Stroke prevention in cardiac surgery

Udo Abah and Stephen Large*

Department of Cardiothoracic Surgery, Papworth Hospital, Cambridge, UK

* Corresponding author. Papworth Hospital, Papworth Everard, Cambridge CB23 3RE, UK. Tel: +44-1480-364478; fax: +44-1480-364334; e-mail: stephen.large@papworth.nhs.uk (S. Large).

Received 18 October 2011; received in revised form 22 December 2011; accepted 30 December 2011

Abstract

This article addresses the main risk factors for stroke in cardiac surgery and discusses the role of carotid artery intervention and perioperative epi-aortic scanning in the prevention of stroke. In great Britain and Northern Ireland, there were ~2789 new strokes following the 105,558 cases of cardiac surgery from 2004 to 2008 (an annual stroke rate of 2.6% complicating heart surgery in the UK). We argue that The National Health Service in the UK is set to spend £187,682 preventing each stroke in some 30 cardiac surgical patients while ignoring the remaining 528 strokes that complicate cardiac surgery in the UK each year. Caution must be taken in pricing the prevention of perioperative stroke as we must question our use of finite resources. Aortic atheroma has been demonstrated as the foremost cause of post-coronary artery bypass graft strokes. Epi-aortic scanning is effective in identifying aortic atheroma encouraging measures to reduce perioperative stroke with heart surgery, and it is cheap. Several studies have confirmed epi-aortic scanning at the time of heart surgery to be effective in reducing the incidence of perioperative brain damage. We suggest that it is time to adopt epi-aortic scanning in our routine cardiac surgical practice if only to confirm or refute its cost-effectiveness in brain protection during this surgery.

Keywords: Stroke • Carotid imaging • Carotid endarterectomy • Epi-aortic scan • Cardiac surgery

INTRODUCTION

Stroke is a devastating complication of cardiac surgery. Despite great advances in the specialty, reflected by reducing mortality rates in the face of increasing risk, postoperative stroke remains a significant complication which many patients fear may lead to death. The current incidence of new postoperative stroke in the UK is 1.0% for coronary artery bypass grafts (CABG), 1.9% for aortic valve replacement, 0.8% for mitral valve repair and 3.0% for mitral valve replacement, with increased rates in combined procedures. Postoperative stroke increases in-hospital mortality from 1.6 to 13.0% and reduces 5-year survival from 90 to 63% [1].

DISCUSSION

There are many attributed causes of postoperative stroke. Carotid artery stenosis (CAS) and aortic plaque load are predominantly responsible; however, cardiac emboli, cerebral vasospasm, particulate emboli from cardiopulmonary bypass, transient hyper-coagulable state and hypo-perfusion have also been implicated. The presence of multiple risk factors in the majority of patients makes understanding the exact aetiology challenging. Nonetheless, it is suggested that up to 30% of early postoperative strokes complicating CABG are caused by a haemodynamically significant CAS [2]; however, new evidence disputes this presumption. Li et al. [3] conducted a retrospective study of 4335 patients undergoing CABG, valve or combined procedures and demonstrated that the majority of strokes were not related to significant CAS; 75% were classified as cardio-embolic, 5.3% as large vessel (carotid and basilar artery) and 13.2% as small vessel. Interestingly, of the 76 patients who suffered a stroke, only 4 had infarcts within the diseased carotid territory, 3 of whom had ipsilateral occlusion and 1 that had 60% ipsilateral stenosis. It appears that the single most significant marker of an adverse cerebral outcome after CABG is the identification of an atherosclerotic ascending aorta [4]. The high prevalence of aortic atherosclerosis in patients with CAS may help to explain the higher stroke rate in patients with lesions outside the territory of their carotid disease.

Both the American Heart Association (AHA) [2] and the European Society of Cardiology/European Association of Cardiothoracic Surgery (ESC/EACTS) [4] have produced guidance for the investigation and management of CAS prior to cardiac surgery (Fig. 1); however, this is based upon low-level evidence resulting in ambiguous guidance. Outside of the context of cardiac surgery, multicentre trials have demonstrated an advantage of surgical management over medical therapy for both symptomatic and asymptomatic patients with significant CAS. These trials concluded that in symptomatic patients, carotid endarterectomy (CEA) is highly effective for severe stenosis (70–99%) and moderately beneficial for 50–69% stenosis, but in cases of lesser stenoses, CEA increases the risk of complications. In asymptomatic patients, the benefit/risk ratio is small, making management of CAS difficult [5]. When considering CEA in the context of cardiac surgery, the evidence is far less clear cut. To date, no randomized control trials have considered CEA versus best medical management in the treatment of CAS with concomitant cardiac surgery. The current evidence shows conflicting
outcomes. Some studies have suggested that staged CEA prior to cardiac surgery can reduce the risk of perioperative stroke and death towards that observed in patients without carotid disease [6], while others have shown an increase in the stroke rate in patients who underwent combined/staged carotid and cardiac surgery [3].

There is no doubt that patients with CAS and an atheromatous aorta have a higher risk of stroke. The unanswered question is how we tackle this risk in order to reduce it. The cost to the NHS for each patient who suffers a stroke is roughly £29 000 over 5 years [4]. On the basis of AHA guidance, this patient group should have received an ultrasound scan each priced at £66, equalling £1 393 365 per annum. With an estimated rate of severe CAS at 6% [2] and the cost of a CEA at £3345, this equates to an annual cost for the NHS of £4 237 098 and a total cost per year of £5 630 463 for investigation and treatment of CAS. If we accept the findings of Li et al. [3] that 5.3% of cardiac surgical strokes have direct correlation to a significant carotid lesion, this would suggest that 30 postoperative cardiac surgical strokes each year are related to CAS in the UK. Assuming CEA not to be complicated by stroke and that it will abolish perioperative stroke in subsequent cardiac surgery, the National Health Service in the UK is set to spend £187 682 preventing stroke in each of these 30 patients while ignoring the remaining 528 strokes that complicate cardiac surgery in the UK each year.

We should be cautious as we put a price on the avoidance of postoperative stroke in an individual, nonetheless we must question our use of finite resources. Aortic atheroma has been demonstrated as the foremost cause of perioperative stroke in cardiac surgery and intra-operative epi-aortic scanning the most effective tool for its identification. Zingone et al. [7] demonstrated a reduction in postoperative stroke from 3.3 to 1.1% with the use of epi-aortic scanning and Yamaguchi et al. [8] reported a Stroke rate of 0% following the introduction of epi-aortic scanning and modification of the operative technique in a series of 909 patients. In 2008, the American Society of Echocardiography and the American Society of Anesthesiologists produced guidance for epi-aortic scanning in cardiac surgery. The guidelines recommend epi-aortic scanning in all patients at increased risk of embolic stroke (i.e. advanced age, female sex, vascular/cerebrovascular disease, diabetes and hypertension) [9].

CONCLUSION

In cardiac surgery, there is no doubt that carotid intervention can prevent postoperative stroke in a particular subgroup of patients (Fig. 2 suggests a structured approach for the investigation and management). However, epi-aortic scanning may prove to be an effective and financially attractive method for the reduction in postoperative stroke and one has to question, with

<table>
<thead>
<tr>
<th>2010 ESC/EACTs guidance [4]:</th>
<th>2004 AHA guidance [2]:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guidance for screening</strong></td>
<td><strong>Guidance for carotid endarterectomy</strong></td>
</tr>
<tr>
<td>Age &gt; 75 years</td>
<td>Age &gt; 65 years</td>
</tr>
<tr>
<td>LM disease</td>
<td>Left main coronary stenosis</td>
</tr>
<tr>
<td>Severe PAD</td>
<td>Peripheral vascular disease</td>
</tr>
<tr>
<td>TIA/Stroke</td>
<td>TIA/CVA</td>
</tr>
<tr>
<td>Carotid bruit</td>
<td>Carotid bruit</td>
</tr>
<tr>
<td>History of smoking</td>
<td></td>
</tr>
</tbody>
</table>

Patients with previous TIA/non disabling stroke, carotid revascularisation:
- Is recommended in 70–99% stenosis.
- May be considered in 50–69% stenosis in men with symptoms < 6 months
- Is not recommended in men with stenosis < 50% and women with stenosis < 70%

Patients with no previous TIA/stroke, carotid revascularisation:
- May be considered in men with bilateral 70–99% stenosis, or 70–99% stenosis with contralateral occlusion
- Is not recommended in women or patients with a life expectancy < 5 years

Probably recommended prior/concomitant to CABG in patients with symptomatic carotid stenosis

Asymptomatic patients with unilateral or bilateral internal carotid stenosis of 80% or more
the current body of evidence, why it is not, to date, standard practice within the UK and many other countries? Perhaps, we need more work in this area to produce a strong cost-effective argument that will encourage a faster adoption of this potentially effective step forwards in the perioperative care of the cardiac surgical patient's brain.

Conflict of interest: none declared.

REFERENCES


Figure 2: Management of carotid stenosis prior to cardiac surgery.