STROKE, IS THERE A ROLE FOR NEUROSURGERY?

Christos Tolias MD, PhD, FRCS (Engl), FRCS (SN)

Consultant Neurosurgeon, Neurovascular Surgery, Clinical Lead Neurosurgery, Clinical Lead South London Neurosurgery Network

Abstract

Brief review of the role of neurosurgery in the management of Stroke.

Key words: stroke, neurosurgery, cerebral vasular abnormalities, Moya-Moya, cerbral bypass

Stroke is a major cause of morbidity and mortality worldwide. Every year, an estimated 150,000 people in the UK have a stroke. That's one person every five minutes. Most people affected are over 65, but anyone can have a stroke, including children and even babies. A stroke is the third most common cause of death in the UK. It is also the single most common cause of severe disability. More than 250,000 people live with disabilities caused by a stroke (Stroke Association) and 1000 people under 30 have a stroke each year.

London is a city with 9 million inhabitants. Stroke remains the second biggest killer and most common cause of disability with more than 11,500 strokes reported every year, which translate to approximate 2,000 deaths. Areas with social deprivation and lower income have higher incidences of stroke, relating to diet, smoking and reduced prevention.

Traditionally Stroke was seen as a non surgical, sub acute condition, however recent advances in its management have altered this perception and are revolutionising stroke management.

The FAST campaigns and the establishment of Stroke hyper acute units strategically located around the capital have streamlined the management of the condition and allowed thrombolysis to be offered in a timely manner (within 4hours window). However the recent advent of thrombectomy have really revolutionise the management of acute stroke. The publication of eight randomised controlled trials (RCTs), including 2423 patients, reported that endovascular thrombectomy was associated with improved functional outcomes at 90 day follow-up (modified Rankin scale score 0–2, odds ratio 1.56, 95% confidence interval [CI] 1.32 to 1.85, $p<0.00001$). Moreover the effects of thrombectomy persisted for more than 2 years. Such results have ushered in the modern era of stroke treatment. Of course a minority of strokes are amenable to thombectomy. For example the area covered by Kings College Hospital (SE London and Kent - approximate 4,5 million people) is treating >1600 cases a year and 15-20% of these are eligible for thrombectomy.

As the procedure requires resources that were traditionally available to stroke use a major reconfiguration of services is currently on going in the UK in order to allocate the the appropriate hardware, personnel and beds to these very urgent patients.

Various paradigms have been proposed:

- 24/7 pure thrombectomy rota,
- Neurology/Cardiology involvement,
- Dually trained neurosurgeons/neurologists,
- incorporation at existing set up,
- extending the neurointerventionist cohort,
- Networks.

It is estimated that 5-7 interventionists will be needed to staff the rota. It is anticipated that 200-300 procedures / annum / per centre (including aneurysm coiling). The full service establishment has taken 4-5 years, but we now have a 24/7 service that covers thrombectomy and management of ruptured aneurysms.

And for neurosurgery? Is there a role?

I will examine five areas were neurosurgery has a significant and increasingly important role:

Patients with malignant Stroke (large MCA)

"Malignant" middle cerebral artery (MCA) stroke refers to life threatening, space occupying MCA infarctions which occur in up to 10% of all stroke patients… The mortality rate of space occupying infarctions in the MCA-territory rises up to 80% despite maximal medical treatment.

Decompressive craniotomy is a procedure proposed for the first time in 1901 by Dr Kocher for stroke and severe trauma. Its scientific basis is the Kelly-Monroe principle of the exponential increase of intracranial pressure (closed "box") as intracranial components (ie oedema or blood increase in volume, and the similar reduction of intracranial pressure when the "box" (cranium) is expanded.

During the past several years, numerous research papers have described the life-saving nature of hemicraniectomy for MCA-territory cerebral infarction. Most hemicraniectomy series report a reduced mortality to approximately 20%.

In three meta-analysis of patients subjected to decompressive craniotomy for stroke: DECIMAL (DEcompressive Craniectomy In MALignant middle cerebral artery infarction), DESTINY (DEcompressive Surgery for the Treatment of malignant INfarction of the middlecerebral arterY), and HAMLET, where patients were randomised within 48 h of stroke onset to surgical decompression, a reduced poor outcome (ARR 16%, -0·1 to 33) and case fatality (ARR 50%, 34 to 66) were reported.

This beneficial effect has been observed even in older individuals and the benefits have persisted for more than a couple of years. Of course controversy still remains on the usefulness of the procedure on the older populations with their significant co-morbidities as well as in patients with dominant hemisphere strokes.

Patients with Haemorrhagic Stroke

Several prospective randomised controlled trials were undertaken during the previous century, culminating in the first large trial of early surgery for spontaneous supratentorial intracerebral haemorrhage STICH the results of which were neutral. This outcome seemed to occur because some groups of patients did worse with surgery (those with deep-seated bleeds or with intraventricular haemorrhage and hydrocephalus) and some better (patients with superficial lobar haematomas without intraventricular haemorrhage). The same effect was noted in a meta-analysis of other studies: a benefit with surgery that was not significant.

The STICH II results confirmed that early surgery does not increase the rate of death or disability at 6 months and might have a small but clinically relevant survival advantage for patients with spontaneous superficial intracerebral haemorrhage without intraventricular haemorrhage.

Vascular abnormalities (Cavernomas, AVMs, DAVFs and Cerebral Aneurysms)

All the vascular abnormalities can present with a stroke type picture depending on the mode of bleeding, the area of the brain affected as well as the premorbid history. With regards to arteriovenous malformations (AVMs) in particular, one group, which is likely to comprise most Grade I and II AVMs, generally benefit from treatment. Another group, including most SIV–V AVMs, probably are best left untreated given the available data. And certainly we will find that in a significant number of patients, probably including most of those with S-M Grade III AVMs, some of the most difficult Grade II AVMs, and the easiest Grade IV AVMs, we simply do not know from the data available whether intervention should be undertaken, and what form of intervention (if any) should be offered. Important also to note that AVMs account for 30-50% of haemorrhagic strokes in children. When compared to the adult population, children suffer AVM-related haemorrhages more frequently, with some paediatric series reporting haemorrhage rates of 80–85%, resulting in mortalities up to 25%. The natural history of untreated ruptured paediatric brain AVMs is grim, with recent studies reporting mortality rates of 42.1% in this group.

Management of vascular lesions of the brain and spinal cord forms a large part of the neurosurgical workload, but specific details are beyond the scope of this brief review.

Patients with Sickle Cell Anaemia and Moya-Moya

The chronic cerebrovascular disorder known as moyamoya disease (MMD) or moyamoya syndrome (MMS) leads to the development of characteristically tortuous and friable vascular collateral network in the region of the terminal portion of the internal carotid artery. These vascular networks are prone to rupture, resulting in haemorrhagic stroke.

MMS is usually associated with: Neurofibromatosis I, Cranial therapeutic irradiation, Down syndrome, Hemoglobinopathy (Sickle), Renal artery stenosis, Ischaemic angiopathy and benign intracranial hypertension.

As many as 43% of patients with Sickle cell disease and strokes will have "moyamoya-like" collaterals on imaging studies, and patients with these findings may have a 5-fold increased risk for recurrent stroke compared with patients without these collaterals.

At present, no reliable medical treatment exists for the primary disease process causing the moyamoya vasculopathy. Current therapies are aimed at preventing symptoms and negative disease sequelae by restoring and improving blood flow to affected cerebral hemispheres. Anti-platelet and anticoagulant agents have been used to reduce the risk of ischaemic stroke with optimal management of Sickle as the main focus. Given that moyamoya preferentially affects the ICA system, surgical treatment exploits the external carotid as a source to restore blood flow to the affected cerebrum, via either a direct or indirect approach. The procedure of choice is usually the indirect approach known as Encephalo-Dura-Arterial Synangiosis (EDAS).

Patients with carotid occlusive disease refractory to maximum medical treatment (?Aspirin resistant)

Bypass surgery falls into 2 distinct categories: flow augmentation and flow preservation. Flow augmentation aims to restore flow to hypoperfused brain territories in patients with steno-occlusive diseases. Flow preservation aims to replace the blood flow provided by a major intracranial vessel, the occlusion of which is necessary for treating an underlying disease, such as an aneurysm or a tumour.

The EC-IC bypass was a procedure developed in the 70s and was the first surgical procedure ever to be subjected to a randomised trial. This early trial and subsequent ones have failed to demonstrate a superiority of the surgical approach compared with best medical management. There remains a very small cohort of patients who may still benefit from blood flow augmentation.

Conclusion

- Stroke care is evolving and management has become acute and more invasive.
- Thrombectomy is revolutionising the management of acute stroke.
- Neurosurgical interventions have a further important role in a significant minority of properly selected patients.
- A multidisciplinary approach is imperative.