU stay (low) • No differences in aortic cross-clamp time and operating time
Twine, 2013 ²⁴	Retroperitoneal vs transperitoneal approach to the infrarenal abdominal aorta	• Retroperitoneal approach is associated with lower rates of postoperative ileus and pneumonia (moderate)

Ausmaß der Operation

Prof. Dr. C. Bünzger

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018						
		We suggest <u>concomitant surgical repair of an AAA and coexistent <u>cholecystitis or an intra-abdominal tumor</u></u> in patients who are not candidates for EVAR or staged intervention. Level of recommendation2 (Weak) Quality of evidenceC (Low)						
		We recommend that <u>all portions</u> of an aortic graft be <u>excluded from direct contact</u> with the intestinal contents of the peritoneal cavity. Level of recommendation1 (Strong) Quality of evidenceA (High)						
	Recommendation 51 It is recommended to perform the <u>proximal anastomosis as close as possible to the renal arteries</u> to prevent later aneurysm development in the remaining infrarenal aortic segment <table><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>I</td><td>C</td><td>[301,302]</td></tr></table>	Class	Level	References	I	C	[301,302]	We recommend performing the proximal aortic anastomosis as close to the renal arteries as possible. Level of recommendation1 (Strong) Quality of evidenceA (High)
Class	Level	References						
I	C	[301,302]						

Überwachung während OAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		Cardiovascular monitoring. We suggest using <u>pulmonary artery catheters</u> only if the likelihood of a major hemodynamic disturbance is high.
		Level of recommendation 1 (Strong) Quality of evidence B (Moderate)
		We recommend <u>central venous access and arterial line</u> monitoring in all patients undergoing open aneurysm repair.
		Level of recommendation 1 (Strong) Quality of evidence B (Moderate)

Prothesenwahl

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Handhabungs- eigenschaften und die Präferenz des Chirurgen sollen die Wahl des Gefäß- prothesenmaterials bestimmen. EG A/ EvG 2a		
		We recommend <u>straight tube grafts</u> for OSR of AAA in the absence of significant disease of the iliac arteries. Level of recommendation 1 (Strong) Quality of evidence A (High)

Pelviner Kollateralkreislauf

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Bei Verdacht auf Minderperfusion des linksseitigen Kolons soll bei offener Versorgung die **Reimplantation** einer offenen A. mesenterica inferior erfolgen.

EG A/ EvG 3b

Bei offener Versorgung soll der Blutfluss zu **wenigstens einer A. iliaca interna** erhalten werden.

EG A/ EvG 3b

Recommendation 52

In selected cases of suspected insufficient perfusion of pelvic organs with risk of colonic ischaemia, reimplantation of the inferior mesenteric artery may be considered during open abdominal aortic aneurysm repair

Class	Level	References
IIb	C	[307,308]

We recommend preserving blood flow to at least one hypogastric artery in the course of OSR.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Recommendation 53

In open abdominal aortic aneurysm repair, it is recommended to preserve the blood flow to at least one internal iliac artery to reduce the risk of buttock claudication and colonic ischaemia

Class	Level	References
I	C	[303-306]

We recommend reimplantation of a patent IMA under circumstances that suggest an increased risk of colonic ischemia.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

We suggest concomitant surgical treatment of other visceral arterial disease at the time of OSR in symptomatic patients who are not candidates for catheter-based intervention.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

Postoperative Überwachung

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Der Patient mit AAA sollte postoperativ nach OAR auf IMC oder ICU verlegt werden. EG B/ EvG 4		

Invasive Therapiewahl- Intaktes AAA

Spezielles Vorgehen bei EVAR

Anästhesie-Form

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
<u>EVAR</u> kann unter Lokalanästhesie, Regionalanästhesie oder Allgemeinanästhesie durchgeführt werden. Eine <u>eindeutige Evidenz</u> dafür, dass ein Verfahren dem anderen hinsichtlich Morbidität oder Mortalität überlegen ist, <u>gibt es nicht</u>.		

Bildgebung

Prof. Dr. C. Bünner

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Die **Strahlenbelastung** bei EVAR ist abhängig von der technischen Ausstattung, dem aktiven und passiven Strahlenschutz, dem Volumen bzw. dem Körpergewicht des Patienten sowie vom Ausbildungsstand und Expertise des Interventionalisten bzw. Operateurs. Ärzte, die unter Röntgenkontrolle EVAR durchführen, müssen in Deutschland im Besitz der erforderlichen **Fachkunde im Strahlenschutz** sein.

EvG 3a

Recommendation 48

During endovascular abdominal aortic aneurysm repair radiation dose reduction strategies are recommended, such as

- Keeping as much distance as possible from the radiation source for both personnel and patient
- Minimising the time of exposure, use of digital subtraction acquisitions and lateral angulations
- Positioning the image intensifier close to the patient, with a well collimated beam
- Using necessary magnification levels only
- Diligent use and appropriate positioning of lead shields, including personal shields (apron, thyroid, shins and goggles) and mobile shields

Class	Level	References
I	B	[280,284,281-283]

Nierenprotektion

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018																
Bei allen Patienten mit EVAR , speziell bei einer GFR < 40, soll vor, während und nach dem Eingriff eine Hydrierung erfolgen. EG A/ EvG 1b																		
Akzessorische kleine Nierenarterien können bei EVAR falls notwendig mit relativ geringem Risiko überstentet werden. EG 0/ EvG 2c	<table><tr><th colspan="3">Recommendation 56</th></tr><tr><td colspan="3"><u>Preservation</u> of large accessory renal arteries (>3 mm) or those that supply a significant portion of the kidney (>1/3) may be considered in endovascular aneurysm repair</td></tr><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>IIb</td><td>C</td><td>[324]</td></tr></table>	Recommendation 56			<u>Preservation</u> of large accessory renal arteries (>3 mm) or those that supply a significant portion of the kidney (>1/3) may be considered in endovascular aneurysm repair			Class	Level	References	IIb	C	[324]	We suggest preservation of accessory renal arteries at the time of EVAR or OSR if the artery is 3 mm or larger in diameter or supplies more than one-third of the renal parenchyma. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)
Recommendation 56																		
<u>Preservation</u> of large accessory renal arteries (>3 mm) or those that supply a significant portion of the kidney (>1/3) may be considered in endovascular aneurysm repair																		
Class	Level	References																
IIb	C	[324]																
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	
		We suggest <u>renal artery</u> or superior mesenteric artery (SMA) <u>angioplasty and stenting</u> for selected patients with <u>symptomatic disease before EVAR or OSR</u>. <table><tr><td>Level of recommendation</td><td>2 (Weak)</td></tr><tr><td>Quality of evidence</td><td>C (Low)</td></tr></table>	Level of recommendation	2 (Weak)	Quality of evidence	C (Low)												
Level of recommendation	2 (Weak)																	
Quality of evidence	C (Low)																	

Vermeidung Mesenterialischämie

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		We suggest renal artery or <u>superior mesenteric artery (SMA) angioplasty and stenting</u> for selected patients with <u>symptomatic disease</u> <u>before EVAR or OSR</u>.
		Level of recommendation 2 (Weak) Quality of evidence C (Low)
		We suggest <u>prophylactic treatment</u> of an asymptomatic, <u>high-grade stenosis of the SMA</u> in the presence of a meandering mesenteric artery based off of a large inferior mesenteric artery (IMA), which will be sacrificed during the course of treatment.
		Level of recommendation 2 (Weak) Quality of evidence C (Low)

Präprozedurale Planung

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Bei Patienten mit EVAR kann die anatomische Komplexität mittels des ASG-Scores präinterventionell klassifiziert werden. EG 0/ EvG 4		

Table 4.1. Cross sectional imaging criteria for planning of infrarenal abdominal aortic aneurysm repair.

Proximal neck to be cross clamped or used as landing zone, including; diameter and length, angulation, shape, presence and extent of calcification and athero-thrombosis.
Iliac arteries to be cross clamped or used for access and landing zone, including: patency; diameter and length; angulation/tortuosity; extent of calcification and athero-thrombosis; patency of internal iliac arteries and pelvic circulation; presence of iliac artery aneurysms.
Access vessel and lower limb “runoff” vessels/circulation.
Anatomy and patency of visceral arteries and presence of accessory renal arteries.
Concomitant aneurysms in visceral arteries or thoracic aorta.
Other: Venous anomalies, including position and patency of inferior vena cava and left renal vein; organ position, including pelvic or horseshoe kidney; signs of concomitant disease potentially altering prognosis and, thereby, indication for repair.

IFU: Instructions for Use

Prof. Dr. C. Bünner

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... sind grundsätzlich zu beachten. Eine <u>ungünstige Anatomie</u> mit der Notwendigkeit, die Anwendungshinweise nicht einhalten zu können, schließt aber die Implantation eines <u>Stentgrafts</u> nicht aus. EvG 4		

IFU: Instructions for Use

Prof. Dr. C. Büngrer



Table 4.4. Anatomical requirements for the most commonly used stent grafts according to the latest instruction for use available to the authors.

Anatomical parameter	Endurant	Excluder	Zenith
Neck length	≥ 10 mm ^a	≥ 15 mm	≥ 15 mm
Neck diameter	19–32	19–29	18–32
Suprarenal neck angulation (α -angle)	$\leq 45^\circ$	–	$< 45^\circ$
Infrarenal neck angulation (β -angle)	$\leq 60^\circ$	$\leq 60^\circ$	$< 60^\circ$
Distal fixation site length	≥ 15 mm	≥ 10 mm	> 10 mm
Distal fixation site diameter	8–25 mm	8–25 mm	7.5–20 mm
Additional criteria	No significant or circumferential calcification or thrombus in proximal and distal landing zones No conical neck shape (< 2 – 3 mm increase in neck diameter for each centimetre of length) Adequate femoral access		

^a ≥ 15 mm with $> 60^\circ$ to $\leq 75^\circ$ infrarenal and $> 45^\circ$ to $\leq 60^\circ$ suprarenal neck angulation.

Neue Prothesengenerationen

Prof. Dr. C. Bünge

Recommendation 57

For newer generations of stent grafts based on existing platforms, such as low profile devices, long-term follow up and evaluation of the durability in prospective registries is recommended

Class	Level	References
I	C	[330,329,331]

Recommendation 58

New techniques/concepts (such as endovascular aneurysm sealing with endobags) are not recommended in clinical practice and should only be used with caution, preferably within the framework of studies approved by research ethics committees, until adequately evaluated

Class	Level	References
III	C	[332,335,330,329,336]

EVAR perkutan

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Wenn möglich, sollte bei EVAR in Abhängigkeit vom Verkalkungsgrad des Zugangsgefäßes und nach Präferenz des Operateurs der **perkutane Zugang** gewählt werden, der hinsichtlich Eingriffszeit und Leisteninfektionsrate gegenüber dem offenen Zugang Vorteile hat.

EG B/ EvG 2b

Recommendation 55

An ultrasound guided percutaneous approach should be considered in endovascular aortic aneurysm repair

Class

Level

References

IIa

B

[318,320,323,319,322]

Kurzer Hals: fenestrierte/gebranchte EVAR und Chimney

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Für die endovaskuläre Versorgung von AAA mit kurzem Hals stehen – falls nicht das offene Vorgehen gewählt wird - fenestrierte/gebranchte Prothesen und - falls dies anatomisch nicht machbar ist - die Chimneytechnik zur Verfügung, wobei mit der Chimneytechnik vergleichsweise weniger publizierte Daten vorliegen. EvG 3a		

Embolisation vor EVAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Vor einer endovaskulären Versorgung kann die Embolisation einer offenen <u>A. mesenterica inferior</u> und/oder von <u>Lumbalarterien</u> zur Senkung der Endoleckage-Rate erwogen werden. EvG 0/ EvG 4		

Postprozedurale Überwachung

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Das Ausmass der Intervention, die Wahl des Anästhesie-verfahrens sowie das individuelle Patientenrisiko sollten die <u>postinterventionelle Überwachung</u> bestimmen. Unkomplizierte EVAR-Prozeduren bedürfen nicht grundsätzlich einer postinterventionellen Intensivüberwachung. EG B/ EvG 4		

Invasive Therapiewahl- Rupturiertes AAA

Definition des rupturierten AAA (rAAA)

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Das rupturierte abdominale Aortenaneurysma ist definiert durch den eindeutigen <u>Nachweis von Blut oder Kontrastmittel außerhalb der Aortenwand</u> , entdeckt z.B. durch ein präprozedurales CT, intraoperative Angiographie oder während des Eingriffs.		

Vorgehen bei rupturierten AAA (rAAA)

S3-Leitlinie AWMF 07/2018

.. gesicherter Ruptur eines AAA sollen **sofort invasiv versorgt** werden.

EG A/ EvG 2b

Die **permissive Hypotension** mit systol. Blutdruck von 80 mm Hg schränkt die Volumenüberladung ein und ... gewährleistet die kritische Endorganperfusion zu gewährleisten. Sie soll bei Patienten mit rAAA implementiert werden.

EG A/ EvG 3b

ESVS 2019

Recommendation 65

Symptomatic non-ruptured abdominal aortic aneurysms should be considered for deferred urgent repair ideally under elective repair conditions

Class	Level	References
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IIa	B	[373-375,196,376,197]
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Recommendation 70

Selection of patients with ruptured abdominal aortic aneurysm for palliation based entirely on scoring systems or solely on advanced age is not recommended

Class	Level	References
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III	B	[419,416,420,414,370,421,353,422,417,423,162,424-427,415]
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Recommendation 66

In patients with ruptured abdominal aortic aneurysm, a policy of permissive hypotension, by restricting fluid resuscitation, is recommended in the conscious patient

Class	Level	References
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I	B	[377,390,380,389,382,379,383-386]
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SVS 01/2018

We suggest that patients with ruptured AAA who require transfer for repair be referred to a facility with an established rupture protocol and suitable endovascular resources.

Level of recommendation	Good Practice Statement
Quality of evidence	Ungraded

We recommend implementing hypotensive hemostasis with restriction of fluid resuscitation in the conscious patient.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Vorgehen bei rupturierten AAA (rAAA)

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Beim rAAA sollte **EVAR** - abhängig von der Anatomie des Aneurysmas und der Erfahrung des Therapeuten - **bevorzugt** werden, wenn OR und EVAR gleichermaßen möglich sind.
EG B/ EvG 1b

Recommendation 74

In patients with ruptured abdominal aortic aneurysm and suitable anatomy, endovascular repair is recommended as a first option

Class I	Level	References
I	B	[25,26,470]

If it is anatomically feasible, we recommend EVAR over open repair for treatment of a ruptured AAA.

Level of recommendation	1 (Strong)
Quality of evidence	C (Low)

Recommendation 69

In patients undergoing endovascular repair for ruptured abdominal aortic aneurysms, a bifurcated device, in preference to an aorto-uni-iliac device, should be considered whenever anatomically suitable

Class	Level	References
IIa	C	[389,393,405,397,382]

Aortaler Okklusionsballon

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Der Einsatz des
aortalen
Okklusionsballons bei
EVAR sollte bei
Patienten mit
hypovolämischem
Schock erwogen
werden.
EG B/ EvG 4

Recommendation 68

Aortic balloon occlusion for proximal control should be considered in haemodynamically unstable ruptured abdominal aortic aneurysm patients undergoing open or endovascular repair

Class	Level	References
Ila	C	[402,380,393,401,397,392, 403,63,382,404,383,400,386]

Anästhesie und Narkoseinduktion

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Die **Narkoseeinleitung** beim Patienten mit rupturiertem AAA soll im OP-Saal erfolgen und zwar erst nach dem Abwaschen, dem sterilen Abdecken und bei eingriffsbereitem Operateur am OP-Tisch. Eine invasive Blutdruckmessung sollte vor der Narkoseeinleitung angelegt werden, darf den OP-Beginn jedoch nicht verzögern. Ein zentralvenöser Zugang sollte erst nach der Narkoseeinleitung und parallel zum Beginn des operativen Eingriffs etabliert werden (Hope et al. 2016).

GCP

EVAR unter Lokalanästhesie

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

SVS 01/2018

Bei Versorgung des rAAA mit EVAR sollte der **Lokalanästhesie** im Vergleich zur Allgemeinanästhesie der Vorzug gegeben werden.

EG B/ EvG 3b

Recommendation 67

Local anaesthesia should be considered as the anaesthetic modality of choice for endovascular repair of ruptured abdominal aortic aneurysm whenever tolerated by the patient

Class	Level	References
IIa	B	[389,370,392]

postoperative / postinterventionelle Überwachung

Prof. Dr. C. Bünner

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Alle Patienten werden nach initialer Versorgung im (Hybrid-) OP auf Intensivstation aufgenommen und dort weiterbehandelt. Die Patienten besitzen ein hohes <u>Risiko</u> für <u>kardiale</u>, <u>respiratorische</u> und <u>renale</u> Komplikationen wie auch für ein abdominelles <u>Kompartmentsyndrom</u>. <u>Spinale Ischämien</u> sind eine seltene, aber schwerwiegende Komplikation nach komplexen Aorteneingriffen. Die Aufgabe des Neuromonitorings besteht in der frühzeitigen Identifikation einer spinalen Durchblutungsstörung. Eine frühe Diagnose kann durch eine verzögerte Extubation erschwert werden. GCP		

Frühkomplikation nach OAR

Komplikationen nach OAR

Prof. Dr. C. Büniger

Table VIII. Estimated perioperative complications after elective open surgery for abdominal aortic aneurysm (AAA)

Complication	Frequency, %
All cardiac	15
Myocardial infarction	2-8
All pulmonary	8-12
Pneumonia	5
Renal insufficiency	5-12
Dialysis	1-6
Bleeding	2-5
Wound infection	<5
Leg ischemia	1-4
Deep venous thrombosis	5-8
Colon ischemia	1-2
Stroke	1-2
Graft thrombosis	<1
Graft infection	<1
Ureteral injury	<1
From Schermerhorn ML, Cronenwett JL. Abdominal aortic and iliac aneurysms. In: Rutherford RB, editor. Vascular surgery. 6th ed. Philadelphia: Elsevier Saunders; 2005. p. 1431.	

Frühkomplikation nach EVAR und OAR

Nierenfunktionsstörung

Prof. Dr. C. Bünner

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Sowohl nach EVAR als auch nach OR (dort ausgeprägter) ist postprozedural mit einer akuten reversiblen <u>Nierenfunktionseinschränkung</u> zu rechnen. Langfristig verschlechtert sich die Nierenfunktion bei diesen Patienten <u>altersabhängig</u> und abhängig von der <u>Ausgangsfunktion</u>. Dass EVAR hier im Vergleich zu OR aufgrund fortgesetzter Kontrastmittelgaben im Nachteil ist, kann evidenzbasiert nicht behauptet werden. EvG 3a		

Abdominelles Kompartmentsyndrom

Prof. Dr. C. Büngrer

Risikofaktoren

- Tiefer Schock mit einem systolischen Blutdruck < 70 mm Hg für 20 Minuten + Hämoglobin < 8 g/dl + pH $< 7,3$
- Intraoperative Flüssigkeitszufuhr > 5 L
- Transfusion > 6 Erythrozytenkonzentraten
- Körpertemperatur $< 35^{\circ}$ C
- Großes retroperitoneales Hämatom
- Massive Darmschwellung

Abdominelles Kompartmentsyndrom

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

Bei Risikopatienten ... **IAP** über die Harnblase zur frühzeitigen Erkennung eines abdominalen Kompartmentsyndroms... Bei persistierendem IAP von > 20 mm Hg und/oder bei einem IAP >30mmHg ist die Indikation für eine abdominelle Dekompression gegeben.

EG B/ EvG 3b

ESVS 2019

Recommendation 71

In all patients undergoing open or endovascular treatment for ruptured abdominal aortic aneurysm, monitoring of intra-abdominal pressure for early diagnosis and management of intra-abdominal hypertension/abdominal compartment syndrome is recommended

Class	Level	References
I	B	[466,461,64,450,430,405,65,458,462,464]

SVS 01/2018

Recommendation 72

In the presence of abdominal compartment syndrome after open or endovascular treatment of ruptured abdominal aortic aneurysm, decompressive laparotomy is recommended

Class	Level	References
I	B	[466,467,450,382,459,464]

Der **VAC-Abdominalverschluss** in Kombination mit einer **Netz-vermittelten Faszien-Traktion** sollte bei Patienten mit offenem Abdomen bevorzugt werden.

EG B/ EvG 4

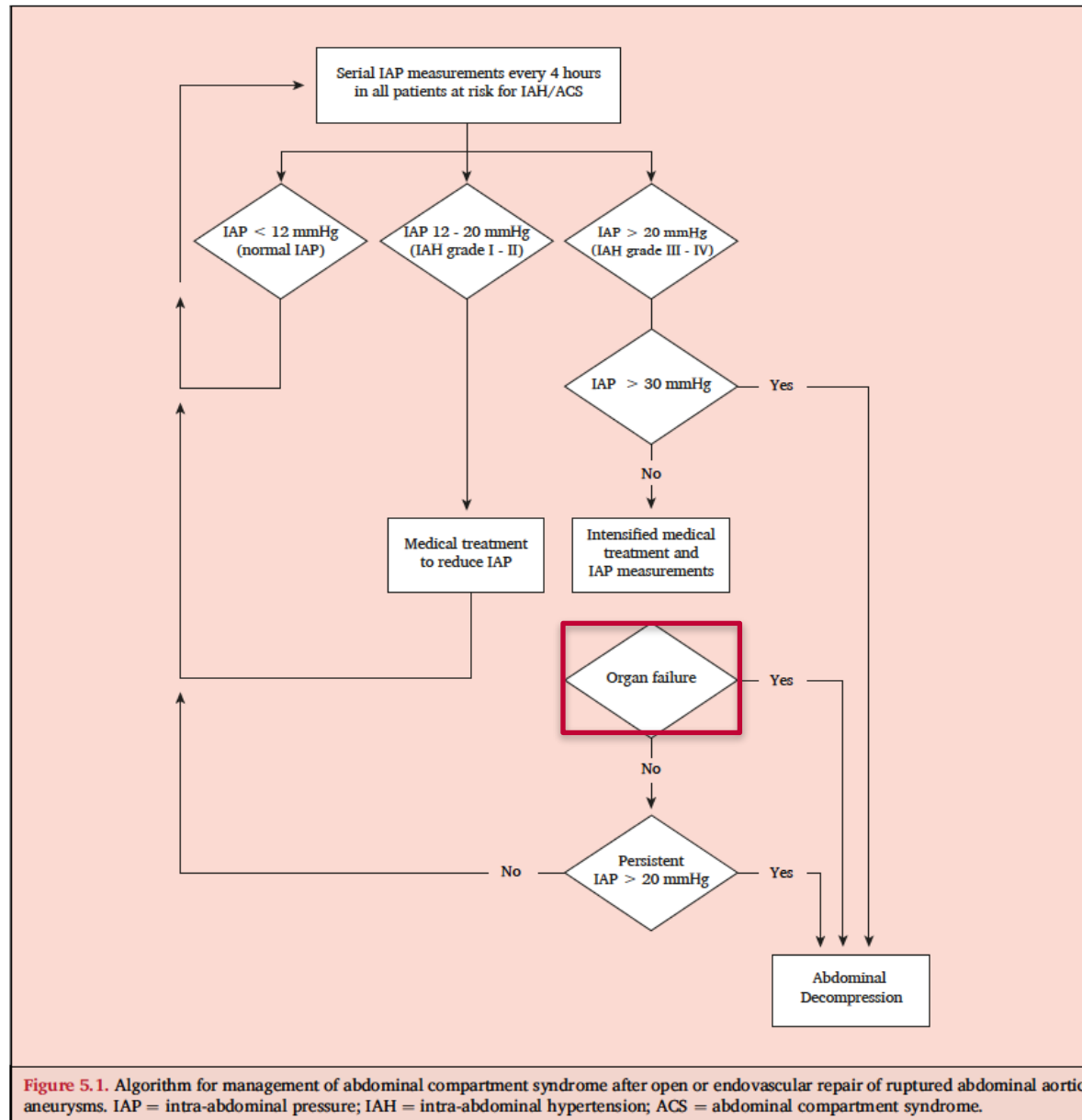
Recommendation 73

In the management of open abdomen following decompression for abdominal compartment syndrome after open or endovascular treatment of ruptured abdominal aortic aneurysm, vacuum assisted closure system should be considered

Class	Level	References
IIa	C	[466,459,464]

Abdominelles Kompartmentsyndrom

Prof. Dr. C. Bünner



Abdominelles Kompartmentsyndrom

Prof. Dr. C. Bünge

Table 5.3. Summary of medical treatment options for intra-abdominal hypertension/abdominal compartment syndrome.

Improve abdominal wall compliance	Pain relief (epidural anaesthesia) Avoid morphine Neuromuscular blockade (may reduce IAP by 50%)
Evacuate intra-luminal/abdominal content	Nasogastric decompression Paracentesis (seldom feasible)
Correct positive fluid balance	Avoid over resuscitation and crystalloids Whole blood and colloids (20% albumin) Diuretics (furosemide) Renal replacement therapy if indicated
Organ support	Optimize ventilation (PEEP) Vasopressors (APP > 60 mmHg)

IAH = intra-abdominal hypertension; ACS = abdominal compartment syndrome; IAP = intra-abdominal pressure; PEEP = positive end expiratory pressure; APP = abdominal perfusion pressure.

Spätkomplikation nach EVAR und OAR

Protheseninfektion

Prof. Dr. C. Böttner

S3-Leitlinie AWMF 07/2018

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SVS 01/2018

... soll in der Regel die **Entfernung** des infizierten Prothesenmaterials und **Revaskularisation** erfolgen.
EG A/ EvG 4

Recommendation 77

For radical treatment of aortic graft or stent graft infection complete graft/stent graft explantation is recommended

Class	Level	References
I	C	[514,521]

After aneurysm repair, we recommend prompt evaluation for possible graft infection if a patient presents with generalized sepsis, groin drainage, pseudoaneurysm formation, or ill-defined pain.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

In ausgewählten Fällen auch **konservatives Vorgehen**...
EG 0/ EvG 4

Recommendation 78

In selected high risk patients with graft/stent graft infection, conservative and/or palliative options should be considered

Class	Level	References
Ila	C	[514,521]

In patients presenting with an infected graft with minimal contamination, we suggest in situ reconstruction with cryopreserved allograft.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

... **Ausbau** und ... **in situ Rekonstruktion** mit autologer Vene oder kryopräservierten Homografts ... Methode 1. Wahl EG A/ EvG 3a

Recommendation 79

In situ reconstruction with prosthetic material is not recommended in heavily contaminated or infected areas

Class	Level	References
III	C	[521]

In patients presenting with an infected graft in the presence of extensive contamination with gross purulence, we recommend extra-anatomic reconstruction followed by excision of all graft material along with aortic stump closure covered by an omental flap.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

In unstable patients with infected graft, we recommend in situ reconstruction with a silver- or antibiotic-impregnated graft, cryopreserved allograft, or polytetrafluoroethylene (PTFE) graft.

Level of recommendation	1 (Strong)
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Aortoenterale Fistel

Prof. Dr. C. Büniger

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Recommendation 82

In any patient with an aortic prosthesis presenting with gastrointestinal bleeding, prompt assessment to identify a possible secondary aortoenteric fistula is recommended

Class	Level	References
I	C	[537,540]

We recommend prompt evaluation for possible aortoenteric fistula in a patient presenting with gastrointestinal bleeding after aneurysm repair.

Level of recommendation	1 (Strong)
Quality of evidence	A (High)

Recommendation 83

In patients with a suspected or confirmed secondary aortoenteric fistula, emergency referral to a high volume vascular surgical centre for treatment decision is recommended

Class	Level	References
I	C	[541,539]

Recommendation 84

In patients with secondary aorto-enteric fistula and bleeding, staged endovascular stent grafting as a bridge to open surgery may be considered

Class	Level	References
IIb	C	[541,539]

Bei **aortoenteralen Fisteln** soll speziell in der Blutungssituation ein zweizeitiges Vorgehen gewählt werden, mit primär endovaskulärer Versorgung und späterer Prothesenexzision mit in situ Revaskularisation.
EG A/ EvG 3b

Spätkomplikation nach OAR

Inzidenz nach 5 bzw. 10-15 Jahren

Prof. Dr. C. Bünker

Table 6.1. Long-term complications after open abdominal aortic aneurysm repair, and their incidence within 5 and 10–15 years.

Complication	Estimated frequency during 5 year follow up	Estimated frequency during 10 year follow up
Para-anastomotic aneurysm formation	1%	12% (15 years)
Limb occlusion	1%	5% (15 years)
Incisional hernia	5–12%	5–21%
Graft infection	0.5–5%	
Secondary aorto-enteric fistula	<1%	

References: [\[492-494,310,311\]](#).

Paraaanastomales Aneurysma

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Paraaanastomale Aneurysmen nach OR sollen, wenn **möglich, endovaskulär** angegangen werden.

EG A/ EvG 4

Wann Welche Größe???

Relaxatio bei retroperitonealem Zugang

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

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Der retroperitoneale Zugang führt ... häufig zu einer Schwächung der lateralen Bauchwand mit Ausbeulung ("bulge") der Flanke. Matsen et al. (2006) sahen bei **56%** ihrer Patienten nach retroperitonealer aortaler Rekonstruktion diese Komplikation in ganz unterschiedlichem Ausmaß, abhängig von dem BMI des Patienten und der Inzisionslänge. Die **Prävention** dieser Komplikation besteht in einer möglichst kurzen Inzision - bei Vermeidung der Muskeldurchtrennung (Igari et al. 2001). Eine Verlängerung der Inzision in den 11. Interkostalraum sollte vermieden werden, da eine Verletzung des Interkostalnerven als eine wesentliche Ursache der Paralyse der Flankenmuskulatur angesehen wird (Gardner et al. 1994).

Hernie

Prof. Dr. C. Bünner

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Narbenbrüche stellen mit Abstand die häufigste Komplikation nach OAR des AAA im Langzeitverlauf dar. Darmpassagestörungen aufgrund von Verwachsungen sind vergleichsweise selten. EvG 2a		

Früh- und Spätkomplikation nach EVAR

Komplikationen nach EVAR nach 5Jahren

Prof. Dr. C. Bünker

Table 6.2. Long-term graft related complications after endovascular aneurysm repair.

Complications	Definition	Estimated frequency during 5 year follow up
Type I endoleak	Peri-graft flow occurring from attachment sites	5%
A	proximal end of stent graft	
B	distal end of stent graft	
C	iliac occluder	
Type II endoleak	Perigraft flow occurring from collateral branches to the aneurysm; inferior mesenteric artery (IIA) and lumbar arteries (IIB)	20–40%, 10% persistent at 2 years
	Categorised as early or late/delayed (before or after 12 months) and as transient or persistent (resolved or not resolved ≤ 6 months)	
Type III endoleak	Peri-graft flow occurring from stent graft defect or junction sites	1–3%
A	leak from junctions or modular disconnection	
B	fabric holes	
Type IV endoleak	Peri-graft flow occurring from stent graft fabric porosity <30 days after placement	1%
Endotension	AAA sac enlargement without visualised endoleak	<1%
Migration	Movement of the stent graft in relation to proximal or distal landing zone	1%
Limb kinking and occlusion	Graft thrombosis or stenosis	4–8%
Infection	Stent graft infection	0.5–1%
Rupture	Aortic rupture	1–5%

AAA = abdominal aortic aneurysm.

References: [495,496,47,497,498,1,499,500].

Endoleak nach EVAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Frühes Endoleak: Innerhalb von 24 Stunden Intermediäres Endoleak: 1. bis 90. Tag Spät-Endoleak: Nach 90 Tagen.		

Endoleak nach EVAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

Endoleaks sollen primär **interventionell / endovaskulär** behandelt werden.

EG A/ EvG 4

Typ I-Endoleckagen, deren Ausschaltung interventionell nicht gelingt, können bei fehlendem Aneurysma-wachstum zunächst sorgfältig nachkontrolliert werden. Bei Größenzunahme soll eine Behandlung erfolgen. EG A/ EvG 4

Typ II- Endoleaks ohne Zunahme des AAA-Durchmesser sollen beobachtet werden. EG A/ EvG 3a

ESVS 2019

Recommendation 86

In patients with Type I endoleak after endovascular abdominal aortic aneurysm repair, re-intervention to achieve a seal, primarily by endovascular means, is recommended

Class	Level	References
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I	B	[554,553]
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SVS 01/2018

Late outcomes. We recommend treatment of type I endoleaks.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Recommendation 87

Expansion of sac diameter ≥ 1 cm detected during follow up after endovascular abdominal aortic aneurysm repair using the same imaging modality and measurement method may be considered as a reasonable threshold for significant growth

Class	Level	References
-------	-------	------------

IIb	C	[499]
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We recommend surveillance of type II endoleaks not associated with aneurysm expansion.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Endoleak nach EVAR

Prof. Dr. C. Bünner

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Typ II-Endoleaks mit AAA-Wachstum sollen behandelt werden. **EG A/ EvG 3a**

Recommendation 88

Re-intervention for Type II endoleak after endovascular abdominal aortic aneurysm repair should be considered in the presence of significant aneurysm growth (see Recommendation 87), primarily by endovascular means

Class	Level	References
IIa	C	[499]

We suggest treatment of type II endoleaks associated with aneurysm expansion.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Typ III-Endoleaks sollen behandelt werden. **EG A/ EvG 3a**

Recommendation 89

In patients with Type III endoleak after endovascular abdominal aortic aneurysm repair, re-intervention is recommended, primarily by endovascular means

Class	Level	References
I	C	[553]

We recommend treatment of type III endoleaks.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

Typ IV-Endoleaks ohne Wachstum sollen nicht behandelt werden. **EG A/ EvG 3a**

We suggest no treatment of type IV endoleaks.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Typ V-Endoleaks
Zunahme des DM > 10 mm in 12 Monaten oder > 5 mm in 6 Monaten sollte chirurgisch oder mit einem neuen Stentgraft versorgt werden **EG B/ EvG 3a**

Recommendation 90

Significant aneurysm sac growth after endovascular abdominal aortic aneurysm repair, without visible endoleak on standard imaging, should be considered for further diagnostic evaluation with alternative imaging modalities to exclude the presence of an unidentified endoleak, and should be considered for treatment

Class	Level	References
IIa	C	[568,553,571,569]

Konversion bei Endoleak

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		We recommend <u>open repair</u> if endovascular intervention fails to treat a type I or type III endoleak with ongoing aneurysm enlargement. Level of recommendation 1 (Strong) Quality of evidence B (Moderate)
		We suggest <u>open repair</u> if endovascular intervention fails to treat a type II endoleak with ongoing aneurysm enlargement. Level of recommendation 2 (Weak) Quality of evidence C (Low)
		We suggest <u>treatment</u> for ongoing aneurysm expansion, <u>even in the absence of a visible endoleak</u>. Level of recommendation 2 (Weak) Quality of evidence C (Low)

Stentgraftmigration

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Stentmigration von > 10 mm bei Zunahme des Aneurysma-DM und / oder Nachweis eines Endoleaks bedürfen der endovaskulären Therapie. EG 0/ EvG 4		

Schenkelverschluss

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018						
		We recommend that follow-up of patients after aneurysm repair include a <u>thorough lower extremity pulse examination or ankle-brachial index (ABI)</u>. Level of recommendation 1 (Strong) Quality of evidence B (Moderate)						
	Recommendation 76 In patients treated for abdominal aortic aneurysm with new onset or worsening of lower limb ischaemia, <u>immediate evaluation of graft related problems</u>, such as limb kinking or occlusion, <u>is recommended</u> <table><tr><th>Class</th><th>Level</th><th>References</th></tr><tr><td>I</td><td>C</td><td>[505-507]</td></tr></table>	Class	Level	References	I	C	[505-507]	We recommend a prompt evaluation for possible graft limb occlusion if patients develop new-onset lower extremity claudication, ischemia, or reduction in ABI after aneurysm repair. Level of recommendation 1 (Strong) Quality of evidence A (High)
Class	Level	References						
I	C	[505-507]						
...werden in ca. 4% der Fälle nach EVAR beschrieben. Sie sollen endovaskulär angegangen werden. Wenn dies nicht möglich ist, sind eine Thrombektomie oder der femoro-femorale Crossover-Bypass die therapeutischen Alternativen. EG A/ EvG 3a								

EVAR-Protheseninfektion

Prof. Dr. C. Bünner

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	Diagnosis is based on clinical symptoms and laboratory findings in combination with imaging. A wide spectrum of clinical presentations can be observed including generalised sepsis, groin purulence, pseudoaneurysm formation, and graft occlusion.⁵²⁰ Back pain (66%) and fever (66%) are the most frequent symptoms of graft infection on presentation.⁵²¹ <u>Early graft infections (<=3 months)</u> are more often associated with clear signs of infections, such as fever and sepsis, wound infections, and signs of peri-graft infection. <u>Late graft infections (>3 months)</u> are usually low grade infections predominantly with local symptoms, such as fistula and peri-aortic gas and pseudoaneurysm formation, often with <u>normal laboratory parameters</u>.	

EVAR-Protheseninfektion

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
	CT provides information about the anatomical location, extent of infection, and other associated abnormalities (peri-aortic mass, fistula, presence of psoas abscess, or peri-aortic gas). CT has a sensitivity of 94% and a specificity of 85 to 100% in advanced graft infection. 522,523 For low grade graft infection CT is, however, less accurate with a sensitivity and specificity of 64%.524	

EVAR-Protheseninfektion

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
	18Fluoro-deoxyglucose PET combined with CT scanning is a reliable non-invasive imaging modality for the diagnosis and follow up of prosthetic infection with a sensitivity of 77 to 93% and a specificity of 70 to 89%.^{525,526} A focal fluoro-deoxyglucose (FDG) uptake with a <u>SUV value > 8</u> in agreement with the clinical picture > 4 to 6 months post-operatively is a strong indicator of graft infection.⁵²⁴ Staphylococcal organisms are most frequently identified in late infections, but any type of bacteria or fungi may be the cause of infection.	

Endorganischämie nach FEVAR/Ch-EVAR/EVAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018

ESVS 2019

SVS 01/2018

Zu den seltenen Komplikationen nach Versorgung eines pararenalen AAA mit einem gebranchten Stentgraft gehört die **spinale Rückenmarksischämie** (Hiramoto et al. 2017). Eine spinale Rückenmarksischämie mit Paraplegie wurde auch nach endovaskulärer Versorgung rupturierter AAA und gleichzeitiger Unterbrechung der A. iliaca interna gesehen, was den Schluss zuließ, bei diesen Patienten den Zufluß in die A. iliaca interna möglichst zu erhalten (Peppelenbosch et al. 2005).

Usai et al. (2015) erstellten eine systematische Übersicht zu der Frage der Häufigkeit der **Chimneygraft-Okklusion** bei Versorgung pararenaler AAA. Die Verschlussrate war niedrig, mit 15 bei 334 renoviszeralen Gefäßversorgungen (4,5%). Der Verschluss der Nierenarterie hatte keine schweren Konsequenzen, während ein Verschluss der A. mesenterica superior zur Darmischämie führen kann. Das gleiche wurde bei Versorgung juxtarenaler AAA mit fenestrierten Stentgrafts beobachtet (Dijkstra et al. 2014).

Follow-Up nach OAR

Follow-Up nach OAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF
07/2018

ESVS 2019

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CT-Kontrolle in
5J-Abständen
EG 0/ EvG 4

Recommendation 85

In all patients after open repair for abdominal aortic aneurysm, imaging follow up of the aorta and peripheral arteries may be considered every five years

Class	Level	References
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IIb	C	[549,548]
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We suggest noncontrast-enhanced CT imaging of the entire aorta at 5-year intervals after open repair or EVAR.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Follow-Up nach EVAR

Ultraschall und CT

Prof. Dr. C. Bünner

**S3-Leitlinie AWMF
07/2018**

ESVS 2019

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CTA, Röntgen-Abdomen leer
30 Tage nach dem Eingriff

Recommendation 91

Early (within 30 days) post-operative follow up after endovascular aortic repair including imaging of the stent graft to assess presence of endoleak, component overlap and sealing zone length is recommended

Class	Level	References
I	B	[607,608,613,47]

Recommendation for postoperative surveillance. We recommend baseline imaging in the first month after EVAR with contrast-enhanced CT and color duplex ultrasound imaging. In the absence of an endoleak or sac enlargement, imaging should be repeated in 12 months using contrast-enhanced CT or color duplex ultrasound imaging.

Level of recommendation	1 (Strong)
Quality of evidence	B (Moderate)

If a type II endoleak is observed 1 month after EVAR, we suggest postoperative surveillance with contrast-enhanced CT and color duplex ultrasound imaging at 6 months.

Level of recommendation	2 (Weak)
Quality of evidence	B (Moderate)

Der **US** nach EVAR sollte standardisiert durchgeführt werden. Die regelmäßige postprozedurale Nachsorge sollte durch das implantierende Gefäßzentrum organisiert werden.
EG B/ EvG 3

Recommendation 92

Patients considered at low risk of endovascular aortic repair failure after their first post-operative CTA, may be considered for stratification to less frequent imaging follow ups

Class	Level	References
IIB	C	[606-608,611,31]

If neither endoleak nor AAA enlargement is observed 1 year after EVAR, we suggest color duplex ultrasound when feasible, or CT imaging if ultrasound is not possible, for annual surveillance.

Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Ultraschall und CT

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
		If a <u>type II endoleak</u> is associated with an aneurysm sac that is shrinking or stable in size, we suggest color duplex ultrasound for continued surveillance <u>at 6-month</u> intervals for 24 months and then annually thereafter. Level of recommendation2 (Weak) Quality of evidenceC (Low)
		If a <u>new endoleak</u> is detected, we suggest evaluation for a type I or type III endoleak. Level of recommendation2 (Weak) Quality of evidenceC (Low)

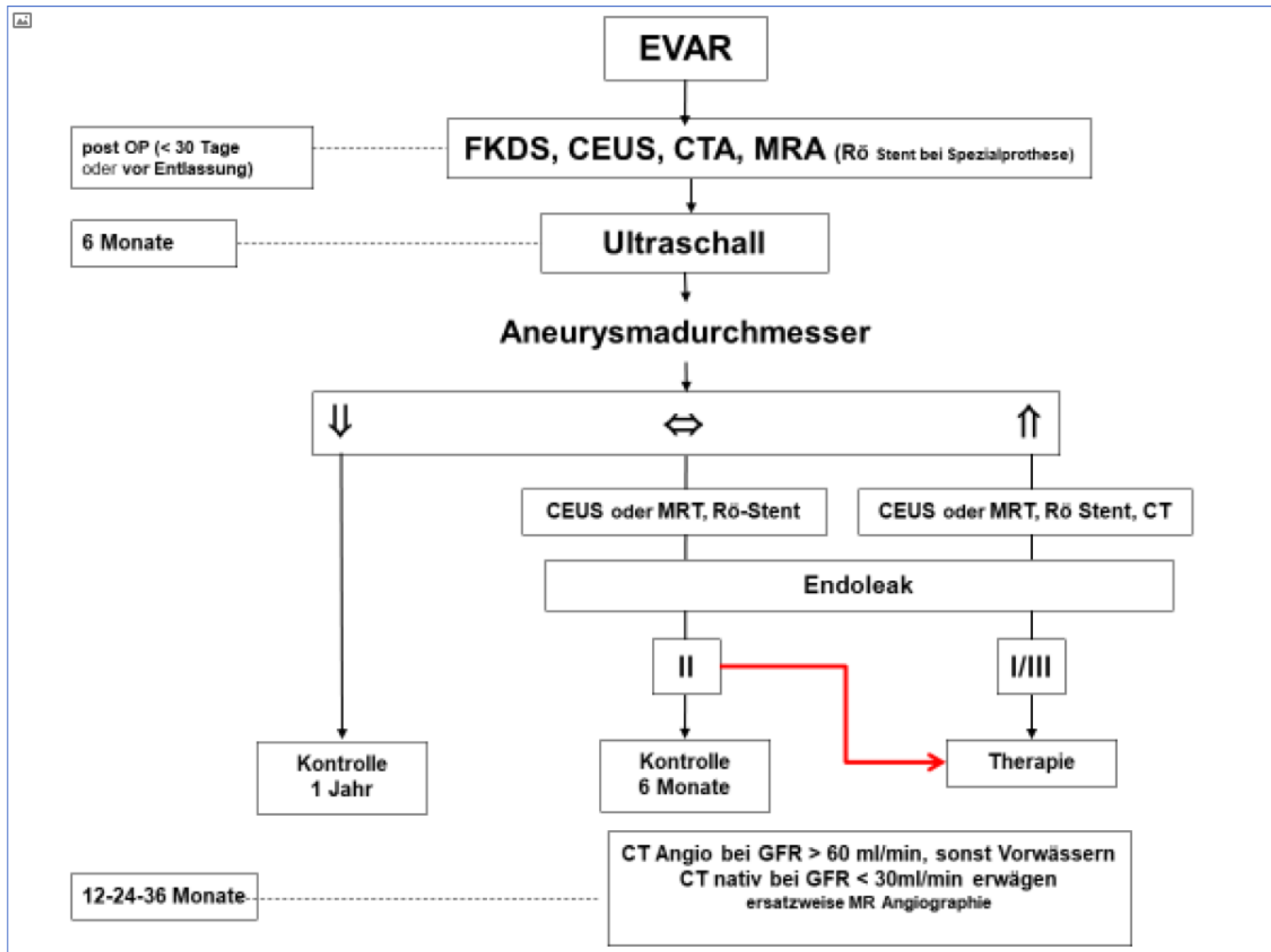
Follow-Up nach EVAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
• Kein Endoleak und gute iliakale und Komponentenüberlappung → CTA nach 12 Monaten. Dann jährliche Duplexsonographie und Abdomenleeraufnahme. • Endoleak oder schlechte Überlappung → CTA nach 6 Monaten und 12 Monaten mit adäquater Behandlung, falls notwendig. Danach jährlich CTA und Röntgen Abdomen. • Jede Zunahme im DM oder ein neues Endoleak erfordert sofortige bildgebende Kontrolle mit CTA • Patienten mit renaler Insuffizienz: zu jedem Zeitpunkt nach EVAR Kontrolle mit Duplexsonographie, CT ohne KM und Abdomenleeraufnahme		

Follow-Up nach EVAR

Prof. Dr. C. Büniger



Follow-Up nach EVAR

Prof. Dr. C. Bünner

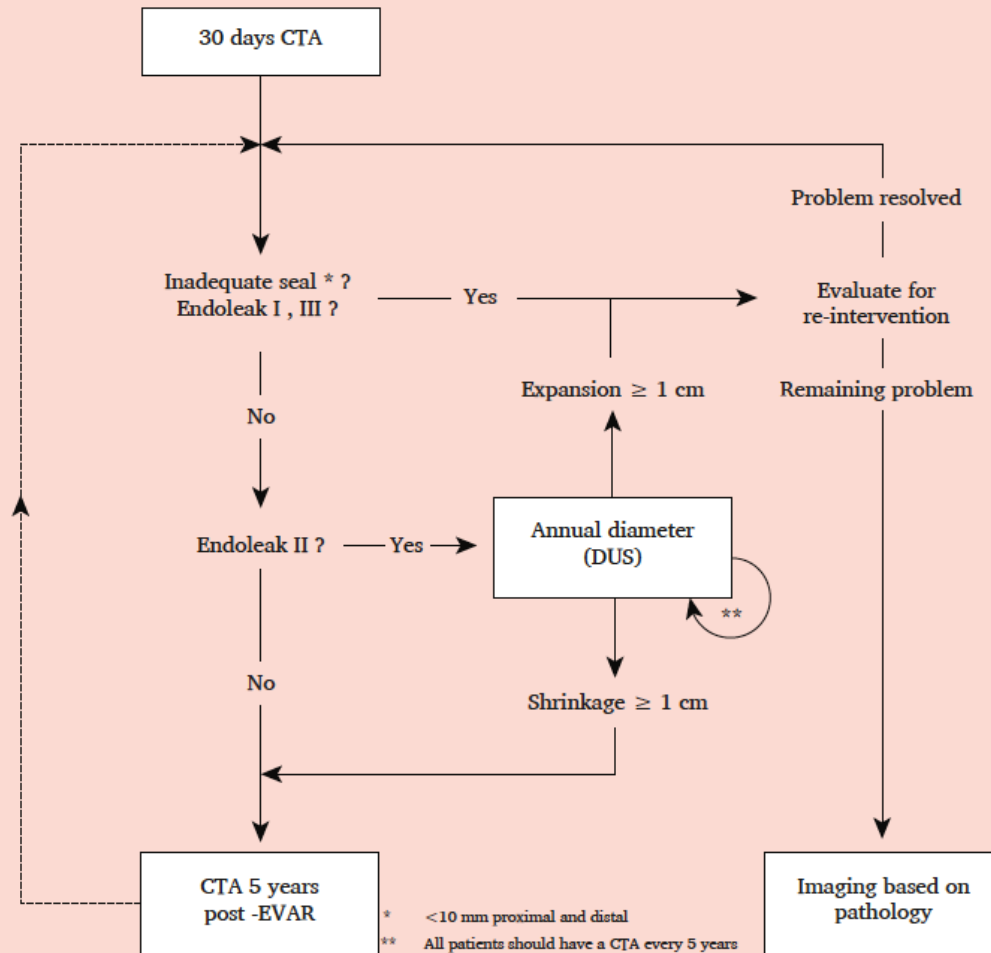


Figure 6.1. This figure offers an example of follow up algorithm post-endovascular aneurysm repair with patient stratification based on initial imaging. All patients should be offered lifelong follow up, including a CT scan at least every 5 years. If necessary more frequent imaging may be performed with CT or duplex ultrasound, and will depend on the aim of the imaging (evaluation of seal length and stent graft integrity requires CT, evaluation of endoleak and sac size can be performed with duplex ultrasound). DUS = duplex ultrasound; 30 d = within 30 days postoperatively; CTA = computed tomography angiography.

Bildgebung nach EVAR

Prof. Dr. C. Bünner

Table 6.3. Imaging techniques applicable to detection of endovascular aneurysm repair complications and used during follow-up. (Modified from Dellagrammaticas et al.⁵⁸⁸).

	Imaging modality						
	AXR	DUS	CE-DUS	CT	CTA	MRA	PET-CT
Detection of possible EVAR complication							
Aneurysm sac enlargement	No	Yes	Yes	Yes	Yes	Yes	Yes
Endoleak	No	Yes	Yes	No	Yes	Yes	No
Sealing zone and component overlap	Yes	Limited	Limited	Yes	Yes	No	Yes
Migration	Yes	Limited	Limited	Yes	Yes	No	Yes
Limb kinking or occlusion	No	Yes	Yes	Kinking	Yes	Yes	Kinking
Stentgraft infection	No	Limited	Limited	Limited	Yes	Yes	Yes
Risks	Ionizing radiation	None known	None known	Ionizing radiation	Ionizing radiation. Contrast nephropathy.	Risk for nephrogenic systemic fibrosis if eGFR<30	Ionizing radiation
Technical aspects	Reproducibility difficult due to changes in patient position	Operator and patient dependent	As DUS	None	Timing of contrast administration important	Unsuitable for ferromagnetic stents & pacemaker bearers. Artefacts.	Non-specific markers for inflammation/cell proliferation, risk of false positive findings.
Suitable as sole modality for EVAR follow-up	No – combined with DUS/CE- DUS	No – combined with CT or AXR ± CE-DUS	No – combined with CT or AXR	No – combined with DUS/CE- DUS	Yes	No – as complement to CT/AXR + DUS/CE-DUS	No - only in case of suspected infection

EVAR = endovascular aneurysm repair; AXR = abdominal Xray; DUS = duplex ultrasound; CE-DUS = contrast enhanced duplex ultrasound; CT = computed tomography; CTA = CT angiography; MRA = magnetic resonance angiography; eGFR = estimated glomerular filtration rate.

Lebensqualität nach EVAR und OAR

Lebensqualität nach EVAR und OAR

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Bis 1 Jahr nach dem Eingriff wird für EVAR im Vergleich zu OR ein Vorteil in der Lebensqualität gesehen. EvG 3a		

Sexuelle Dysfunktion nach EVAR und OAR

Sexuelle Dysfunktion

Prof. Dr. C. Bünner

S3-Leitlinie AWMF 07/2018	ESVS 2019	SVS 01/2018
Der Patient soll präprozedural sowohl bei OR als auch bei EVAR über eine mögliche Verschlechterung der Sexualfunktion nach dem Eingriff aufgeklärt werden. EG A/ EvG 2b		

Juxta-, Para- und suprarenales AAA

Juxtarenal AAA

Prof. Dr. C. Büngrer

ESVS 2019

Recommendation 93

In patients with juxtarenal abdominal aortic aneurysm and acceptable surgical risk, the minimum threshold for elective repair may be considered to be 5.5 cm diameter

Class	Level	References
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IIb	C	[189]
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Recommendation 94

Centralisation to specialised high volume centres that can offer both complex open and complex endovascular repair for treatment of juxtarenal abdominal aortic aneurysm is recommended

Class	Level	References
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I	C	[45,34]
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Recommendation 95

In patients with juxtarenal abdominal aortic aneurysm, open repair or complex endovascular repair should be considered based on patient status, anatomy, local routines, team experience, and patient preference

Class	Level	References
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IIa	C	[650,651]
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Juxtarenals AAA

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ESVS 2019

Recommendation 96

In complex endovascular repair of juxtarenal abdominal aortic aneurysm, endovascular repair with fenestrated stent grafts should be considered the preferred treatment option when feasible

Class	Level	References
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IIa	C	[619]
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Recommendation 97

In complex endovascular repair for juxtarenal abdominal aortic aneurysm, using parallel graft techniques may be considered as an alternative in the emergency setting or when fenestrated stent grafts are not indicated or available, or as a bailout, ideally restricted to ≤ 2 chimneys

Class	Level	References
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IIb	C	[451]
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Recommendation 98

In patients with juxtarenal abdominal aortic aneurysm, new techniques/concepts, including endovascular aneurysm seal, endostaples, and in situ laser fenestration, are not recommended as first line treatment, but should be limited to studies approved by research ethics committees, until adequately evaluated

Class	Level	References
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III	C	[647,649,335,330,336]
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Juxtarenales AAA

Prof. Dr. C. Büngrer

ESVS 2019

Recommendation 99

In patients with ruptured juxta/pararenal abdominal aortic aneurysm open repair or complex endovascular repair (with a physician modified fenestrated stent graft, off the shelf branched stent graft, or parallel graft) may be considered based on patient status, anatomy, local routines, team experience, and patient preference

Class	Level	References
IIb	C	[655,657,490]

Recommendation 100

In patients undergoing open repair of juxtarenal abdominal aortic aneurysm a strategy to preserve renal function by means of cold crystalloid renal perfusion may be considered

Class	Level	References
IIb	C	[629,626]

Recommendation 101

In patients treated for juxtarenal abdominal aortic aneurysm by endovascular repair, a thorough long-term follow up programme including annual computed tomography angiography is recommended

Class	Level	References
I	C	[451]



Vielen Dank für Ihre Aufmerksamkeit!

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