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MARRIOTT RIVE GAUCHE & CONFERENCE CENTER, PARIS, FRANCE
CONTROVERSES ET ACTUALITÉS EN CHIRURGIE VASCULAIRE
CONTROVERSIES & UPDATES IN VASCULAR SURGERY

Can stent graft design influence cardiac outcome?

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Faculty Disclosure

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I have no financial relationships to disclose

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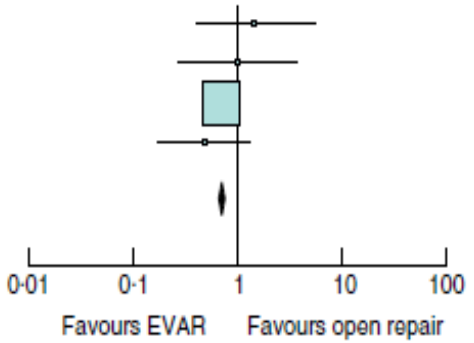
Short-term vs. long-term MI following EVAR and Open AAA Repair

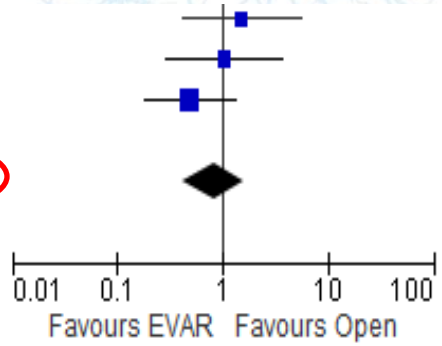
Reference	Event rate: EVAR	Event rate: Open repair	Weight (%)	Odds ratio
a Myocardial infarction				
ACE[33]	6 of 150	4 of 149	0·3	1·51 (0·42, 5·47)
DREAM[35]	5 of 173	5 of 178	0·3	1·03 (0·29, 3·62)
Medicare[9]	1598 of 22 830	2146 of 22 830	99·0	0·73 (0·68, 0·78)
OVER[38]	6 of 444	12 of 437	0·5	0·49 (0·18, 1·30)
Total	1615 of 23 597	2167 of 23 594	100·0	0·73 (0·68, 0·78)

Heterogeneity: $\tau^2 = 0{\cdot}00$; $\chi^2 = 2{\cdot}18$, 3 d.f., $P = 0{\cdot}54$; $I^2 = 0\%$
Test for overall effect: $Z = 9{\cdot}33$, $P < 0{\cdot}001$



b ACE	6	150	4	149	27.0%	1.51 [0.42, 5.47]
DREAM	5	173	5	178	28.2%	1.03 [0.29, 3.62]
OVER	6	444	12	437	44.8%	0.49 [0.18, 1.30]
Total (95% CI)		**767**		**764**	**100.0%**	**0.82 [0.41, 1.61]**
Total events	17		21			

Heterogeneity: Tau² = 0.01; Chi² = 2.07, df = 2 (P = 0.35); I² = 4%
Test for overall effect: Z = 0.59 (P = 0.56)



Stather et.al *British Journal of Surgery 2013;* 100: 863–872

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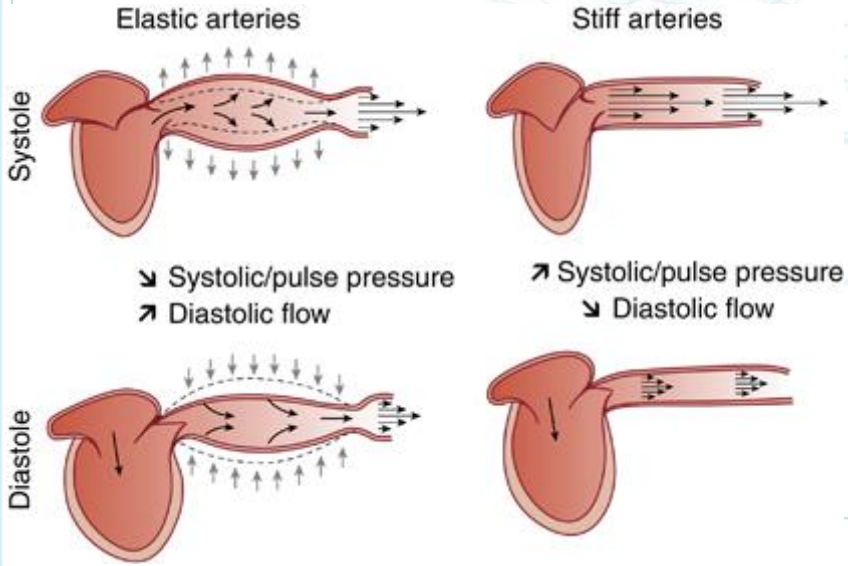
Arterial Stiffness and cardiac outcomes

- Arterial stiffness has been correlated with long-term cardiovascular outcomes independent of traditional cardiovascular risk factors (e.g. hypertension, diabetes, obesity, dyslipidemia, smoking)

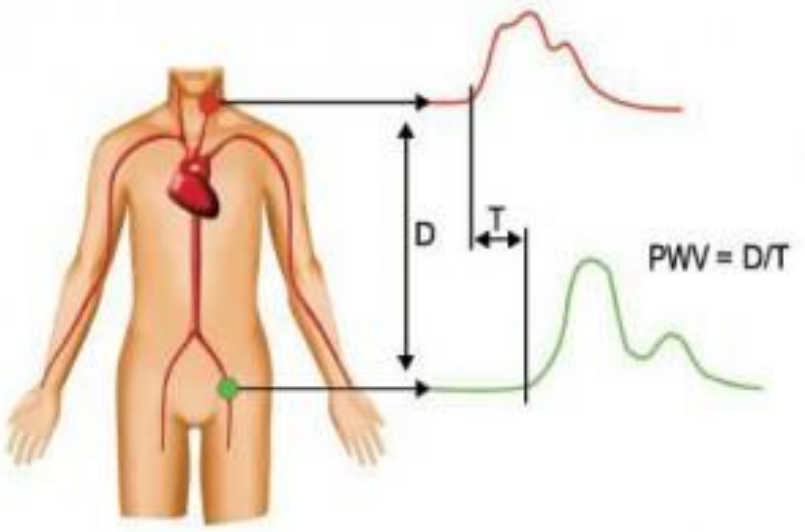


- Arterial stiffening results in increased pulse pressure, left ventricular hypertrophy, subendocardial ischemia, endothelial dysfunction and cardiac fibrosis

Liao J et al Curr Ather Reports 2014

Pulse wave velocity (PWV) and cardiac outcomes

- **Pulse wave velocity (PWV)**: the gold standard method of arterial stiffness measurement and a strong independent predictor of cardiovascular morbidity and mortality.



- Therapeutic modalities reducing PWV are associated with less cardiovascular events rate and improved prognosis

Cavalcante JL et al JACC 2011; Ben-Shlomo Y et al JACC 2013

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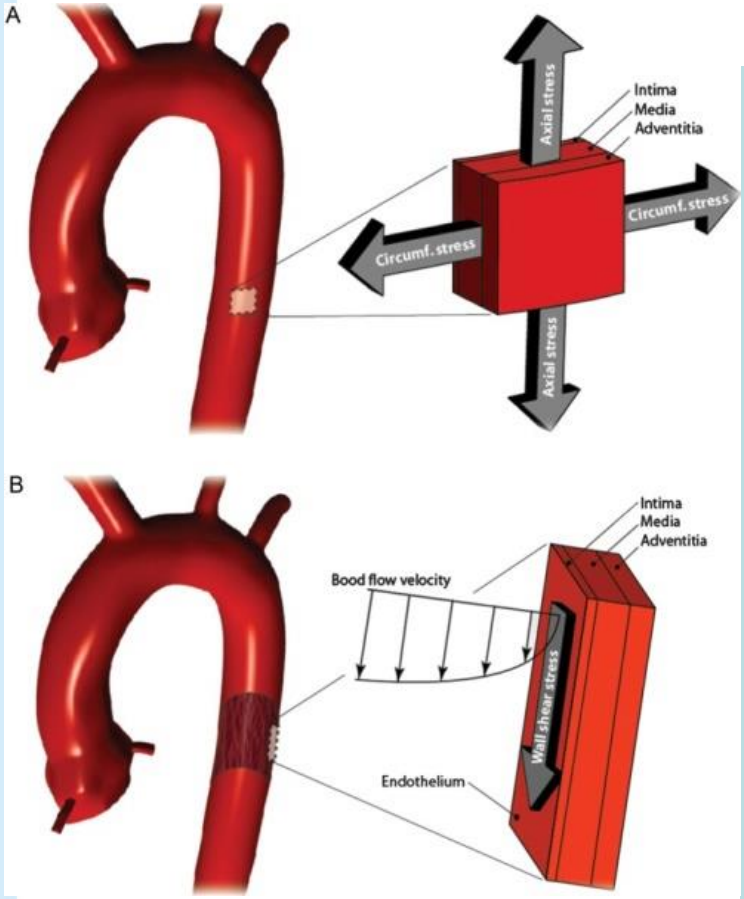
Arterial stiffness in patients with abdominal (AAA) or thoracic aortic aneurysms (TAA)



- Men with AAA presented with significantly elevated PWV levels compared to age-matched controls
- Mean blood pressure, AAA diameter and age: independent determinants of PWV in AAA
- TAA is associated with increased augmentation index

Shingu Y, et al Ann Thorac Surg 2009;
Kadoglou NPE, Liapis C et al J Endovasc Surg 2012

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Arterial stiffness, circulating vascular calcification inhibitors and inflammatory mediators in pts with AAA

	AAA group (N = 108)	CO group (N = 42)	p
hsCRP (mg/L)	5.90 ± 2.05	2.96 ± 1.02	<0.001
WBC (cells/μL)	9870 ± 2231	8850 ± 2001	0.039
TC (mg/dl)	218 ± 31	184 ± 48	0.118
HDL (mg/dl)	42 ± 11	45 ± 13	0.501
LDL (mg/dl)	137 ± 19	113 ± 22	0.098
TG	148 ± 56	130 ± 39	0.319
PWV (m/s)	12.99 ± 3.75	10.03 ± 1.57	<0.001
Osteoprotegerin (pmol/L)	16.11 ± 3.01	12.13 ± 1.98	<0.001
Osteopontin (ng/ml)	54.4 ± 16.05	42.33 ± 13.72	0.047
IL-6 (pg/ml)	5.51 ± 2.42	4.22 ± 1.63	0.038

	B	p
MBP	0.501	<0.001
OPG	0.405	0.022
OPN	0.204	0.272
IL-6	0.251	0.189
AAA diameter	0.348	0.006

- **PWV and hsCRP, WBC, IL-6, Osteoprotegerin** were significantly upregulated in pts with AAA.
- Independent association of PWV with **mean blood pressure**, **OPG** and **AAA diameter**

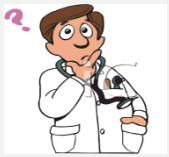
Kadoglou NP, Liapis CD et al. Arterial stiffness and novel biomarkers in patients with abdominal aortic aneurysms. Regul Pept. 2012

Arterial Stiffness after EVAR and TEVAR

Impaired aortic biomechanics may directly increase the rigidity of the arterial wall measured by Pulse Wave Velocity

Limited data implicate the adverse impact of endograft implantation on arterial stiffness which is more pronounced in the descending aorta

Does the choice of graft affect arterial stiffness?



Is there any clinical significance?

De Wit A, et al Heart Lunf Circul 2013;
Tzialis VD JL et al Ann Vasc Surg 2012

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Changes in arterial stiffness in patients undergoing EVAR and TEVAR

Computational Fluid Dynamics
Ongoing Trial

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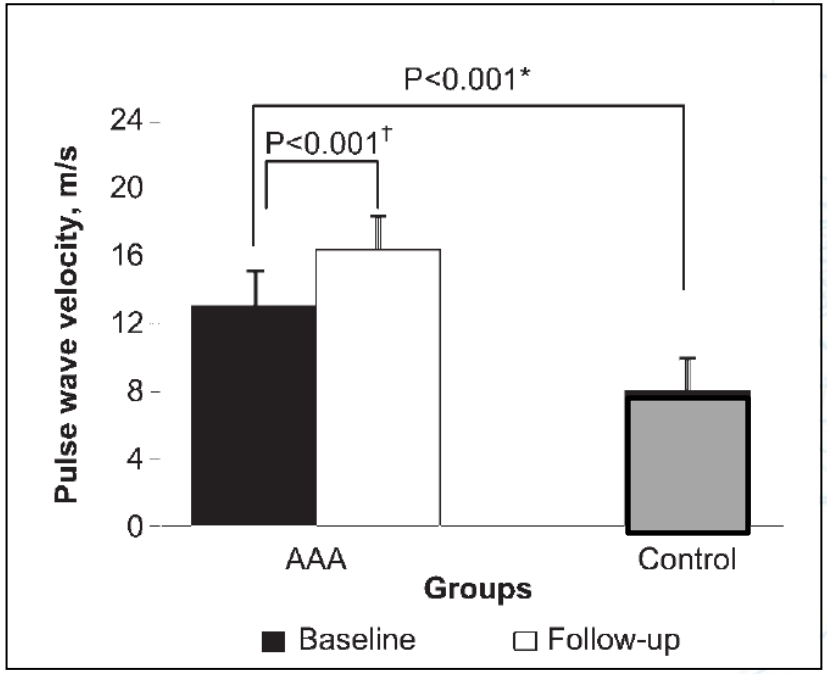
Changes in arterial stiffness in patients undergoing AAA repair



- Stent-graft implantation (n=48) was associated with significant increase in PWV 6 months following EVAR

- Open surgical repair (n=39) of AAA induced modest increase of PWV (median follow-up: 47d)

Kadoglou NPE, Liapis C et al J Endovasc Surg 2012;
Lantelme P et al J Hypertens 2009

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EVAR alters cardiac structure and function

Table 3. Baseline (Pre-Op) Characteristics of Patients and 1-Year (Follow-up) Outcomes After Endovascular Aortic Repair

Characteristic	Pre-op (n=22)	Follow-up (n=22)	P value
Specific activity scale score	6.0±1.6	5.3±1.9	<0.05
Systolic blood pressure (mmHg)	131±15	131±16	0.953
Diastolic blood pressure (mmHg)	75±8	74±10	0.476
Heart rate (beats/min)	64±9	62±10	0.283
baPWV (cm/s)	1,834±329	1,942±387	<0.05
Inferior vena cava dimension (mm)	12±3	12±2	0.606
LV volume index at end-diastole (ml/m$^{2.7}$)	29.2±4.8	27.2±4.4	<0.05
Left atrial volume index (ml/m$^{2.7}$)	14.0±5.3	16.2±4.7	<0.05
LVEF (%)	68±5	68±5	0.866
IVST at end-diastole (mm)	9.5±2.6	9.8±2.8	0.088
LV PWT at end-diastole (mm)	8.6±1.0	9.0±1.0	0.201
LV PWT at end-systole (mm)	15.0±1.7	14.8±2.4	0.646
DWS	0.42±0.09	0.38±0.10	0.066
LV mass index (g/m$^{2.7}$)	43±11	45±11	<0.05
Relative wall thickness	0.35±0.05	0.37±0.04	<0.05
E/A ratio	0.82±0.21	0.75±0.19	<0.05
Deceleration time of E wave (ms)	249±32	246±47	0.733
E' (cm/s)	7.8±1.5	7.3±1.8	0.060
E/E' ratio	8.5±1.7	8.6±2.1	0.052

EVAR in 22 pts increased baPWV and induced left ventricular hypertrophy, left atrium enlargement and impaired diastolic function

Takeda Y et al Circ J 2014

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Differential effects of endograft types on arterial stiffness in patients undergoing EVAR

N=118 pts

Values of PWV and novel biomarkers at **baseline** and **after 12 months**

	PTFE group (N=46)		Polyester Woven group (N=72)		P
	Baseline	12 m	Baseline	12 m	
• PWV (m/s)	12.05±2.55	14.87±2.43*	12.63±2.75	16.75±2.88*	0.033
• OPG (pmol/L)	15.18±3.78	10.51±4.46*	15.72±5.02	12.45±4.94	0.048
• IL-8 (pg/ml)	11.27±5.09	17.97±8.1*	10.27±5.02	25.68±11.11*	<0.001
• IL-6 (pg/ml)	3.81±1.51	3.69±1.37	3.89±4.56	3.58±1.50	0.883
• IL-10 (pg/ml)	5.35±1.57	8.39±2.22*	4.36±2.08	7.64±1.52	0.518

PWV, OPG and IL-8 increase was more pronounced in Polyester Woven group compared to PTFE group (p=0.033, p=0.048, p<0.001 respectively)

Under review J Hypertens

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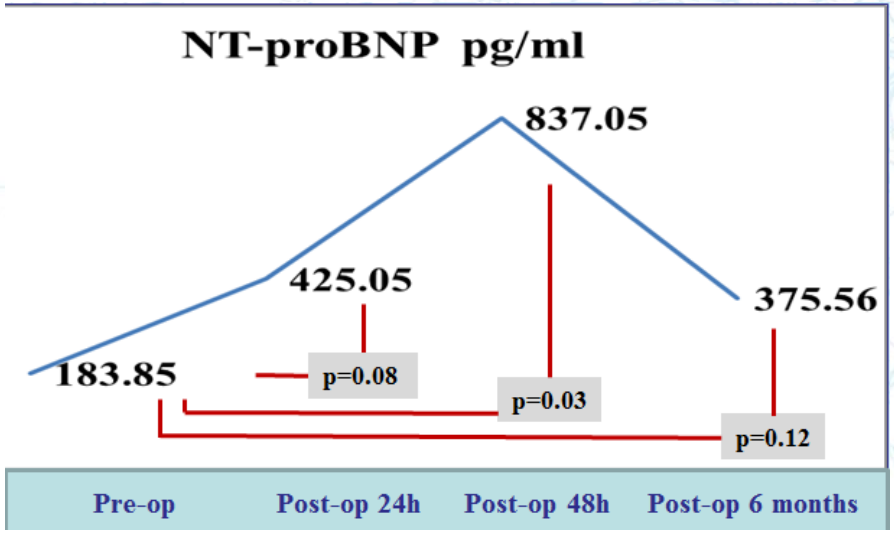
Arterial stiffness and myocardial strain in TEVAR

PWV and NT-proBNP changes

30 consecutive pts - Preliminary results

	Before Surgery	6 months post TEVAR	P
PWV (m/s)	11.7 (m/s)	15 (m/s)	<0.001



Kadoglou N, et al Under review

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Conclusions (I)

EVAR is associated with lower perioperative mortality and morbidity rates compared to open surgical repair

This advantage is blunted at long term, mainly due to an increase in cardiovascular complications

Arterial stiffening together with adverse cardiac function after **stent graft implantation** may explain this change in the long-term outcome

Conclusions (II)

There is evidence of :

- increased **arterial stiffness and biomarkers elevation 1-year** after EVAR **related to endograft type** (**polyester more than PTFE).**
- **increased arterial stiffness and myocardial strain** after TEVAR was observed. The effect of endograft type in the thoracic aorta requires further investigation.

Conclusions (III)

- Implantation of an endograft although considered to be a minimally invasive procedure may have serious long-term effects on the cardiovascular system and should be included in the risk factors
- Patients with an endograft should have vigorous monitoring and control of blood pressure, lipids etc and life-long follow-up
- Arterial stiffness should be taken into consideration by the industry when designing new endografts

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