Anaesthetic management of stroke

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Endovascular thrombectomy (EVT) is a proven technique for treatment of anterior circulation large vessel occlusion acute ischaemic stroke that reduces patient morbidity and mortality[1]. It is a time critical procedure and thus patient management requires a clear multidisciplinary approach between the neurology, interventional radiology and anaesthesia teams. The main goals of anaesthetic management are to reduce time to recanalisation of blocked cerebral vessel and to offer physiologic protection of the ischaemic penumbra prior to recanalisation.

The involvement of anaesthesia team occurs from activation of the stroke team, when a patient is confirmed on computerised tomography (CT) angiography to have a lesion amenable to endovascular treatment. The patient may have received thrombolysis, especially if they were transferred from another hospital in the region.

Anaesthetic challenges for EVT
Patient evaluation is often by the time sensitive nature of EVT. Clinical records from patients domiciled out of the treating district health board (DHB) are often not available. There is limited ability to assess the patient for medical comorbidities, fitness for anaesthesia, fasting status and airway concerns. This is partly as a result of symptomology from the stroke itself; patients can present with aphasia, dysphasia, dysarthria or decreased Glasgow Coma Score (GCS). Collateral history from the stroke team should be sought if there was no direct handover. Best interest consent is often required from the treatment team. Post-operative disposition to higher level care should be considered/arranged if patient is significantly comorbid or if there were neurologic concerns about extubation e.g. low GCS pre-operatively or combative patient.

Familiarity of the location and environment of the neuro-interventional suite is also an important factor to consider. It is often located away from the main operating rooms and therefore arrival of anaesthetic assistance may be delayed. The positioning of radiology equipment such as portable X-ray "C-arm" limits access to the patient. The airway, circuit, monitoring and intravenous lines must be meticulously secured and bundled away from moving equipment. Radiation exposure for the anaesthetist is also a consideration.

Controversies in anaesthetic management
There are now multiple papers comparing general anaesthesia (GA) to conscious sedation (CS) for EVT. Potential benefits of GA include definitive airway protection, patient immobility, control of ventilation, and no risk of conversion to GA during the case. Benefits of CS include shorter arrival to groin puncture time, less haemodynamic effects and direct mental state monitoring. Although initial observational studies suggested that patients had better outcomes after CS, subsequent randomised controlled trials (RCT) demonstrated that patients who had GA for EVT had at least the same or better functional neurological outcomes[2, 3]. A meta-analysis published in 2021 of four RCTs demonstrated that patients who received GA in specialised neuroanaesthesia centres had superior recanalisation rates (GA 86.2% vs CS 74.6%; OR 2.14, 95% CI 1.26-3.62; *P*=0.005) and better functional outcome at 3 months (GA 49.3% vs CS 36.6%; OR 1.71, 95% CI 1.13-2.59, *P*=0.01), with no significant difference in intracerebral haemorrhage or death[4].

The key physiological parameter affecting patient outcome during EVT appears to be blood pressure (BP). Physiological studies have demonstrated impaired cerebral autoregulation during acute ischaemic stroke, resulting in pressure-dependent perfusion to ischaemic penumbra. Evidently, lower BP is likely to result in decreased cerebral blood flow to the penumbra, leading to increased size of cerebral infarction[5]. While the exact BP target during EVT is still under investigation, both hypotension (systolic BP < 140mmHg)[6] and hypertension (BP > 220/120mmHg or > 185/110mmHg after thrombolytic therapy)[7] appear to worsen patient outcome due to increased infarct size and the risk of haemorrhagic transformation respectively. In all four RCTs comparing GA vs CS, BP management was strictly controlled with target systolic BP of >140mmHg in both intervention groups[2]. Previously published observational studies did not report or control for BP and the results favouring CS may have been confounded by more hypotension in the GA group[2-4]. Research examining the potential therapeutic benefit of augmenting BP (systolic BP to 170 ± 10 mmHg) compared to standard care (systolic BP 140 ± 10mmHg) prior to recanalisation is currently underway with the multicentre MASTERStroke RCT (MAnagement of Systolic blood pressure during Thrombectomy by Endovascular Route for acute ischaemic STROKE)[8].

While both propofol and volatile anaesthetic agents reduce cerebral metabolic demand ($CMRO_2$), propofol is thought to maintain cerebral autoregulation thereby reducing cerebral blood flow (CBF), while the volatile agents increase CBF due to impaired cerebral autoregulation. There is controversy regarding which maintenance anaesthetic agent is superior for EVT and there are no large RCTs published in this domain. Local retrospective observational data from Auckland suggest that patients who had maintenance of anaesthesia with propofol had increased odds of functional independence at 3 months (odds ratio=2.65; 95% confidence interval, 1.14-6.22; P=0.03) and a nonsignificant trend towards reduced mortality (odds ratio=0.37; 95% CI, 0.12-1.10; P=0.07). This was despite the apparent low usage of propofol (59 patients, 19% in the cohort of 313 patients) compared with sevoflurane[9].

Maintaining normothermia and active treatment of hyperthermia (> 38°C) appears to confer better outcomes in patients undergoing endovascular thrombectomy, with studies thus far failing to show benefit of cooling stroke patients[6, 7, 10]. Published local data from Auckland analysing 458 patients between March 2011 to June 2019 found significant decrease in functional independence and increase in mortality with increasing body temperature both during and after EVT[10].

Currently there are few recommendations for intraoperative end-tidal/arterial CO_2 management during EVT. The 2019 American Heart Association/American Stroke Association guideline recommends moderate hyperventilation in cases of acute severe neurological decline due to increased intracranial pressure as a bridge to definitive therapy. There were no recommended targets for CO_2 during EVT[7]. A previous retrospective observational study published in 2014 by Takahashi et al. found that patients with low CO_2 appear to have worse outcomes after stroke intervention, and maintaining low normal CO_2 appears to cause least harm[11].

While hyperglycaemia is known to worsen brain ischaemia in experimental models, a review of 258 patients in Spain by Laredo et al. was not able to demonstrate an association between severe hypoperfusion on pre-procedure CT imaging and glucose levels. They did however demonstrate that elevated glucose pre-thrombectomy may be associated with an increased risk of parenchymal haematoma post EVT, which is a significant predictor of poor outcome[12]. On the other hand, treatment of hypoglycaemia is indicated to maintain blood glucose above 3.3mmol/L[7].

Post-operatively it is routine for the patients to be extubated for neurological assessment and admitted to the stroke ward for ongoing care. However, high dependency care or intensive care with ongoing ventilation may be required particularly if patient had pre-operative GCS < 8 or had been combative, or if the procedure was difficult and full recanalisation was not able to be achieved with ongoing concerns for haemodynamic and/or neurologic stability. Currently there have not been major trials studying post-procedural haemodynamic targets in patients who have achieved full, partial or failed recanalisation.

To summarise, during anaesthesia for EVT, there is good evidence to support the avoidance of hypotension (systolic BP < 140mmHg), and current evidence supports that patients having EVT under GA have at least equivalent if not better functional outcomes than patients having CS. However strong evidence for many key components of physiological management appears to be lacking. This includes the choice of anaesthetic maintenance agent, temperature, end-tidal/arterial CO_2 and blood glucose parameters. Further studies are required to provide definitive guidance.

Current Practice at Auckland DHB
In light of the evidence presented, the current guidelines for anaesthesia for EVT at Auckland DHB places emphasis on reducing the time to recanalisation with blood pressure management as key principles[13]. For this GA with endotracheal intubation is the preferred anaesthetic technique for most patients unless otherwise indicated (e.g. difficult airway, significant cardiorespiratory comorbidities precluding GA in a patient who is able to cooperate and follow instructions). Systolic BP targets are > 140mmHg and < 220mmHg, or < 180mmHg if the patient had been thrombolysed. Pre-induction invasive arterial BP monitoring is preferred given the need to avoid post-induction hypotension, and this may be inserted by the anaesthetist or by the interventional radiologist through awake placement of the femoral sheath. Choice of anaesthetic agents and drugs (opioid, muscle relaxant, vasopressors) is at the discretion of the attending anaesthetist and there are variations in practice. There are ongoing research and local quality improvement projects to improve patient outcomes after EVT at Auckland DHB.

References

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