



Ultrasound Surveillance following Vascular Surgery

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Vascular Imaging Study Day
Royal Blackburn Hospital
10th March 2017

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Disclosure

- Supporter of the Greatest Football Team in the World



Disclosure

- Supporter of the Greatest Football Team in the World
..... Albeit from the 1980s



Learning Outcomes

- Why perform ultrasound surveillance after a vascular intervention ?
- How is ultrasound surveillance completed ?
- What are the magic numbers – indices ...?
- What do I do in my vascular practice ?
- What is the current evidence for ultrasound surveillance ?



Stroke



Has their face fallen on
one side?
Can they smile?



Can they raise both
arms and keep
them there?



Is their
speech slurred?



Time to call **999**
if you see any single one
of these signs.



Stroke

East Lancashire Hospitals **NHS**
NHS Trust

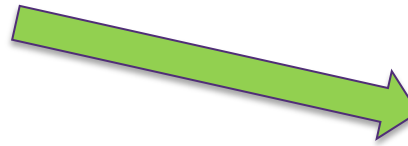
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Stroke



Ischaemia 80%



Haemorrhagic 20%

East Lancashire Hospitals **NHS**
NHS Trust



Stroke

East Lancashire Hospitals **NHS**
NHS Trust

Ischaemia 80%

Haemorrhagic 20%

Carotid 80%

Vertebrobasilar 20%



Stroke

East Lancashire Hospitals **NHS**
NHS Trust

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**Thromboembolism of
ICA / middle cerebral
artery 50%**

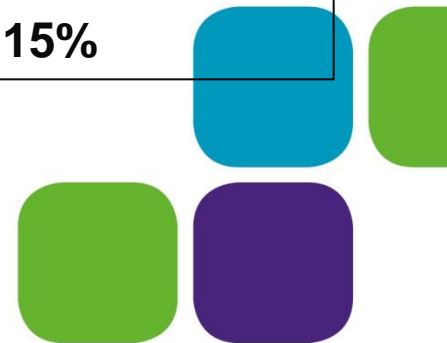
**Small vessel occlusion
of end-arteries
25%**

**Cardiogenic
embolism
15%**

**Haematological
disorders
5%**

**Miscellaneous –
tumours, arteritis
5%**

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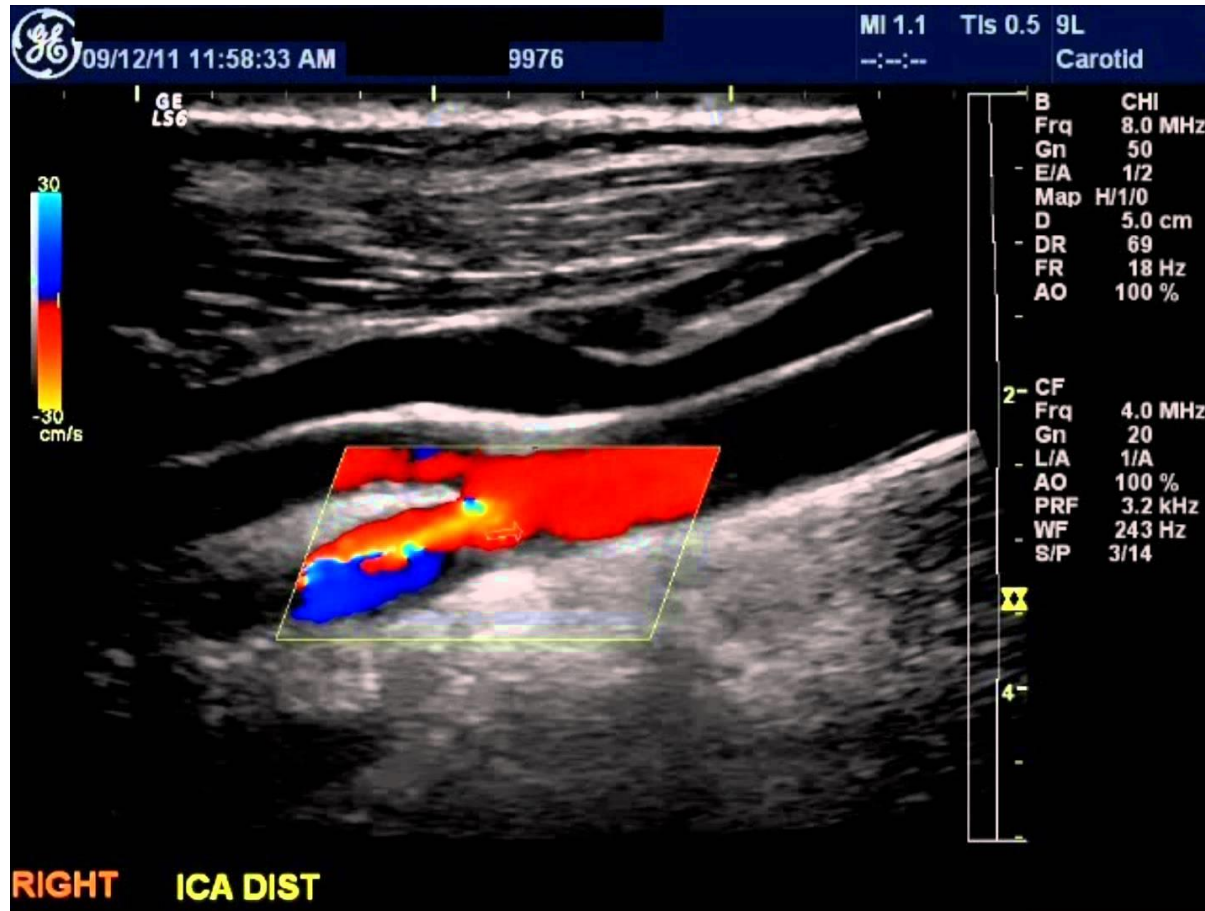
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Carotid Duplex



CT Angiogram



Why perform carotid endarterectomy ?

- Early treatment saves brain
- Best Medical Therapy;
 - Risk factor optimisation.
 - Antiplatelets - Aspirin 300mg for 14 days followed by Clopidogrel 75mg for life.
 - Lipid lowering therapy - statins.
- Evaluation by stroke physician – thrombolysis or prompt referral to vascular surgeon for consideration of carotid endarterectomy within 14 days.



Table 10.6 • Carotid Endarterectomy Trialists Collaboration: 5-year risk of any stroke (including 30-day stroke/death) from the combined VA, ECST and NASCET trials

Trial	Stenosis	n	30-day CEA risk	5-year risk		ARR	RRR	NNT	Strokes prevented per 1000 CEAs
				Surgery	Medical				
CETC	<30%	1746	No data	18.36%	15.71%	– 2.6%	N/b	N/b	None at 5 years
CETC	30–49%	1429	6.7%	22.80%	25.45%	+ 2.6%	10%	38	26 at 5 years
CETC	50–69%	1549	8.4%	20.00%	27.77%	+ 7.8%	28%	13	78 at 5 years
CETC	70–99%	1095	6.2%	17.13%	32.71%	+ 15.6%	48%	6	156 at 5 years
CETC	String	262	5.4%	22.40%	22.30%	– 0.1%	N/b	N/b	None at 5 years

ARR, absolute risk reduction; N/b, no benefit conferred by CEA; NNT, number needed to treat; RRR, relative risk reduction; strokes prevented per 1000 CEAs, number of strokes prevented at 5 years by performing 1000 CEAs.

Data derived from the CETC^{36–38} with all pre-randomisation angiograms remeasured using NASCET method.



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Data derived from the CETC³⁶⁻³⁸ with all pre-randomisation angiograms remeasured using NASCET method.



Post-operative Follow-Up

- Varies according to individual consultant practice.
- Out-Patient Clinical Review:
 - Overall patient wellbeing – cerebrovascular symptomatology.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Cranial nerve injury.
- Vascular Laboratory Assessment:
 - Carotid Duplex.



Carotid Duplex - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.



Eur J Vasc Endovasc Surg (2009) 37, 251–261



ELSEVIER



REVIEW

Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom

C.P. Oates ^{a,*}, A.R. Naylor ^b, T. Hartshorne ^b, S.M. Charles ^c, T. Fail ^d,
K. Humphries ^e, M. Aslam ^f, P. Khodabakhsh ^g

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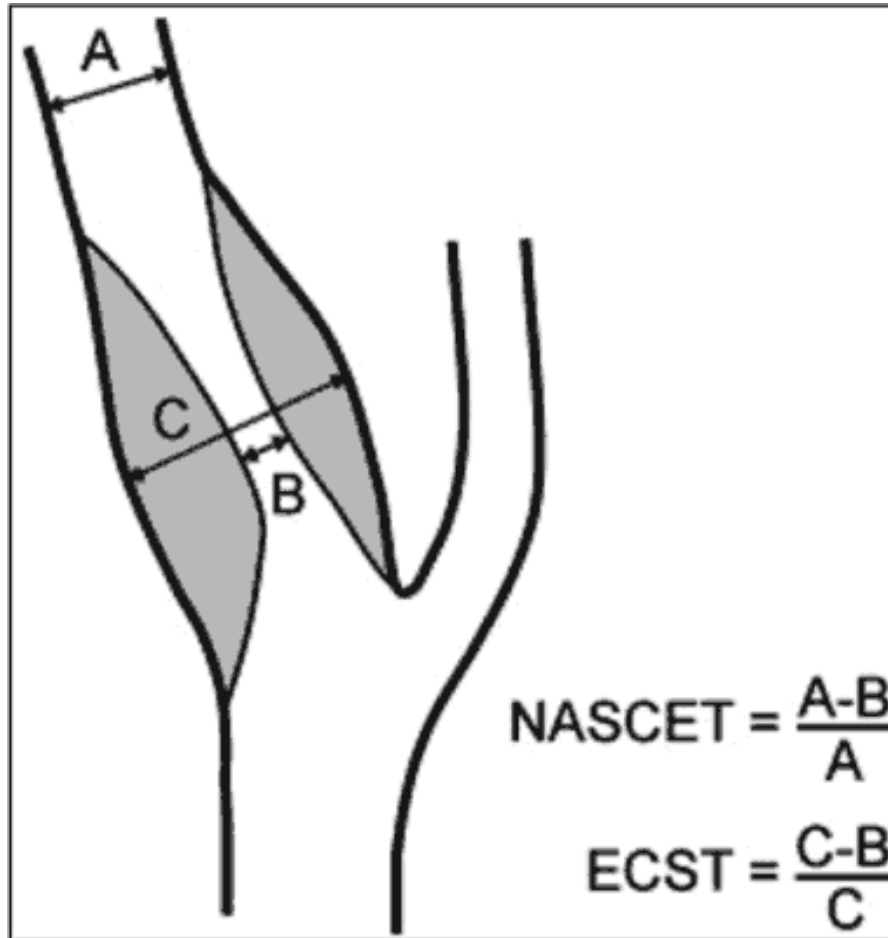


Carotid Duplex - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.
- Can determine degree of stenosis:
 - **NASCET.**



NASCET



Carotid Flow - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.
- Can determine degree of stenosis:
 - NASCET.
 - **Velocities.**



Carotid Duplex Velocities

Degree of Stenosis (%)	Primary Parameters		Additional Parameters	
	ICA PSV (cm/sec)	Plaque Estimate (%)*	ICA/CCA PSV Ratio	ICA EDV (cm/sec)
Normal	<125	None	<2.0	<40
<50	<125	<50	<2.0	<40
50–69	125–230	≥50	2.0–4.0	40–100
≥70 but less than near occlusion	>230	≥50	>4.0	>100
Near occlusion	High, low, or undetectable	Visible	Variable	Variable
Total occlusion	Undetectable	Visible, no detectable lumen	Not applicable	Not applicable



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Carotid Duplex - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.
- Can determine degree of stenosis:
 - NASCET.
 - Velocities.
- Provides information about surface or plaque morphology;
 - Smooth.
 - Irregular.



Carotid Duplex - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.
- Can determine degree of stenosis:
 - NASCET.
 - Velocities.
- Provides information about surface or plaque morphology;
 - Smooth.
 - Irregular.
- Can document progression / recurrence of disease.



Carotid Duplex - Limitations

- Patient characteristics:
 - Size and contour of neck.
 - Depth and course of vessel.
- Patient co-operation;
 - Respiratory status.
 - Movement.
- Vessel characteristics:
 - Acoustic shadowing from calcification should not be an issue post-operatively.
- Post-operative dressings, sutures or staples.



Doppler Angle

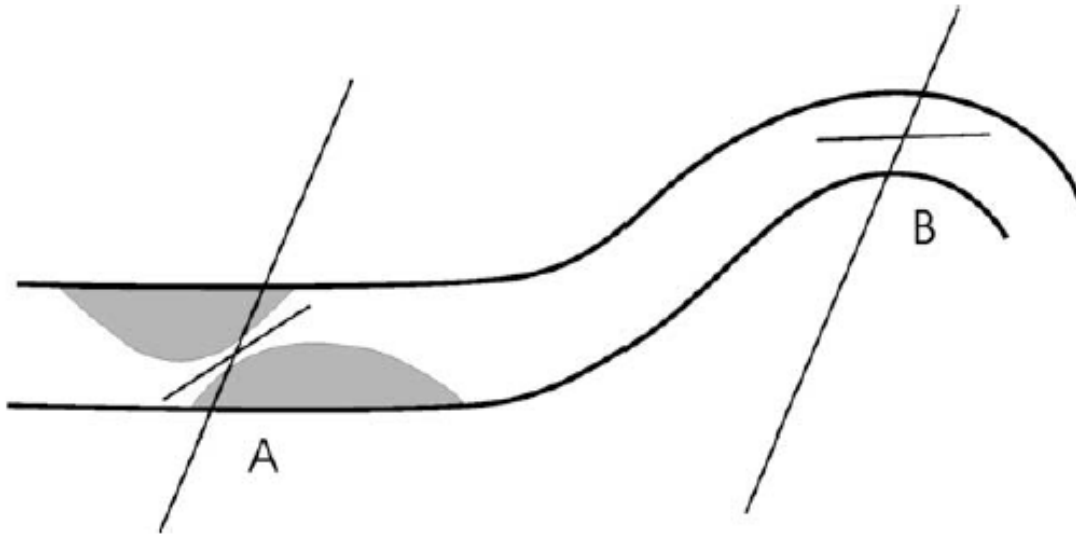


Figure 4 Showing correct alignment for the Doppler angle cursor in the case (A) of an eccentric stenotic jet, and (B) aligning along the tangent of a curved vessel.



Doppler Angle

If in doubt go and watch the
scan being done and talk to
your vascular laboratory
sonographer

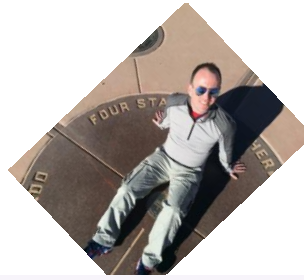
What I do



- Four-hour enhanced recovery or POCU bed overnight.
- Drain-out next morning.
- Discharge day-1 afternoon on best medical therapy.
- Review 3-months in out-patient clinic with carotid duplex.



What I do



My practice governed by
patient symptomatology





What I do

My practice governed by
patient symptomatology

What if area of stenosis
identified on follow-up
carotid duplex ??? in an
asymptomatic patient



REVIEW

Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom

C.P. Oates ^{a,*}, A.R. Naylor ^b, T. Hartshorne ^b, S.M. Charles ^c, T. Fail ^d,
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Recommendations only apply to native blood vessels.

Does not cover the diagnostic criteria post-surgery or following insertion of carotid stents.



Frequency of postoperative carotid duplex surveillance and type of closure: results from a randomized trial.AbuRahma AF¹, Robinson PA, Mullins DA, Holt SM, Herzog TA, Mowery NT.

Objective: To analyse the frequency and timing of postoperative carotid duplex ultrasound scanning (PCDS) according to the type of closure from a randomized carotid endarterectomy (CEA) trial comparing primary closure (PC) versus patching.

Patient Population: 399 CEAs were randomised into 135 PCs, 134 polytetrafluoroethylene (PTFE) patch closures, and 130 vein patch closures (VPCs) with a mean follow-up of 47 months.

Methods: PCDS was performed at 1, 6, and 12 months and every year thereafter (a mean of 4.0 studies per artery). Kaplan-Meier analysis was used to estimate the rate of $\geq 80\%$ restenosis over time and the time frame of progression from less than 50%, from 50%-79% and equal / greater than 80% stenosis.

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Frequency of postoperative carotid duplex surveillance and type of closure: results from a randomized trial.AbuRahma AF¹, Robinson PA, Mullins DA, Holt SM, Herzog TA, Mowery NT.

Results: Restenoses of 80% or more developed in 24 (21%) arteries with PC and nine (4%) with patching.

Kaplan-Meier estimate of freedom of 80% or more restenosis at 1, 2, 3, 4, and 5 years was 92%, 83%, 80%, 76%, and 68% for PC, respectively, and 100%, 99%, 98%, 98%, and 91% for patching, respectively, ($P < .01$).

Of the 24 PC patients with >80% restenosis, 10 were symptomatic. Therefore, therefore 14 asymptomatic arteries (12%) detected only with PCDS cost \$139, 200.),

Of the 9 arteries closed with patches (3 PTFE closures and 6 VPCs) with greater than 80% restenosis 3 patients were symptomatic.



Frequency of postoperative carotid duplex surveillance and type of closure: results from a randomized trial.AbuRahma AF¹, Robinson PA, Mullins DA, Holt SM, Herzog TA, Mowery NT.

Results: In patients with normal duplex scan findings at the first 6 months, only four (2%) of 222 patched arteries (two asymptomatic) developed greater than 80% restenosis versus five (38%) of 13 in patients with abnormal duplex scan examination findings identified at the 6 month scan ($P<.001$).

Conclusions: PCDS is beneficial in patients with PC, but is less beneficial in patients with patch closure.

PCDS examinations at 6 months and at 1- to 2-year intervals for several years after PC are adequate.

For patients with patching, a 6-month postoperative duplex scan examination with normal results is adequate.

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J Vasc Surg. 2000 Dec;32(6):1043-51.

Frequency of postoperative carotid duplex surveillance and type of closure: results from a randomized trial.

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Effects of best medical
therapy

Cost implications

Surgery only in symptomatic
patients

Results
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Duplex ultrasound surveillance after carotid artery endarterectomy.

Al Shakarchi J¹, Lowry D², Nath J³, Khawaja AZ³, Inston N³, Tiwari A².

Journal of
Vascular Surgery®

Objective: This study assessed and systematically reviewed the evidence base for long-term surveillance after CEA and a normal early scan.

Methods: Electronic databases were searched for studies assessing duplex surveillance after CEA in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Outcomes: The primary outcome for this study was the incidence of restenosis after a normal early scan. The secondary outcome was the number of re-interventions after a normal early scan.



Duplex ultrasound surveillance after carotid artery endarterectomy.

Al Shakarchi J¹, Lowry D², Nath J³, Khawaja AZ³, Inston N³, Tiwari A².

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Results: The review included seven studies that reported 2317 procedures.

Of those patients with a normal early scan, 2.8% (95% confidence interval, 0.7%-6%) developed a restenosis, and 0.4% (95% confidence interval, 0%-0.9%) underwent a re-intervention for their restenosis during the follow-up period.



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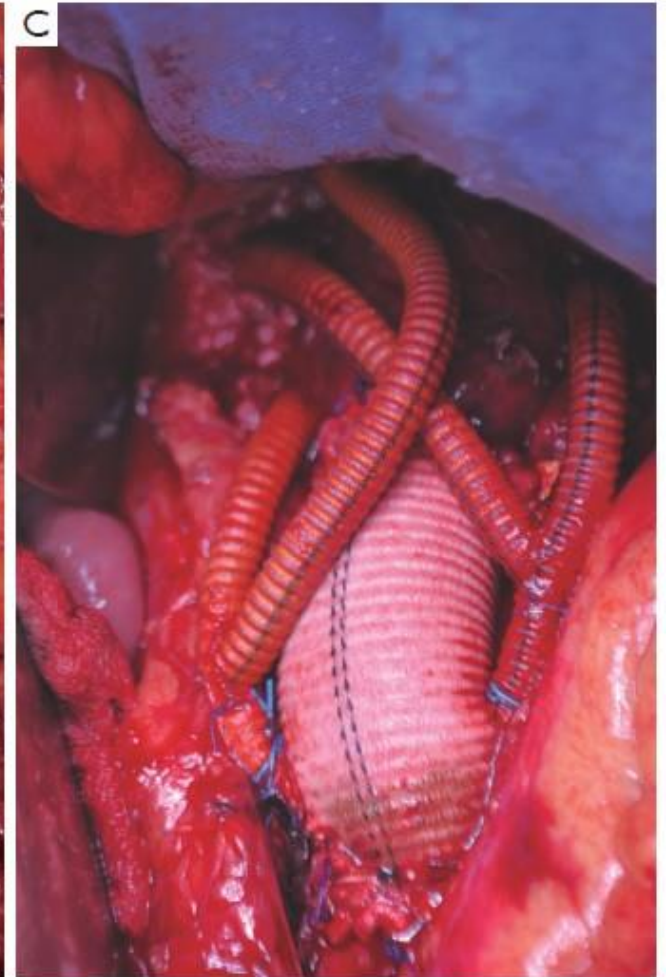
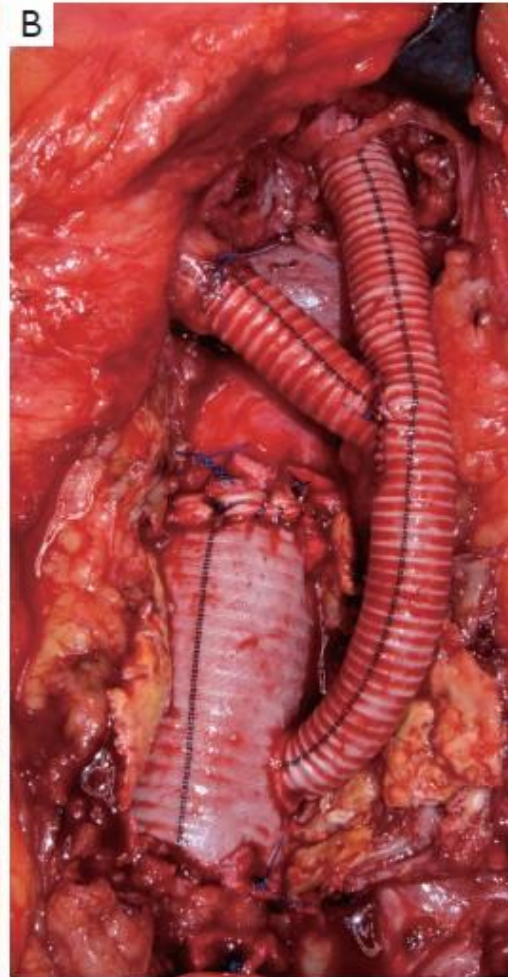
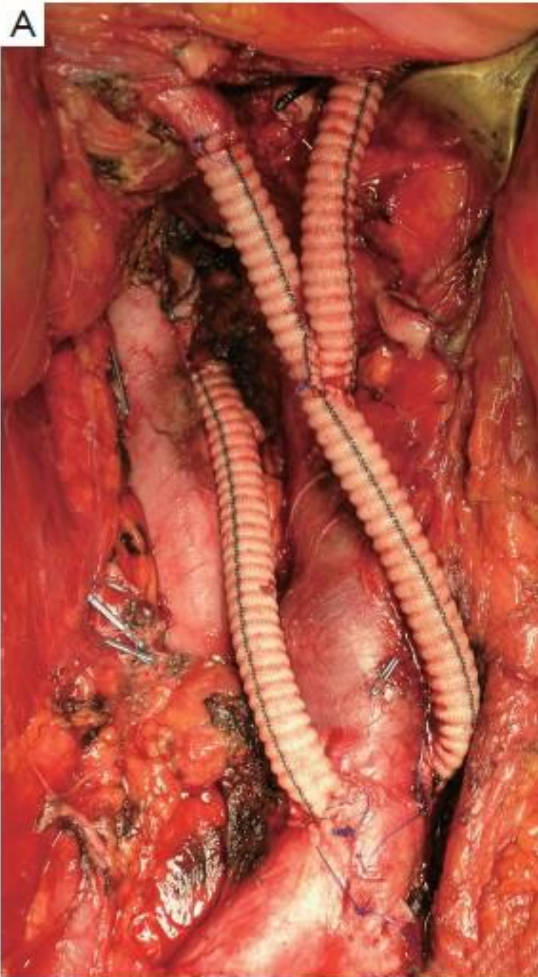
What I do



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- Drain-out next morning.
- Discharge day-1 afternoon on best medical therapy.
- Review 3-months in out-patient clinic with carotid duplex.



Aortic Aneurysm Disease



AAA - Why Treat ??

- Risk of AAA rupture;

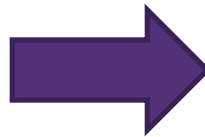
■ Below 5cm	<2%
■ 5cm to 5.9cm	5%
■ 6cm to 6.9cm	6.6%
■ 7cm to 7.9cm	20%
■ Greater than 8cm	30-50%

- UK Small Aneurysm Trial;
 - Multicentre RCT across 93 UK hospitals.
 - 1276 patients between 60-76 with AAA between 4.0 and 5.5cm.
 - Safe to monitor AAA up to 5.5cm unless tender or growth rates >1cm per year.



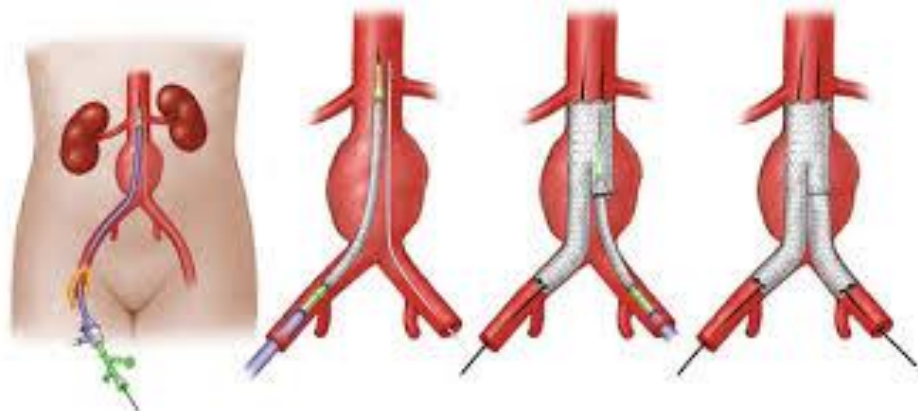
Treatment

- Standard Surgical Repair:
 - Replace diseased aorta with artificial artery.
 - Requires 7 day hospital stay.
 - Recovery time 3-6 months.
 - Proven method with good long term results.



Treatment

- Endovascular Repair:
 - Repair through an incision in the groin with expandable prosthesis under fluoroscopic guidance
 - Requires both surgical and radiological assistance
 - Significantly reduced morbidity.
 - Long term result unknown
 - Hospital stay 1-2 days, Recovery time 1-2 weeks



Post-operative Follow-Up

- Varies according to individual and/or institutional practice.
- Open AAA Repair - Out-Patient Clinical Review:
 - Overall patient wellbeing.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Discharge.
- EVAR - Out-Patient Clinical Review:
 - Overall patient wellbeing.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Review of follow-up imaging.
 - Life-long follow-up.



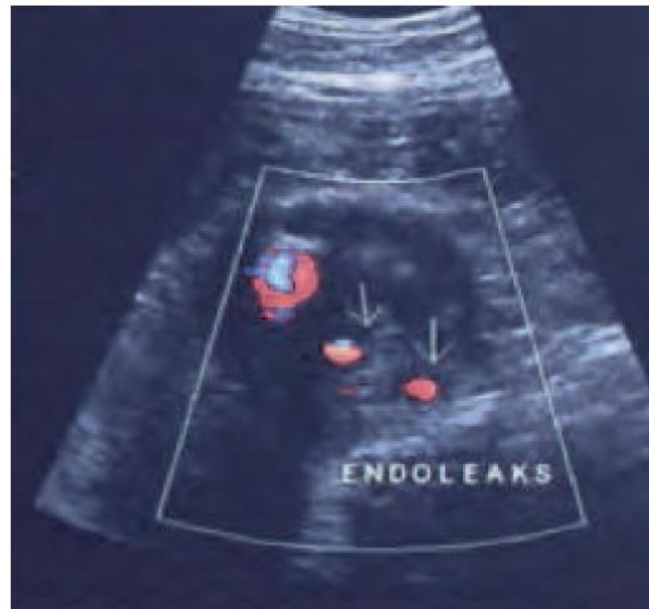
Post-EVAR AAA Surveillance Scanning

- Surveillance post-EVAR is universally agreed.
- Concerns regarding current CTA protocols due to ionising radiation, administration of intravenous contrast agents (nephrotoxicity and allergy) and cost.
- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
 - Intra-vascular ultrasound (IVUS).



AAA - Duplex Ultrasound

- Continuing concerns regarding ultrasonographer experience and patient related factors (Collins et al; Ann Vasc Surg 2007).
- May be suitable as a primary follow-up modality if initial CT scan normal (Patel and Carpenter; J Vasc Surg 2010).



AAA - Duplex Ultrasound

- However, the sensitivity of duplex ultrasound to depict in-stent flow ranges from around 40% to 97% (*d'Audiffret A et al. J Vasc Surg 2001*).
- More recent meta-analyses have demonstrated sensitivities between 69% and 77% for detection of endoleaks using color doppler ultrasound suggesting that colour duplex ultrasound alone has insufficient for the detection of endoleaks Mirza et al. Eur J Vasc Endovasc Surg 2010.
- Therefore should duplex ultrasound be utilised for sac diameter alone for medium to long-term follow-up ?

AAA – Contrast-Enhanced Ultrasound

- CEUS is performed using intravenous administration of sulphur hexafluoride microbubbles contrast agents (Sonovue);
 - Repetitive bolus of maximum 2.4 mls.
 - Dose can be titrated between according to equipment sensitivity and patient constitution 1.0mls up to 4.8 mls.
- Intraluminal arterial enhancement usually becomes detectable between 10 to 30 seconds after bolus injection and peaks at approximately 30 to 90 seconds, and gradually decreases to background within the next 5 minutes.



AAA – Contrast-Enhanced Ultrasound

- Alternative contrast protocols may involve bolus injections repeated every 3-5 minutes or alternatively a continuous infusion to achieve a stable enhancement over several minutes (VueJect[®]) of 1-2 mls per minute.
- The ultrasound equipment for aortic applications with ultrasound contrast agent usually contains a low frequency curved array (e.g., 1 to 5 MHz) in conjunction with a low-mechanical-index contrast-specific ultrasound mode (e.g., pulse inversion harmonic imaging, power modulation) which is mandatory for CEUS.



AAA – Contrast-Enhanced Ultrasound

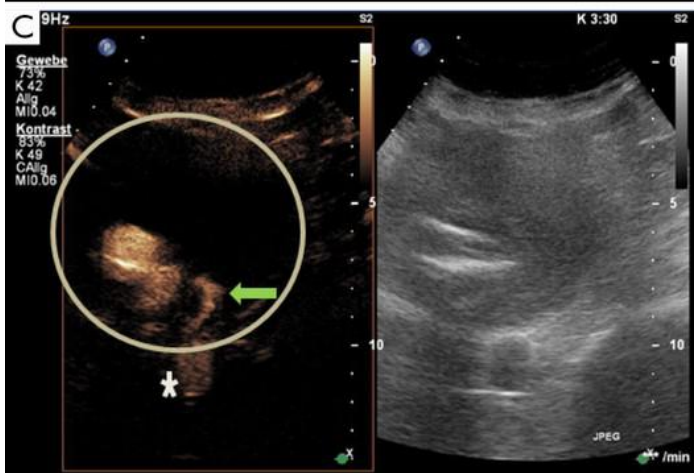
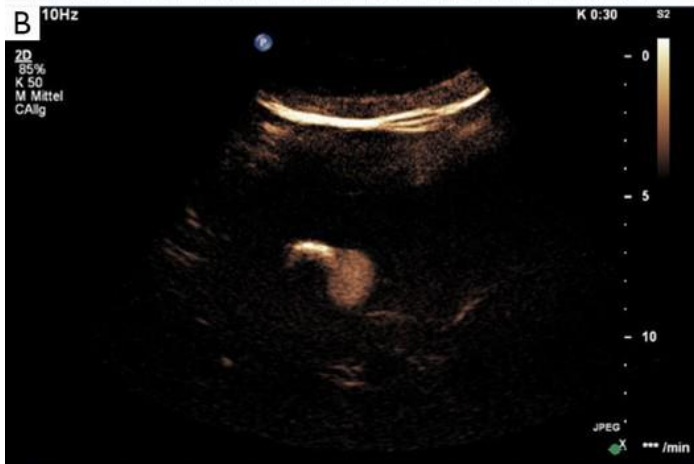


Standard and contrast-enhanced ultrasound in a patient with type II endoleak after endovascular aortic repair (EVAR)

(A) Detection of a slow flow endoleak (arrow) using color and pulse-wave ultrasound; spectral curve with to-and-fro signal;

(B) Contrast mode 30 sec after bolus injection, showing no extravascular enhancement;

(C) Contrast mode (left) and conventional B-mode (right) simultaneously, 210 sec after bolus injection, showing endoleak (arrow), dorsal and lateral of the left prosthetic limb; pseudoenhancement (star) outside the aneurysm sack (circle).



AAA – Contrast-Enhanced Ultrasound

- Millen et al. J Vasc Surg 2013 reported discordant or unresolved findings in 33 out of 539 patients post EVAR (approximately 6%) after imaging with duplex ultrasound and CTA where additional use of CEUS resolved the clinical questions in all cases.
 - 10 of these 33 (30%) required a secondary intervention based on the information derived from the CEUS study.
 - CEUS clarified endoleak detection and target vessel patency.



Post-EVAR Endoleak detection by CEUS

Study	Study size	Type of contrast administration	Comparator	Sensitivity to detect endoleak	Specificity to detect endoleak
Iezzi <i>et al.</i> (37)	N=84	Consecutive bolus injection of 1.2 mL and 2.4 mL SonoVue [®] followed each by 5 mL saline solution	CTA	97.3%	81.8%
Cantisani <i>et al.</i> (31)	N=108	Bolus injection of 2.4 mL SonoVue [®] followed by 5 mL saline solution	CTA and MRA (or angiography when available)	96%	100%
Motta <i>et al.</i> (32)	N=88	Two consecutive bolus injections of 2.4 mL SonoVue [®] followed by 10 mL saline solution	CTA	92%	100%
Gilabert <i>et al.</i> (10)	N=35	Bolus injection of 2.4 mL SonoVue [®] followed by 5 mL saline solution	CTA	97%	100%
Gürtler <i>et al.</i> (34)	N=132	Bolus injection of 1.0 mL (or 2.4 mL) SonoVue [®] followed by 10 mL saline solution	CTA	97%	93%
Abbas <i>et al.</i> (9)	N=23	Bolus injection of 2-5 mL SonoVue [®] using 3D CEUS technology	CTA	100%	92%
Mirza <i>et al.</i> (22)	7 studies in 285 patients (bivariate meta-analysis)	CEUS using LevoVist [®] , Optison [®] or SonoVue [®]	CTA	98% (95% CI, 90-99%)	88% (95% CI, 78-94%)
Karthikesalingam <i>et al.</i> (38)	11 studies with total 961 paired scans (bivariate meta-analysis)	NA	CTA	96% (95% CI, 85-99%)	85% (95% CI, 76-92%)



AAA – 3-D Ultrasound

- The Curefab 3D system comprises tracking sensors installed in the transducer of a high-definition duplex Doppler ultrasound system (IU22- C5) and an electromagnetic box (McCollum E J Vasc Endovasc Surg 2014);
 - Motion tracking mini-GPS (global positioning system) with a magnetic field emitter and two tracking sensors that transform standard 2D CEUS images into high-definition 3D format.¹²
 - Unlike conventional ultrasound, all the acquired 2D information is utilised to construct a high-definition 3D image.



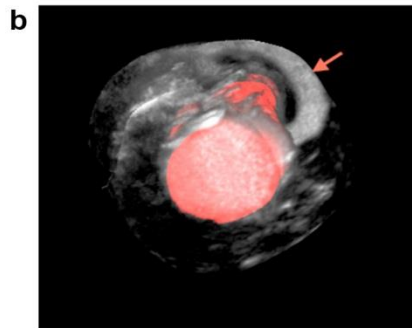
AAA – 3-D Ultrasound

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- These are dynamic images that may be manipulated by the operator to interrogate any area of interest.
- The colour coding of the stent-graft is added manually.

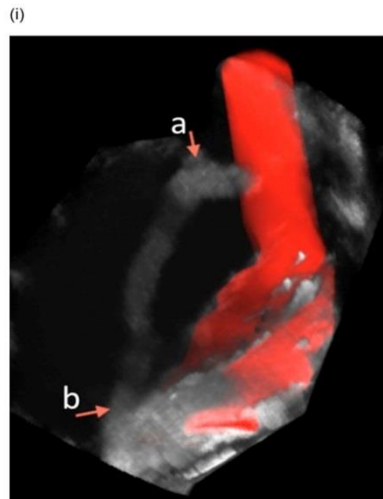




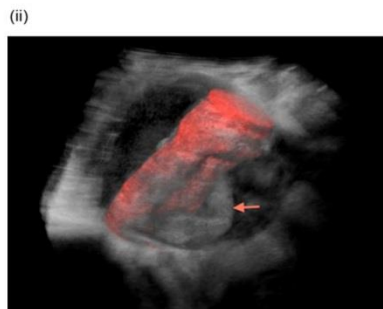
- (A) CTA showing Type II endoleak.



- (B) 3D CEUS of same subject showing a Type II endoleak (red arrows) flowing from the (a) inferior mesenteric artery (b) to a lumbar artery.



- The stent-graft is coloured red by the **3D ultrasound software to distinguish flow within the stent-graft from flow outside** (i) cross section (ii) longitudinal section (iii) obliqueRange of ultrasonic modalities;



Aorto-Iliac Arterial Scanning - Capabilities

- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- Can determine the presence / absence of;
 - Significant stenosis.
 - Follow-up after bypass graft surgery.
 - Evaluation of aneurysms.



Aorto-Iliac Arterial Scanning - Capabilities

- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- Can determine the presence / absence of;
 - Significant stenosis.
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- Aneurysm > 3cm.



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- Stenosis velocities and indices as per lower extremity.



Aorto-Iliac Arterial Scanning - Limitations

- Patient characteristics:
 - Depth of ultrasound – size of patient.
 - Previous abdominal surgery – scar tissue.
 - Bowel gas.
- Patient co-operation;
 - Non-fasting.
 - Respiratory status - movement.
- Post-operative dressings, sutures or staples.



What I do



- Open AAA:
 - Post-operative care in POCU / HDU / ICU.
 - Avoid naso-gastric tubes if possible.
 - Slow restoration of normal GI intake.
 - Early mobilisation.
 - Discharge day 5 to 10.
 - Review clinic 3 months.

- EVAR:
 - Four-hour enhanced recovery or POCU bed overnight.
 - Early restoration of normal diet and mobilisation.
 - CT scan 1, 6 and 12 months and AXR at 12-moths.
 - Out-patient clinic review 3-months.



What I do



Most patients take 3-months
to heal after major surgery

EVAR follow-up protocol
driven according to National
Guidelines

Evidence

- Varies according to individual and/or institutional practice.
- Open AAA Repair - Out-Patient Clinical Review:
 - Overall patient wellbeing.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Discharge.
- EVAR - Out-Patient Clinical Review:
 - Overall patient wellbeing.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Review of follow-up imaging.
 - Life-long follow-up.



Mesenteric Ischaemia !!!!!



Conservative Treatment



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Conservative Treatment



**VAGUE SYMPTOMS
NORMAL or ELEVATED BMI**

**INTERVENTION NOT
REQUIRED**



Conservative Treatment



Conservative Treatment



Medical Treatment

- Risk factor modification.
- Best Medical Therapy;
 - Antiplatelet / Anticoagulation.
 - Statin therapy.



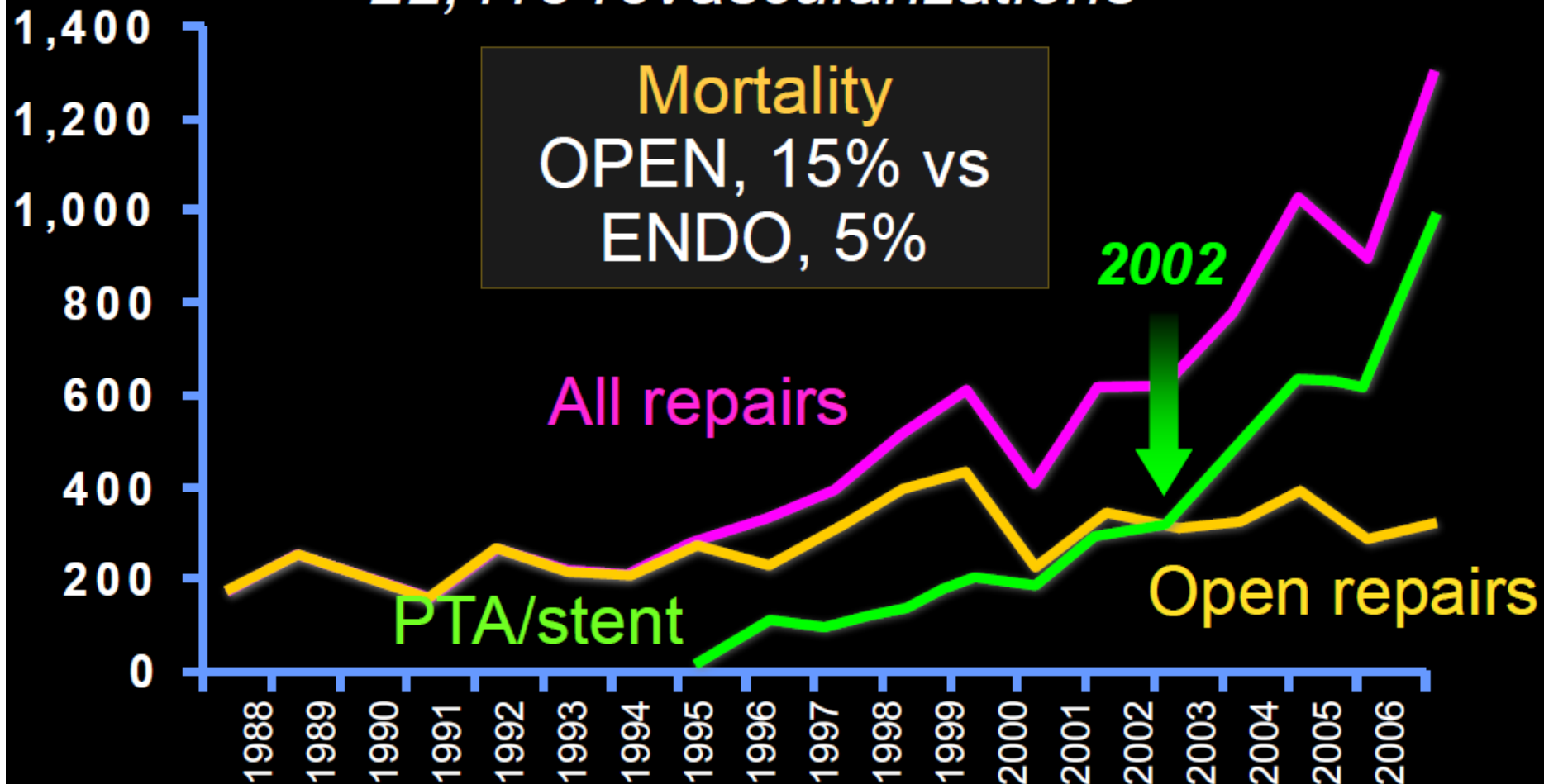
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Mesenteric Ischaemia – Changing Paradigm

1988 to 2006

22,413 revascularizations



Mesenteric Ischaemia – Changing Paradigm

1988 to 2006

1,400
1,200
1,000
800
600
400
200
0

Endovascular interventions increasing in frequency for revascularization of both AMI and CMI.

The lower in-hospital mortality rate for patients, as they are currently being selected, shows that endovascular intervention is appropriate therapy for selected patients with CMI.

The greater proportion of patients undergoing bowel resection with bypass for AMI suggests a more advanced level of ischemia in this group, making comparison with endovascular series difficult.

198 198 199 199 199 199 199 199 199 199 199 200 200 200 200 200 200 2006

repairs

Mesenteric Arterial Scanning - Capabilities

- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- Can determine the presence / absence of;
 - Significant stenosis.
 - Follow-up after bypass graft surgery.
 - Evaluation of aneurysms.
- Aneurysm > 3cm.
- Stenosis velocities and indices as per lower extremity.



Mesenteric Arterial Scanning - Capabilities

- Include renal etc
- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- Can determine the presence / absence of;
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■ Stenosis velocities and indices as per lower extremity.

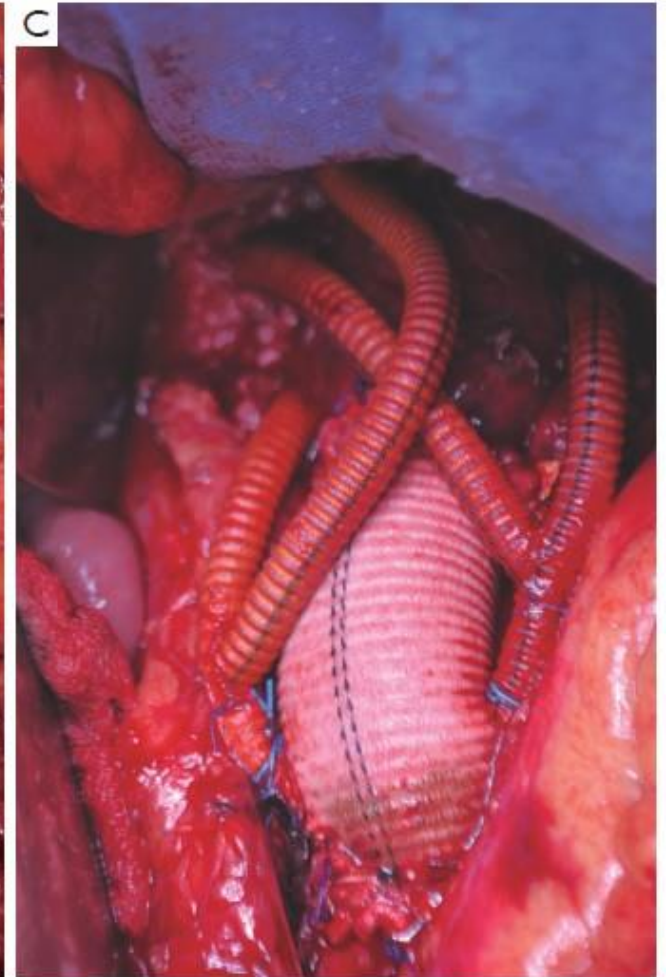


Aorto-Iliac Arterial Scanning - Limitations

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 - Depth of ultrasound – size of patient.
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 - Bowel gas.
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Aortic Aneurysm Disease



AAA - Why Treat ??

- Risk of AAA rupture;

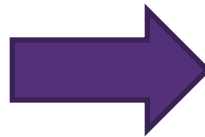
■ Below 5cm	<2%
■ 5cm to 5.9cm	5%
■ 6cm to 6.9cm	6.6%
■ 7cm to 7.9cm	20%
■ Greater than 8cm	30-50%

- UK Small Aneurysm Trial;
 - Multicentre RCT across 93 UK hospitals.
 - 1276 patients between 60-76 with AAA between 4.0 and 5.5cm.
 - Safe to monitor AAA up to 5.5cm unless tender or growth rates >1cm per year.



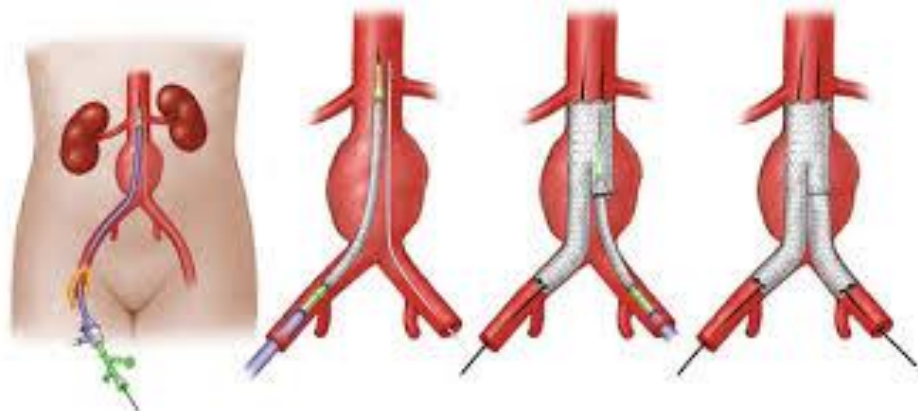
Treatment

- Standard Surgical Repair:
 - Replace diseased aorta with artificial artery.
 - Requires 7 day hospital stay.
 - Recovery time 3-6 months.
 - Proven method with good long term results.



Treatment

- Endovascular Repair:
 - Repair through an incision in the groin with expandable prosthesis under fluoroscopic guidance
 - Requires both surgical and radiological assistance
 - Significantly reduced morbidity.
 - Long term result unknown
 - Hospital stay 1-2 days, Recovery time 1-2 weeks



Post-operative Follow-Up

- Varies according to individual and/or institutional practice.
- Open AAA Repair - Out-Patient Clinical Review:
 - Overall patient wellbeing.
 - Optimisation of best medical therapy.
 - Wound evaluation.
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- EVAR - Out-Patient Clinical Review:
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 - 3-D ultrasound.
- *Add in slides about each And their special factors with pics*



AAA - Duplex Ultrasound

- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- *Add in slides about each And their special factors with pics*



AAA – Contrast-Enhanced Ultrasound

- Range of ultrasonic modalities;
 - Duplex ultrasound.
 - Contrast-enhanced ultrasound.
 - 3-D ultrasound.
- *Add in slides about each And their special factors with pics*



Why perform carotid endarterectomy ?

- Early treatment saves brain
- Best Medical Therapy;
 - Risk factor optimisation.
 - Antiplatelets - Aspirin 300mg for 14 days followed by Clopidogrel 75mg for life.
 - Lipid lowering therapy - statins.
- Evaluation by stroke physician – thrombolysis or prompt referral to vascular surgeon for consideration of carotid endarterectomy within 14 days.



Post-operative Follow-Up

- Varies according to individual consultant practice.
- Out-Patient Clinical Review:
 - Overall patient wellbeing – cerebrovascular symptomatology.
 - Optimisation of best medical therapy.
 - Wound evaluation.
 - Cranial nerve injury.
- Vascular Laboratory Assessment:
 - Carotid Duplex.



Carotid Duplex - Capabilities

- Can accurately identify and localise the presence of arterial disease in the extra-cranial carotid arteries.



Carotid Duplex - Limitations

- Patient characteristics:
 - Size and contour of neck.
 - Depth and course of vessel.
- Patient co-operation;
 - Respiratory status.
 - Movement.
- Vessel characteristics:
 - Acoustic shadowing from calcification should not be an issue post-operatively.
- Post-operative dressings, sutures or staples.



What I do



- Four-hour enhanced recovery or POCU bed overnight.
- Drain-out next morning.
- Discharge day-1 afternoon on best medical therapy.
- Review 3-months in out-patient clinic with carotid duplex.



What I do



My practice governed by
patient symptomatology

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What I do



My practice governed by
patient symptomatology

Further Reading

- Carotid:
 - https://www.bmus.org/static/uploads/resources/Recommendations_for_reporting_Carotid_Investigations.pdf
- Rifampicin soaked grafts.
- Silver impregnated grafts.
- Silver acetate and triclosan impregnated grafts.



Questions ?

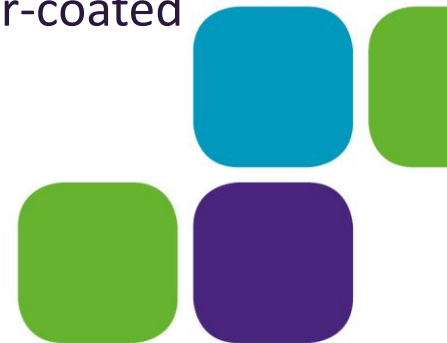


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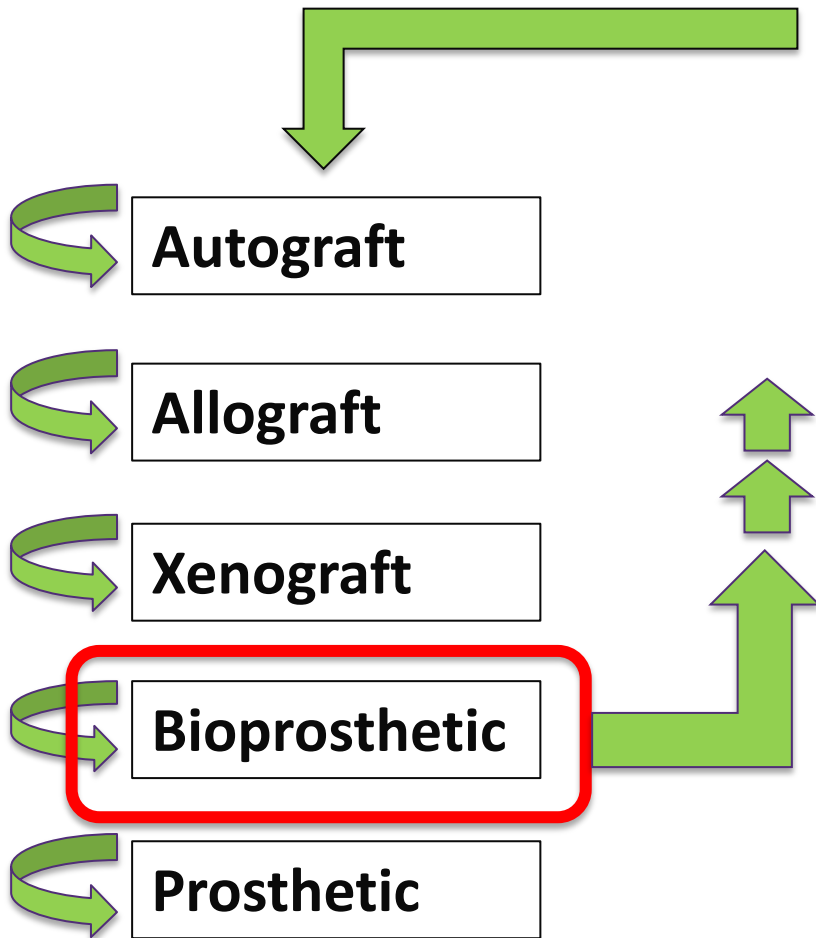


Clinical Evidence

- Hayes et al (1999) – 11 patients treated with rifampicin soaked grafts after total excision of the infected aortic graft;
 - 30-day mortality – 18% & late mortality 36%.
 - Both deaths (early = 1, late =1) had previous surgery for rAAA.
- Bandyk et al (2001) – 22 patients with aortic graft infections;
 - One death reported not related to graft infection.
 - No amputations or deaths due to graft sepsis at mean follow-up of 17 months.
- Bisdas (2010) – 11 out of 56 patients treated with silver-coated grafts;
 - 30-day mortality - 18%.
 - 2-year mortality – 27%.
 - 2 –year limb salvage and graft patency – 100%.



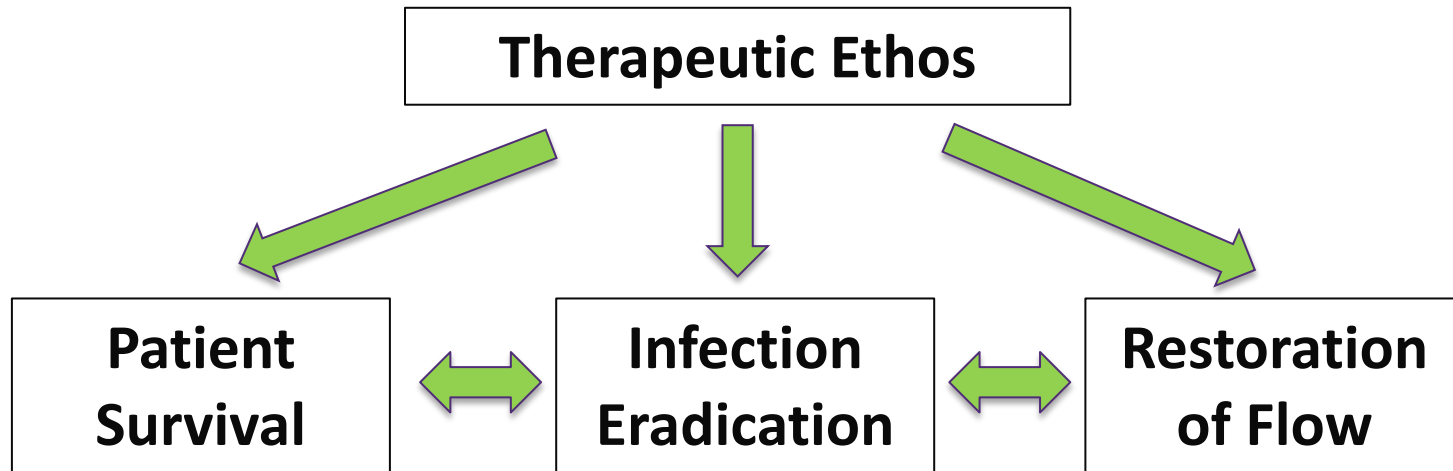
Reconstructive Conduit



**Lowest
Infection**

**Highest
Infection**





**Durable
+
Minimise
Re-infection**



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