thermal stimulation between the two groups in the forehead was significant ($P = 0.001$, Man-Whitney) while the forearm responses were not.

**Conclusion:** Microvascular response to thermal stimulation was significantly diminished in the lower limbs of subjects at high risk of developing atherosclerotic arterial disease compared with their upper limbs and with low-risk subjects. Regional variation in these abnormalities may play an important role in the predisposition to and distribution of arterial disease.

**Vascular 09**

**The influence of peripheral vascular disease on the carotid and femoral viscoelastic properties and intima-media thickness in subjects with abdominal aortic aneurysm**

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**Background:** Aortic and carotid stiffness are elevated in patients with abdominal aortic aneurysm (AAA). Failure of aortic compliance to increase with size may account for the higher risk of rupture. Peripheral vascular disease (PVD) frequently coexists with AAA and may further impair the arterial wall mechanics. We studied carotid and femoral viscoelastic properties and intima-media thickness (IMT) in this group of patients higher mortality risk.

**Methods:** The viscoelastic properties and IMT of the common carotid and common femoral arteries were determined in 30 AAA patients (15 with PVD) using a duplex ultrasound scanner coupled with wall tracking system. Physiological and biochemical variables were also assessed in these patients.

**Results:** Patients with both AAA and PVD have significantly stiffer carotid and femoral arteries without statistical difference in the IMT. They were matched for age, body mass index, systolic and diastolic pressures, heart rate, proximal cardiovascular load and plasma creatinine, glucose and lipid concentrations.

**Methods:** The distal anastomotic geometry was acquired in vivo by 2-D or 3-D time of flight MR angiography from 10 patients undergoing infrageniculate autologous venous bypass at a median 2 weeks postoperatively. Four patients underwent repeat examinations 13–49 days later. Computer generated 3-D lumen surface reconstructions of the anastomosis were produced and lumen centroids were extracted. Geometric features including angles between graft and proximal host (α), graft and distal host (β), and proximal and distal host (γ) were calculated. Diameter ratios between the graft and host vessels were calculated from the cross-sectional areas of the three vessels at the reconstructed anastomosis boundaries. A preliminary distal anastomotic planarity index (API) is introduced (for planar anastomoses API = 0) and was evaluated for the patient population studied.

**Results:**

<table>
<thead>
<tr>
<th>Angles (degrees)</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>28</td>
<td>101</td>
<td>41.6</td>
<td>20.3</td>
</tr>
<tr>
<td>β</td>
<td>144</td>
<td>177</td>
<td>163.8</td>
<td>9.9</td>
</tr>
<tr>
<td>γ</td>
<td>113</td>
<td>175</td>
<td>148.4</td>
<td>16.3</td>
</tr>
</tbody>
</table>

Diameter ratios

<table>
<thead>
<tr>
<th>Proximal host/graf t</th>
<th>0.35</th>
<th>0.79</th>
<th>0.56</th>
<th>0.16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal host/graf t</td>
<td>0.41</td>
<td>0.96</td>
<td>0.59</td>
<td>0.16</td>
</tr>
<tr>
<td>Anastomotic planarity index (API)</td>
<td>0.04</td>
<td>1.4</td>
<td>0.37</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Good agreement was found between the distal anastomotic angles in the initial and follow-up examinations. The differences in the angles varied between 1 and 10 degrees with a mean of 4.3 degrees.

**Conclusions:** In the early postoperative period distal graft anastomoses exhibit wide variations in angles α, β, and γ, diameter ratios, and planarity. The reported relationship between local haemodynamics and MIIH suggests that these geometric features may play a role in MIIH development.

**Vascular 11**

**Breaking symmetry: the influence of non-planar configuration on distal anastomotic flow patterns in infra-inguinal bypass grafts**

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**Objectives:** Evidence suggests an inverse relationship between wall shear stress (WSS) and distal anastomotic myointimal hyperplasia (MIIH), the commonest cause of bypass graft occlusion. Anastomotic configuration influences flow patterns and WSS, impacting upon anastomotic techniques. The aim of this study was to analyse the influence of non-planar distal anastomoses.

**Methods:** Contrast enhanced CT scans of distal anastomoses, with three dimensional reconstruction, enabled subjective analysis of in vivo non-planar configuration. In vitro flow visualization studies and laser Doppler anemometry (LDA) were performed using anastomotic models reflecting these configurations, perfused with glycerol blood analogue under physiological conditions.

**Results:** The in vivo angle between graft and recipient artery ranged from 0 to 45 degrees. In vitro flow patterns were altered by an angle of 30 degrees or more with the characteristic vortical flow pattern of a Miller cuff deviated away from the mid-line. In the proximal and distal outflow segments a helical flow pattern occurred, extending several diameters distance down the vessel. LDA velocity vector mapping corroborated the presence of helical flow within the run-off vessels, in direct contrast to symmetrical flow patterns observed within planar models. Out-of-plane configuration within the 5 cm of graft immediately proximal to the distal anastomosis was critical, with no observed influence on flow patterns imparted by more proximal deviation.

**Conclusion:** In vivo non-planar configuration depends in part upon the tunnelling of the graft, and can therefore be influenced. Non-planar anastomotic configurations >30 degrees induce helical outflow patterns which may beneficially increase WSS, thereby potentially inhibiting MIIH.