Review: Is general anaesthetic preferable to conscious sedation in the treatment of acute ischaemic stroke with intra-arterial mechanical thrombectomy?

N. John (1), P. Mitchell (2), R. Dowling (2), B. Yan (3)

(1) Royal Melbourne Hospital, Grattan St, Parkville, Victoria 3050, Australia (First author)

(2) Department of Radiology, Royal Melbourne Hospital, Grattan St, Parkville, Victoria 3050, Australia

(3) Melbourne Brain Centre, Royal Melbourne Hospital, University of Melbourne, Parkville, Victoria 3050, Australia (Senior and Corresponding author)

Corresponding Author:
Professor Bernard Yan
Neurologist and Neurointerventionist
Melbourne Brain Centre
Royal Melbourne Hospital
University of Melbourne
Parkville
Victoria 3050
Australia
Bernard.yan@mh.org.au
B: +61 (3) 9349 2477
F: +61 (3) 9349 4489

Abstract

Introduction:
Intra-arterial mechanical thrombectomy (IAMT) is an endovascular technique that allows for the acute retrieval of intravascular thrombi and is increasingly being used for the treatment of acute ischaemic stroke (AIS). There are currently two anaesthetic options during IAMT: General anaesthesia (GA) and conscious sedation (CS). The decision to use GA versus CS is the source of controversy, as it requires careful balance between patient pain, movement, and airway protection whilst minimizing time delay and haemodynamic fluctuations. This review examines and summarises the evidence for the use of GA versus CS in the treatment of AIS by IAMT.

Methods:
Studies were identified using systematic bibliographic searches. The 5 applicable studies were analysed with reference to overall outcomes and the key parameters that govern the decision to use GA or CS. The key parameters included the impact of GA and CS on pain, complication rates, time delays, airway protection and haemodynamic stability.

Results:
Several retrospective analyses have shown that the use of GA is associated with adverse outcomes.

Conclusion:
Intra-arterial mechanical thrombectomy under general anaesthesia is associated with poor outcomes in observational studies. It is reasonable to offer conscious sedation as the preferred option where adverse patient factors such as agitation are lacking.

Keywords

stroke; general anesthetic; conscious sedation; endovascular therapy

1. Introduction

The management of acute ischaemic stroke (AIS) has evolved rapidly over the last decade with the use of intravenous tissue plasminogen activator (IV TPA) shown to improve both morbidity and mortality in patients eligible to receive this treatment [1-4]. There are however a significant proportion of patients in whom IV TPA is contraindicated and up to 50-70% of patients fail treatment with IV TPA due to recanalisation failure [1, 5-8]. Occlusion of proximal arteries such as the proximal internal carotid or middle cerebral arteries has been associated with decreased rates of recanalisation post IV thrombolysis [1, 5, 8-9].
Intra-arterial mechanical thrombectomy (IAMT) was developed to improve the rate of recanalisation by means of endovascular retrieval of larger thrombi. IAMT also provides an alternative revascularisation strategy when IV TPA is contraindicated [10-13]. Intra-arterial therapy and mechanical thrombectomy have been shown to increase recanalisation rates in AIS when used after IV TPA and when IV TPA is contraindicated [5, 9-15]. IAMT involves the manipulation of devices in the intracranial vasculature and the use of angiographic techniques such as road-mapping to extract occlusive clots in the parent artery [13, 16-18]. A cooperative and stationary patient is optimal in the prevention of intra-procedural and device related complications such as dissection, perforation and distal embolisation [16]. This is more likely to be achieved with the use of general anaesthesia (GA) rather than conscious sedation (CS), particularly as pain is more commonly experienced with the newer mechanical devices compared to IA thrombolysis alone.

There is controversy regarding the decision to use GA or CS during the endovascular treatment of AIS. The key issues that encourage debate relate to the relative time delay to re-canalisation, peri-procedural haemodynamic alterations and patient safety. This review will present the current literature for and against the use of GA versus CS as anaesthetic modalities in the endovascular treatment of AIS.

2. Methodology

Studies on conscious sedation versus general anaesthesia in the endovascular management of stroke were identified using systematic searches of two bibliographic databases: PubMed and MEDLINE. Studies that were published between 1980 to current were deemed eligible for inclusion. Trials that provided background information on the evolution of acute stroke therapy were identified using the PubMed and MEDLINE bibliographic databases and from seminal studies that have previously been published.

There were 5 studies that directly addressed the issue of GA versus CS in the endovascular treatment of AIS. These comprised 4 retrospective cohort studies/analyses and 1 observational study [19-23].

The review author assessed for relevance, the titles and where available, abstracts of all the trials retrieved by the aforementioned search strategy. All relevant articles were attempted to be retrieved in full and the review author extracted data from the relevant studies.

The study investigated GA and CS and its association with overall outcome in patients with AIS treated with IAMT. The use of CS and GA and their respective impact on patient pain, movement, airway protection and haemodynamic parameters was also analysed. These outcomes were represented in the key studies as odd ratios or hazard ratios reflecting their association with positive or adverse outcomes. In situations where statistical measures were not available or feasible, direct values and data were utilized.

3. General overview

3.1 The steps involved in initiating mechanical thrombectomy

The time process of organizing and undertaking IAMT in the treatment of AIS can be broadly divided into two parts occurring before and during sedation.

First part: Before sedation

Prior to commencement of the procedure, the patient must first be admitted to the emergency department and undergo immediate imaging (usually non contrast CT and CT Angiography or MRI if available) [17]. The patient must then be assessed and be deemed suitable for acute intervention with IV TPA. If the patient fails IV TPA or IV TPA is contraindicated then the merits of IAMT need to be considered [17]. Once the decision has been made to proceed to IAMT, the endovascular suite needs to be made available and the neuro-interventional team (neuro-interventionalist, technicians, anaesthetics) needs to be contacted.

Second part: During sedation

The procedure begins with the patient being placed under CS or GA, the choice of which depends on patient characteristics and the preferences of the neuro-interventionalist and anaesthetic staff involved [18-19]. Whilst specific protocols vary from institution to institution, thrombectomy is an invasive endovascular technique and includes the following steps:

The common femoral artery (CFA) is punctured and via the Seldinger technique, a 5 French (F) femoral sheath is introduced into the CFA. Cerebral digital subtraction angiography is then performed to confirm the site of occlusion. The existing 5F femoral sheath is then exchanged for a 6F or 8 F femoral sheath. The diagnostic catheter is exchanged for a guide catheter (6 F or 8 F) and this is placed in the parent artery e.g. distal internal carotid artery, distal vertebral artery. Under roadmap guidance, a microcatheter is placed in the artery distal to the thrombus and the mechanical thrombectomy device e.g. Solitaire FR Stentriever (ev3, Irvine, California), Merci Retrieval System (Concentric Medical) is deployed distal to the thrombus and retrieved. The mechanical thrombectomy device and microcatheter are then removed through the guide catheter and suction is applied during withdrawal. This process is repeated to ensure revascularisation (defined as TIMI grade $\geq$ 2) and to assess for complications including distal embolisation and blood vessel injury [24]. Adjunctive intra-arterial thrombolytics can also be used in situations where vessel tortuosity limits the withdrawal of a fully deployed stent [15-16].

3.2 Key factors affecting the choice of general anaesthesia and conscious sedation in the use of intra-arterial mechanical thrombectomy

The decision to use GA or CS as the anaesthetic modality of choice in the treatment of AIS by IAMT requires careful consideration of the following factors: pain, patient movement and complications, respective time delays, airway management and the alteration of hemodynamic parameters and its effect on the acute stroke patient.

3.2.1 Pain

The insertion of the endoluminal devices into the intracranial vasculature and the process of clot extraction causes patient discomfort in a significant number of cases [25].

General anaesthesia:

GA is induced and maintained by the action of anxiolytic, analgesic and neuromuscular blocking agents thereby preventing the sensation, memory and response to painful stimuli [26]. A potential advantage of GA in the endovascular treatment of AIS would be the prevention of intra-procedural pain thereby also reducing the risk of patient agitation and restlessness.

Conscious sedation:

The use of CS or local anaesthetic does not prevent the perception of pain particularly during angioplasty and dilatation of intravascular balloons in the intracranial vasculature [25]. However the use of local anaesthetic or mild CS has been used to monitor patient pain in awake patients undergoing intracranial stenting or angioplasty for symptomatic intracranial stenosis. The complaint of pain by the patient is then used to adjust aspects of the endovascular procedure e.g. decrease the degree of balloon dilatation, reposition wires to alleviate the headache and prevent vessel injury and to predict the presence of a complicating subarachnoid haemorrhage [25]. The use of CS and analgesia was examined in a 2006 study by Abou-Chebl and colleagues. They conducted a prospective non-randomised trial that examined the safety of local anaesthetic/CS during intra-cranial stenting and angioplasty in awake patients. This study aimed to show that the monitoring of pain during endovascular device manipulation could alter management alerting the physician to pending vessel damage or the possibility of a complicating subarachnoid haemorrhage [25]. Out of 44 awake patients, 27 (61.4%) patients developed severe headache during this procedure. This was most commonly due to balloon inflation with balloon deflation resulting in resolution of the headache in 19 of those patients. 17 patients (38.6%) also developed severe headache due to wire manipulation in the intracranial vasculature. Again the headache resolved with wire withdrawal or repositioning [25]. This study was undertaken in awake patients, demonstrating that pain is a common intra-procedural complication. It must be noted however that patients in this trial were well educated as to the possible occurrence of pain and pain itself was used to guide on-table treatment by deflating balloons or repositioning catheters to prevent vessel damage which otherwise would not have been noted until potential rupture [25]. A more recent trial by the same group was a multi-centre retrospective trial directly comparing GA with CS in patients with AIS undergoing endovascular therapy. Documentation of intra-procedural pain and its effect on the procedure was beyond the scope of this research article [19]. Most recently, Brekenfeld and Mattle provide anecdotal evidence of pain being caused during microcatheter advancement across the thrombus or during advancement of large aspiration catheters into the MCA resulting in patient head movement [20].

Whilst this initial study on awake intra-cranial endovascular stenosis by Abou-Chebl suggests some benefit to using pain (headache) as a tool to alter management, it is acknowledged that the correlation between headache severity and vessel perforation is not well documented [25]. With regards to IAMT in the treatment of acute stroke, it is very difficult to extrapolate the findings in this trial to support the use of CS to use headache as a harbinger of potential adverse outcomes. The majority of patients in this trial were elective acutely asymptomatic awake patients undergoing intra-cranial angioplasty or stenting who were well educated about the procedure and the complications (pain) involved. This is in direct contrast to the acute stroke patient who has significant acute neurological deficits, underlying cerebral irritation and is commonly dysphasic. These features would make it very difficult for the acute stroke patient to respond appropriately to intra-procedural questioning. Furthermore, if this line of direct communication between patient and physician is neither feasible nor accurate then the use of the local anaesthesia or CS as a method of monitoring pain to alter interventional technique at the expense of exposing the patient to pain and its potentially hazardous sequelae may not be justified.

Given the pain that is caused by the advancement and manipulation of endovascular devices during IAMT, the lack of analgesia afforded by CS could result in adverse patient experiences and furthermore lead to agitation and restlessness that could result in negative outcomes for the acute stroke patient undergoing IAMT.

The use of GA is favoured over CS in the use of IAMT in AIS from a pain perspective.

3.2.2 Patient movement and its potential complications

Mechanical thrombectomy relies on the use of radiography superimposed on fluoroscopy to provide a roadmap for the real-time movement of intra-arterial instruments [16]. The movement of the patient can disrupt this roadmap thus increasing the risk of complications such as dissection, perforation and subsequent haemorrhage and can reduce angiographic accuracy causing an increase in procedural time [16].

General anaesthesia:

The use of GA eliminates patient movement thereby providing the basis for accurate angiographic road-mapping which would allow for greater procedural accuracy, reduced time delay when compared to the moving patient and a potentially reduced risk of intra-procedural complications [20].

Conscious sedation:

The trial by Abou-Chebl et al on intra-cranial stenting in the awake patient included 3 patients who required conversion to GA with the reasons being severe deafness, severe anxiety and restlessness and patient movement in the setting of acute stroke [25]. The trial by Abou-Chebl in 2010 on GA versus CS did not examine patient movement and its impact on the procedure and adverse outcomes. The rate of conversion to GA from CS due to patient agitation or movement was also not examined in this study but the study cites the similar incidences of intra-cranial haemorrhage as evidence that patient movement is unlikely to have a negative impact [25]. Jumaa and colleagues published a study in 2010, which looked at 126 patients with M1 occlusion who underwent intra-arterial therapy and MT. The study design was a retrospective cohort study that compared outcomes in patients in the intubated state (IS) with those in the non-intubated state (NIS). In this study, 2 of the 73 initially non-intubated patients had to be converted to GA due to severe agitation and emesis/altered conscious state respectively [21]. The study did not examine whether there was a link between patient movement and the occurrence of the intra-procedural complications listed above [21]. The 2006 study on intracranial stenting in the awake patient does look for the presence of a link but the cohort of patients were stable awake patients with intra-cranial stenosis rather than patients with AIS undergoing IAMT. A point to note in this trial was that the 1 patient with acute stroke required conversion to GA due to agitation [25].

Whilst there is a paucity of literature directly examining the correlation between patient movement and its complications, the potential effect of movement on angiographic precision and the potential time delay and risk associated with intra-procedural conversion to GA raise concerns about the safety of CS during IAMT.

3.2.3 Complications and overall outcomes

There are a number of complications that can occur during IAMT. The most feared procedural complication is symptomatic intra-cerebral haemorrhage. The important device related procedural complications include vessel perforation, intramural arterial dissection, distal embolisation and issues with the groin access site [14-15]. The Multi-Merci trial looked at the safety issue of IAMT in their cohort of 111 patients and they documented a low device related complication rate with the rates of dissection, perforation, embolisation and groin complications being 3%, 3%, 1% and 0% respectively [27]. The symptomatic haemorrhage rate was 10% and this included 1 patient who had a device related perforation that went to develop a symptomatic haemorrhage [14]. The mode of anaesthesia was not recorded in the multi-MERCI study [27].

General anaesthesia:

The study by Abou-Chebl on CS versus GA in the treatment of AIS with IAMT only looked at symptomatic hemorrhages as a complication of patient undergoing IAMT. Out of 1079 patients, the rates of symptomatic haemorrhage for patients undergoing GA was 9.3% [19]. The incidence of device related complications was not examined as part of this study. In the study by Jumaa and colleagues on the use IAMT in the IS versus the NIS, the intra-procedural complication rate for patients undergoing GA was 15% (8/53 patients). Of the 8 patients suffering intra-procedural complications, 5 patients suffered cervical carotid dissections and 3 developed vascular perforations caused by microwire or microcatheter perforation [21].

Conscious sedation:

The above two trials also recorded the complication rate for patients undergoing CS or who were in the NIS. The procedural complication rate (symptomatic haemorrhage) for patients undergoing CS was 9.1% [19]. In the study by Jumaa and colleagues, the device related intra-procedural complication rate for patients in the NIS was 6% (5/73 patients). Of these 5 patients, 3 suffered cervical carotid dissections and 1 developed a microwire/microcatheter induced perforation [21]. This study did not examine the frequency of symptomatic haemorrhage.

In comparing the procedural and device related complication rate for patients, the incidence of symptomatic haemorrhage was similar for patients undergoing GA or CS [19]. The device related intra-procedural complications was looked at in more detail by Jumaa and colleagues and interestingly the frequency of these complications was higher amongst patients in the IS. However, this difference was not statistically significant and in terms of pure numbers they difference was extremely small [21]. Jumaa acknowledges that the increase in complication rate for patients in the IS was likely due to chance [21]. It is difficult to draw conclusions based on these results as the direct comparison of GA versus CS failed to examine the rate of device related complications and used the similar rates of symptomatic haemorrhage to infer that CS was at least as safe as GA. These results must also be interpreted in the setting of the Multi MERCI trial where the device related complication rate was extremely small [27].

Four studies have suggested that the use of GA or being in the IS was independently associated with poorer outcomes during the use of intra-arterial therapy or IAMT and that the use of CS is at least as safe as GA [19, 21, 22-23]. The first of these was a study by Nichols on the impact of sedation practices on the outcomes of patients enrolled in the IMS II trial. This study noted that the use of heavy sedation (encompassing sedative medications altering conscious state or pharmacological paralysis) was independently associated with increased mortality. Whilst most of this effect was thought to be due to increased stroke severity in those who underwent heavy sedation, the association was still significant after correction for baseline stroke severity (NIHSS scores). This study did not delineate CS and GA and rather the definition of heavy sedation included both a spectrum of CS and GA. Whilst not delivering clear answers regarding the most suitable anaesthetic modality for IAMT, this study generated interest in determining the effect of sedation on outcomes following IAMT [23]. The study by Abou-Chebl comparing GA with CS in IAMT showed that GA was an independent predictor of poor outcome (OR 2.46) after correction for baseline stroke severity (NIHSS scores) and other variables [19]. This group hypothesized that this finding was due to a haemodynamic alterations at GA induction, CS allowing assessment of clinical improvement rather than relying on angiographic recanalisation and that movement was unlikely to be factor citing the similar rates of symptomatic haemorrhages in both groups. The study does acknowledge that none of these hypotheses were analysed and that the retrospective design and inability to control for variables were major study limitations [19]. Jumaa and colleagues found that being in the NIS was associated with reduced mortality. Whilst this association was confounded by baseline stroke severity, the association remained significant after correction for this variable [21]. Like Abou-Chebl, Jumaa and colleagues hypothesized that these findings could be explained by GA associated haemodynamic alterations and time delays [21]. Davis, Menon and colleagues completed the most recent of these studies when they retrospectively analysed anaesthetic modalities and their associated outcomes in patients undergoing IAMT. They found that patients undergoing GA had a worse clinical outcome at 3 months and hypothesized that lower peri-procedural blood pressure was a significant contributing factor [22].

The overall complication rate for IAMT is low but further study is needed before one anaesthetic modality can be recommended over the other. The impact of specific agents used in conscious sedation is unknown. GA has been shown to be an independent predictor of mortality and the reasons for this need elucidation.

3.2.4 Time points in initiation of IAMT

Time to recanalisation has been repeatedly shown to be a critical factor in determining outcome following revascularisation therapy [1-3, 5, 28].
From the time a patient arrives in the emergency department, there are a number of clearly defined time delays that impact on patient flow. These include the appropriate triaging of potential stroke patients, rapid assessment of clinical status and neurological deficit by emergency department staff and expedient cerebral imaging [17]. One of the concerns with IAMT is the time delay associated with organising endovascular intervention [18]. The significant time points in organising IAMT include the ability to rapidly organize staff and access to the endovascular suite. The administration of GA or CS represents another significant time delay.

General anaesthesia:

The perceived time delay involved in the induction of GA is of concern to neuro-interventional doctors [18]. This time delay is felt to be impacted upon by the availability of anaesthetic staff [18]. Brekenfeld and colleagues outlined their experience of patients undergoing IAMT for AIS and documented the median time from cerebral imaging to first angiographic run to be 65 minutes (interquartile range 55-85 minutes) [20]. In the study by Abou-Chebl on GA versus CS in IAMT, the average time from symptom onset to treatment or recanalisation was 306 $\pm$ 133 minutes [19]. In the study by Jumaa looking at IS versus NIS receiving IAMT, the average baseline time from symptom onset to IAMT (time points not specifically defined) was 418 minutes [21].

Conscious sedation:

CS is thought to minimize initial delays in commencing IAMT as it can be administered by nursing staff [18, 25]. This perceived reduction in time delay must be balanced with the time delay that occurs if the patient requires conversion to GA [21, 25]. In the trial by Abou-Chebl on CS versus GA, the time from symptom onset to treatment by IAMT in patients having CS was 296$\pm$172 minutes [19]. Jumaa and colleagues found the time from symptoms onset to IAMT to be 654 minutes for patients in the NIS [21]. Brekenfeld and colleagues noted the median time from cerebral imaging to the first angiographic run to be 50 minutes (interquartile range 45-55 minutes) [20].

In the study conducted by McDonagh and colleagues on the practices of 46 neuro-interventionalists, the main reason for not using GA on all patients undergoing IAMT for AIS was the perceived time delay [18]. This was not however borne out in the results of the 2 studies comparing patients in the GA/IS versus CS/NIS. In the study by Jumaa looking at IS versus NIS receiving IAMT, the average baseline time from symptom onset to IAMT was significantly longer for patients under CS when compared to patients in the IS and this result was statistically significant [21]. Abou-Chebl and colleagues found that the timings for patients undergoing GA and CS were almost identical [19]. The perception is that the time delays associated with GA are longer than those associated with CS but the results from the 2 studies that identified and measured significant time points suggests otherwise [18]. Brekenfeld measured the specific time point from cerebral imaging to the first angiographic run and found the median difference to be only 15 minutes [20]. Outside of the anecdotal evidence provided by Brekenfeld et al, the measured time points in the above studies are very general and the true impact of time delays from GS and CS can only be better assessed by looking at specific time points e.g. time from decision to undertake IAMT to arterial puncture in future studies.

There is mixed evidence regarding the oft-held notion that CS is preferable to GA from a time perspective. Anecdotal studies suggest a small increase in time delay with the use of GA but larger studies are inconclusive as specific time points are not specified or analysed.

3.2.5 Airway protection

General anaesthesia:

GA is a loss of consciousness induced by anaesthetic agents and patients under GA are not arousable even when stimulated by pain. Ventilatory function is often impaired during this period and assistance is required to protect the airway and prevent pulmonary aspiration [26]. All patients undergoing GA need definitive airway management most commonly achieved via endotracheal intubation or by the use of a laryngeal mask airway [16]. GA and its associated airway management protocols ensure airway protection and obviate the need for emergency conversion to GA. In acute stroke patients undergoing

IAMT this prevents pulmonary aspiration and prevents the associated time delays and peri-procedural risk of emergency conversion to GA.

Conscious sedation:

CS is a state of depressed consciousness that can be induced by a variety of anaesthetic agents. Patients under CS are able to respond purposely to verbal commands and/or tactile stimulation. Interventions to maintain airway patency and adequate ventilation are generally not required however there is the potential for upper airway obstruction [26]. There are a variety of sedation regimens available and CS can be achieved using 1 or more agents: Ketamine, Propofol, Fentanyl, Midazolam and Dexmedetomidine [21, 30]. Dexmedetomidine is a more recently approved agent that enables sedation whilst minimizing the risk of respiratory depression and haemodynamic complications. The impact of dexmedetomidine on outcomes after IAMT for AIS needs ongoing research [16, 29-30]. There are 3 major concerns with the use of CS and airway protection in the acute stroke patient:
Patients are unlikely to be have been adequately fasted which places them at high risk of pulmonary aspiration and most patients with large cerebral artery occlusion have a degree of dysphagia and may be unable to protect their airway after stroke [31-32]. The urgent need for conversion to GA increases the risk of patient injury from endovascular devices, hypoxia and aspiration and would increase the time to recanalisation [16, 18, 33].

There is a paucity of information in the literature on the rates of conversion to GA from CS in patients undergoing IAMT for the treatment of AIS.. The retrospective multicentre trial by Abou-Chebl did not examine the conversion rates and outcomes of patient who required emergent conversion from CS to GA for airway compromise [19]. The prospective cohort study by Jumaa et al identified 2 patients out of 73 that required acute conversion to GA but their outcomes were not documented and this parameter was not analyzed statistically. Jumaa did note that being intubated was associated with a statistically significant longer stay in intensive care units and a trend towards increased rates of tracheostomy [21].

The lack of airway protection in the acute stroke patient afforded by CS coupled with the potentially negative sequelae of emergency intubation makes the use of GA a safer option from a patient perspective in the treatment of AIS by IAMT.

3.2.6 Alteration of haemodynamic parameters

General anaesthesia:

The ischaemic penumbra has been shown to be sensitive to variations in blood pressure [34]. Wide fluctuations in blood pressure during the first 3 hours of stroke is associated with an increased risk of death at 90 days [35]. The induction of GA can cause significant alterations in haemodynamic parameters and cerebral perfusion pressures. Studies have shown that immediate post-induction hypotension is predicted by the use of propofol, increasing induction dosages of fentanyl, patients aged greater than 50 and baseline hypotension defined as a systolic blood pressure (SBP) < 70 [36].
A number of anaesthetic agents have been found to have a varying effect on cerebral blood flow by altering cerebral metabolism, increasing intra-cranial pressure (ICP) and decreasing mean arterial pressure (MAP) either alone or in combination with each other [16,19]. Several anaesthetic gases are thought to exhibit the reverse ‘Robin Hood’ Syndrome where abnormal cerebral vasodilation results in blood flow being ‘stolen’ from areas of need and being diverted to areas of ‘less need’ [37]. Laryngoscopy can cause a rapid increase in blood pressure which can increase ICP thereby reducing cerebral blood flow but fentanyl has been shown to decrease this exaggerated hemodynamic response [38]. Whilst the properties of these anaesthetic agents is relatively well studied, the specific effect of this alteration on cerebral blood flow in the setting of IAMT for AIS is unknown and has not been analysed in the literature [19]. Jumaa et al and Abou-Chebl et al both postulate that the negative clinical outcomes associated with the use of GA could be due to hypotension encountered during GA induction but both groups acknowledge that these parameters were not assessed in their respective studies [19, 21]. Menon and Davis recently conducted a retrospective analysis of the peri-procedural anaesthetic factors that impact on clinical outcomes in AIS patients undergoing IAMT. They suggested there was a poorer outcome in patients undergoing GA because of lower peri-procedural blood pressures [22]. There is certainly a clear risk of hypotension and abnormal cerebral auto-regulation on GA induction. This could result in the rapid loss of ischaemic penumbra with subsequent negative outcomes but this link requires further elucidation.

Conscious sedation:
The goal of CS is to alleviate patient discomfort, ensuring the patient remains stationary whilst avoiding the risks associated with GA [30]. There is the additional benefit of still being able to reduce patient sedation to assess neurological status [39]. Common regimens for CS have minimal effect on haemodynamics but there must be close monitoring of airway patency and respiratory depression especially if opioids are being used [30]. The study by Menon et al found that lower blood pressures were associated with worse outcomes in patients undergoing CS or GA and the mean SBP in patients undergoing CS was 135 mmHg compared with 104 mm Hg in patients with GA [22].

Given the known effect of general anaesthetic agents on blood pressure and the association of early fluctuations and lower peri-procedural blood pressures with negative clinical outcomes, CS is preferable to GA.

4. Conclusion:

Although data from randomized controlled trials are lacking, observational studies have shown poorer outcomes in patients treated by intra-arterial mechanical thrombectomy under general anaesthesia. We believe that it is reasonable to offer conscious sedation in a significant proportion of cases whereby patient factors such as agitation are lacking.

Conflict of Interest:

We declare that we have no conflict of interest

References:

1. NINDS rt-PA Stroke Study Group (1995) Tissue plasminogen activator for acute ischemic stroke. N Engl J Med 333:1581–87
2. Hacke W, Kaste M, Fieschi C et al (1995) Intravenous thrombolysis with recombinant tissue plasminogen activator for acute hemispheric stroke: The European Cooperative Acute Stroke Study (ECASS). J American Med Assoc 274:1017–25
3. Hacke W, Kaste M, Fieschi C et al (1998) Randomised double-blind placebo-controlled trial of thrombolytic therapy with intravenous alteplase in acute ischaemic stroke (ECASS II): Second European-Australasian Acute Stroke Study Investigators. Lancet 352:1245–511
4. Hacke W, Kaste M, Bluhmki E et al (2008) Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. N Engl J Med 359:1317–29
5. Mazighi M, Serfaty JM, Labreuche J et al (2009). Comparison of intravenous alteplase with a combined intravenous-endovascular approach in patients with stroke and confirmed arterial occlusion (RECANALISE study): a prospective cohort study. Lancet Neurol 8:802–09
6. Molina CA, Alexandrov AV, Demchuk AM, Saqqur M, Uchino K, Alvarez-Sabin J (2004) Improving the predictive accuracy of recanalization on stroke outcome in patients treated with tissue plasminogen activator. Stroke 35:151–56
7. Saqqur M, Uchino K, Demchuk AM et al (2007) Site of arterial occlusion identified by transcranial Doppler predicts the response to intravenous thrombolysis for stroke. Stroke 38:948–54
8. Del Zoppo GJ, Poeck K, Pessin MS, et al (1992). Recombinant tissue plasminogen activator in acute thrombotic and embolic stroke. Ann Neurol 32:78-86
9. IMS Study Investigators (2004). Combined intravenous and intra-arterial recanalization for acute ischemic stroke: the Interventional Management of Stroke Study. Stroke 35:904-11
10. Lewandowski CA, Frankel M, Tomsick TA et al (1999). Combined intravenous and intra-arterial r-TPA versus intra-arterial therapy of acute ischemic stroke: Emergency Management of Stroke (EMS) Bridging Trial. Stroke 30:2598-2605
11. Del Zoppo GJ, Higashida RT, Furlan AJ, Pessin MS, Rowley HA, Gent M (1998) PROACT: a phase II randomized trial of recombinant pro-urokinase by direct arterial delivery in acute middle cerebral artery stroke – PROACT Investigators. Prolyse in Acute Cerebral Thromboembolism. Stroke 29:4-11

12. Furlan A, Higashida R, Wechsler L et al (1999) Intra-arterial prourokinase for acute ischemic stroke: The PROACT II study – a randomized controlled trial. Prolyse in Acute Cerebral Thromboembolism. J American Med Assoc 282:2003-11
13. Gobin YP, Starkman S, Duckwiler GP et al (2004) Merci 1: a phase 1 study of mechanical embolus removal in cerebral ischemia. Stroke 35:2848-54
14. Smith W, Sung G, Saver J et al (2008) Mechanical thrombectomy for acute ischemic stroke: final results of the Multi Merci trial. Stroke 39:1205-12
15. Miteff F, Faulder KC, Goh AC, Steinfort BS, Sue C, Harrington TJ (2011) Mechanical Thrombectomy with a Self-Expanding Retrievable Intracranial Stent (Solitaire AB): Experience in 26 Patients with Acute Cerebral Artery Occlusion. Am J Neuroradiol 32:1078-81
16. Varma, MK, Price K, Jayakrishnan V, Manickam B, Kessell G (2007) Anaesthetic considerations for interventional neuroradiology. Br J of Anaesth 99(1):75-85
17. Adams H, Zoppo GD, Alberts M et al (2007) Guidelines for the Early Management of Adults With Ischemic Stroke. Stroke 38:1655-1711
18. McDonagh Dm Olson D, Kalia J, Gupta R, Abou-Chebl A, Zaidat OO (2010) Anaesthesia and sedation practices among neurointerventionalists during acute ischaemic stroke endovascular therapy. Front Neurol 1:118
19. Abou-Chebl A, Lin R, Hussain MS et al (2010) Conscious Sedation Versus General Anesthesia During Endovascular Therapy for Acute Anterior Circulation Stroke : Preliminary Results From a retrospective multicenter Study. Stroke 41:1175-1179
20. Brekenheld C, Mattle H, Schroth G (2010) General Is Better Than Local Anesthesia During Endovascular Procedures. Stroke 41:2716-2717
21. Jumaa M, Zhang F, Ruiz-Ares G, Gelzinis T et al (2010) Comparison of safety and clinical and radiographic outcomes in endovascular acute stroke therapy for proximal middle cerebral artery occlusion with intubation and general anesthesia versus the non-intubated state. Stroke 41:1180–1184
22. Davis MJ, Menon BK, Baghirzada LB, Campos-Herrera CR, Goyal M, Hill M, Archer D (2012) Anesthetic management and outcome in patients during endovascular therapy for acute stroke. Anesthesiology 116:396-405
23. Nichols C, Carrozzella J, Yeatts S, Tomsick T, Broderick J, Khatri P (2010) Is peri-procedural sedation during acute stroke therapy associated with poorer functional outcomes? J Neurointerv Surg. 2(1):67–70. doi:10.1136/jnis.2009.001768
24. TIMI Study Group (1985) The Thrombolysis in Myocardial Infarction (TIMI) trial: Phase I findings. N Engl J Med 312:932–36
25. Abou-Chebl A, Krieger DW, Bajzer CT, Yadav JS (2006) Intracranial angioplasty and stenting in the awake patient. J Neuroimaging 16:216–223
26. American society of anesthesiologists (2009) Guidelines on Continuum of depth of sedation: definition of general anesthesia and levels of sedation/analgesia. http://www.asahq.org/For-Members/Standards-Guidelines-and-Statements.aspx. Accessed March 28 2012
27. Smith WS, Sung G, Starkmann S et al (2005) Safety and efficacy of mechanical embolectomy in acute ischemic stroke: results of the MERCI trial. Stroke 36:1432–38
28. Khatri P, Abruzzo T, Yeatts SD, Nichols C, Broderick JP, Tomsick TA (2009) Good clinical outcome after ischemic stroke with successful revascularization is time-dependent. Neurology 73(13):1066-72
29. Klinger RY, White WD, Hale B, Habib AS, Bennett-Guerrero E (2012) Hemodynamic impact of dexmedetomidine administration in 15,656 non-cardiac surgical cases. J Clin Anesth. 24(3):212-20
30. Young WL (2007) Anesthesia for Endovascular Neurosurgery and Interventional Neuroradiology. Anesthesiology Clin 25:391–412
31. Practice Guidelines for preoperative fasting and the use of pharmacological agents to reduce the risk of pulmonary aspiration: Application to healthy patients undergoing elective procedures: a report by the American Society of Anesthesiologist Task Force on Preoperative Fasting (1999) Anesthesiology 90(3):896-905
32. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R (2005) Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke 36:2756–2763
33. Rosenberg M, Weaver J (1991) General anesthesia. Anesth Prog. 38:172–186
34. Ginsberg MD, Pulsinelli WA (1994) The ischemic penumbra, injury thresholds, and the therapeutic window for acute stroke. Ann Neurol 36:557–65

35. Stead LG, Gilmore RM, Vedula KC, Weaver AL, Decker WW, Brown RD Jr (2006) Impact of acute blood pressure variability on ischaemic stroke outcome. Neurology 66(12):1878-1881
36. Reich DL, Hossain S, Krol M, Baez B, Patel P, Bernstein A, Bodian CA (2005) Predictors of hypotension after induction of General anaesthesia. Anesth Analg. 101(3):622-8
37. Alexandrov AV, Sharma VK, Lao AY, Tsivgoulis G, Malkoff MD, Alexandrov AW (2007) Reversed Robin Hood syndrome in acute ischemic stroke patients. Stroke 38:3045–3048
38. Ahmed A (2007) Anaesthesia For Interventional Neuroradiology. J Ayub Med Coll Abbottabad 19(3):80-4
39. Manninen PH, Chan AS, Papworth D (1997) Conscious sedation for interventional neuroradiology: a comparison of midazolam and propofol infusion. Can J Anaesth 44(1):26-30