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EDITORIAL

WELCOME to our 2nd issue of the inaugural volume of Journal of Cardiovascular, Neurovascular, and Stroke (CVNS). With thousands of journals available worldwide, why do we need another one? In this competitive era of publications driven by advancements in research, particularly in the medical field, scientists and clinicians continually strive to publish their research findings. Authors, and particularly those from South East Asian countries, may find it difficult to publish their papers in the more established European or American journals. Thus, we felt that there was a need to provide such a platform for these authors to showcase and share their research. Furthermore, many of the established journals are no longer accepting case reports, yet there is always something to be learned from anecdotal case studies. This journal provides a venue for case reports to be published.

We cannot ignore the COVID-19 pandemic that is currently raging throughout the world. It may affect our readers differently. Some of you may be confined to your homes and some may still be able to continue with daily life, albeit with limitations. In terms of research and publications, some may find that their research activities are limited or even completely halted. However, others may choose to use this period of relative inactivity to catch up on their writing, reviews, and publications or merely catch up on the latest findings in medical sciences. Research grants, particularly related to COVID-19, are still being offered and new papers are still being published. The editorial committee members of this journal remain committed to reviewing and publishing submissions in a timely manner. We welcome all submissions related to Cardiovascular, Neurovascular and Stroke and will do our best to expeditiously process them through our peer review system .

Our hope is that everyone will stay safe during this trying period. Take care.

Thank you.
Dr Hilwati Hashim
CVNS Editor in Chief

Editor

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revascularization device

CRANIAL POLYNEUROPATHY CAUSED BY VERTEBROBASILAR DOLICHOECTASIA

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ABSTRACT
Vertebrobasilar Dolichoectasia (VBD) is a condition characterized by abnormal elongation, dilatation and tortuosity of the vertebrobasilar system. It is usually asymptomatic but rarely, it can present with cranial nerve compression symptoms. We present a case of simultaneous trigeminal neuralgia and hypoglossal nerve palsy due to compression by VBD. Neuroimaging plays an important role in diagnosing this condition so that further treatment can be provided.

Keywords: Vertebrobasilar Dolichoectasia, VBD, trigeminal neuralgia, hypoglossal nerve palsy, cranial polyneuropathy.

1. INTRODUCTION

Neurovascular compression is one of the most important cause to be considered in patient presented with cranial neuropathy. Direct compression of cranial nerves by vertebral or basilar arteries is extremely rare and can be seen in patient with vertebrobasilar dolichoectasia (VBD). We report a rare case of vertebrobasilar dolichoectasia which causes multiple cranial nerves compression and polyneuropathy.

2. CASE PRESENTATION

A 50-year-old man with underlying hypertension, diabetes mellitus and dyslipidemia presented to our hospital with a 3-month history of right sided jaw pain which has worsened in the past 2 days. The pain was localized to the right lower facial region with a pain score of 10/10. The pain was sharp in nature and triggered by touching or mouth opening. He had previously visited a dental clinic suspecting that he had dental caries and had his right lower 2nd molar extracted. Despite the tooth extraction, the pain didn't subside. He was subsequently started on Carbamazepine 200mg TDS and Gabapentin 300mg ON which managed to control his pain since then.

On cranial nerves examination, there was no sensory abnormality at the trigeminal area, no facial weakness and cranial reflex was present. There was atrophy at the right side of the tongue with deviation to the right, signifying right hypoglossal nerve palsy. The rest of the cranial nerves and neurological examinations were normal. MRI brain was performed which showed dilated, elongated and tortuous vertebrobasilar arteries in keeping with dolichoectasia. The abnormal vertebrobasilar arteries caused compression and distortion onto multiple right-sided cranial nerves, which included trigeminal, facial, vestibulocochlear and hypoglossal nerves [***Figure 1*** and ***2***]. CTA Cerebral Artery was also performed and further confirmed the diagnosis of vertebrobasilar dolichoectasia [***Figure 3***].

The patient was subsequently planned for microvascular decompression (MVD) surgery by the neurosurgical team.

3. DISCUSSION

Vertebrobasilar Dolichoectasia (VBD) is an abnormal dilatation, elongation and tortuosity of the vertebrobasilar arteries. Dolichoectasia can occur at any of the intracranial arteries, but it is more commonly found in the vertebrobasilar arteries[1]. The diagnosis of VBD can be made if the diameter of the basilar artery measures greater than 4.5mm with evidence of elongation of the basilar artery i.e. basilar artery lies lateral to the clivus/dorsum sellae or it bifurcates above the plane of suprasellar cistern.[2]

The exact etiology for dolichoectasia is still unknown but it is postulated that severe atherosclerosis and hypertensive are likely to be responsible. However, some authors believe that congenital anomalies may also be a cause as dolichoectasia is also seen in young healthy patients and histological examination of the diseased vessels reveal defect in the internal elastic lamina and smooth muscle atrophy.[3]

Cranial nerves compression with neuropathy is one of the clinical presentations of VBD as shown in our case. Trigeminal and facial nerves are two of the most common cranial nerves to be involved.[4] Most patients with VBD are asymptomatic, likely because cranial nerves compression in VBD is a gradual progressive process as such that the brainstem can functionally tolerate severe distortion without producing overt clinical symptoms.[5] This is demonstrated in our case as multiple cranial nerves are compressed and distorted, but he presented only with trigeminal neuralgia and hypoglossal nerve palsy.

The diagnosis of VBD can only be made with cross sectional imaging such as CT and MRI. With a patient presenting with cranial polyneuropathy, MRI with Constructive Imaging In Steady State (CISS) sequence is essential to identify any evidence of neurovascular compression. CISS sequence produce high resolution images using heavily T2 weighted three-dimensional gradient echo technique which provides good contrast between cerebrospinal fluid and cranial nerves. MR angiography or CT angiography will be needed to confirm the diagnosis of VBD.

In patient presented with trigeminal neuralgia (TN) from neurovascular compression, medical therapy with anticonvulsant is usually the first line treatment. Systematic review has shown that carbamazepine is the most effective drug for TN and should be used for initial management. Second line medication would include oxcarbazepine, gabapentin, sodium valproate, phenytoin and lamtrigine.[6,7] With progression of symptoms or evidence of other cranial nerves involvement, surgical decompressive surgery i.e. microvascular decompression (MVD) or radiosurgery should be considered.

4. CONCLUSION

VBD is an unusual cause for trigeminal neuralgia and other cranial neuropathy. It is important for clinician to be aware of this entity. If a patient present with unusual combination of cranial nerves palsies, VBD should be considered as one of the differential diagnosis and further evaluation with MRI can be performed.

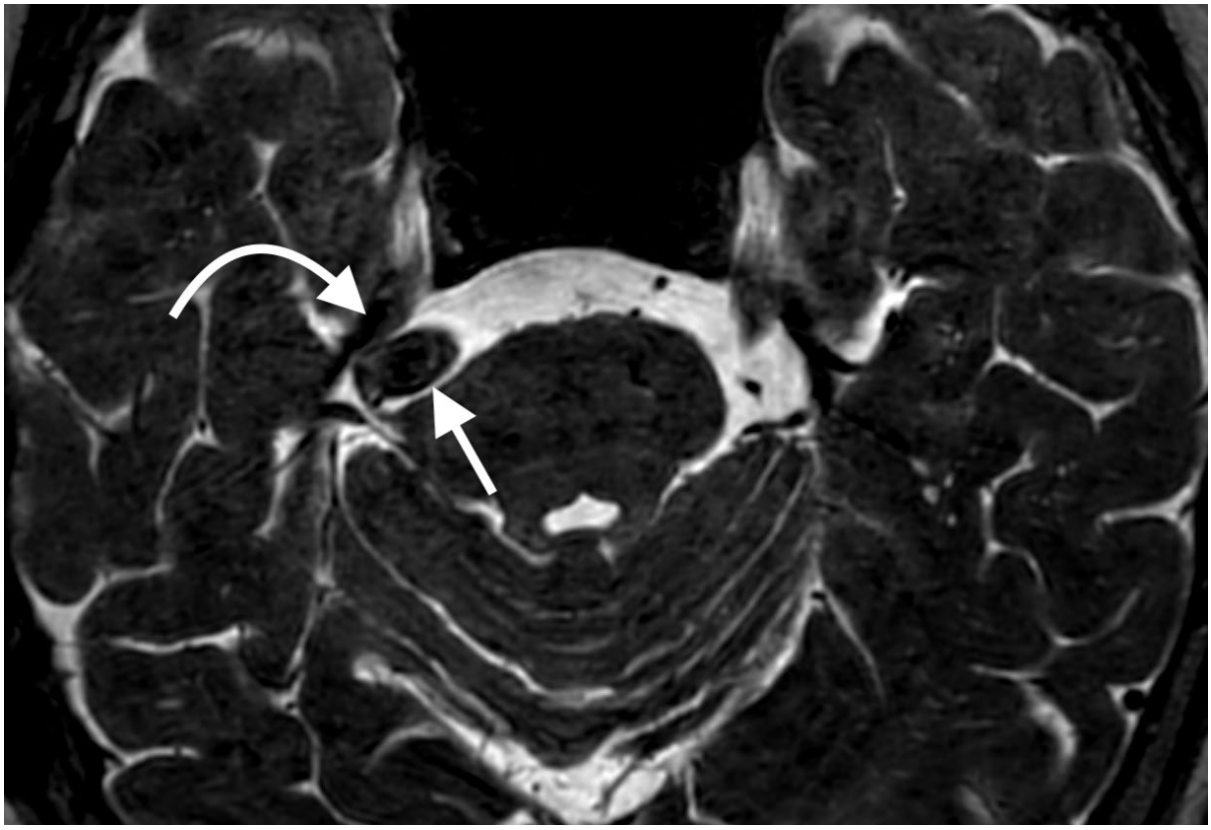

Figure 1: Axial CISS 3D sequence at the level of pons. The basilar artery is dilated and tortuous (straight arrow). It is located lateral to the clivus and compresses onto the right trigeminal nerve (curved arrow). Note the normal left trigeminal nerve.

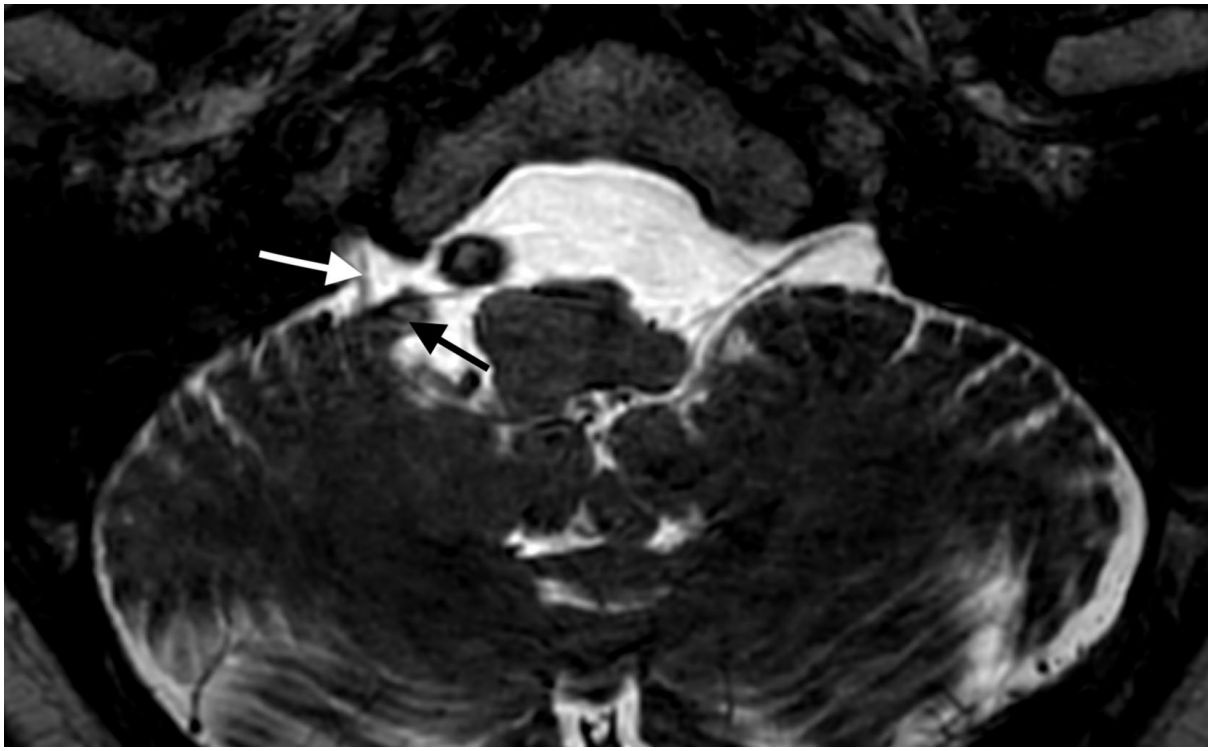

Figure 2: Axial CISS 3D sequence at the level of medulla. The dilated right vertebral artery (black arrow) compresses onto the right hypoglossal nerve (white arrow). Note the normal left hypoglossal nerve.

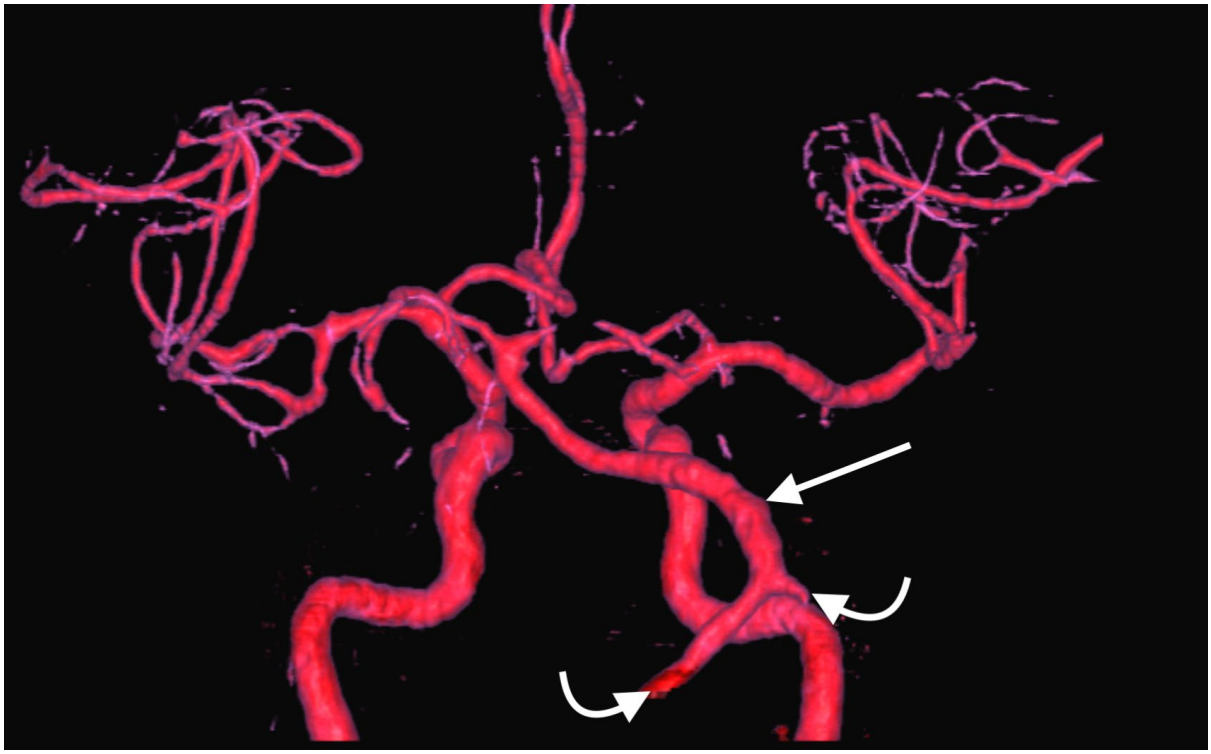

Figure 3: Volume Rendering image of the CTA shows vertebrobasilar artery dolichoectasia. Note the dilated and tortuous vertebral arteries (curved arrows) and basilar artery (straight arrow). There are irregularities along the basilar artery likely due to atherosclerotic changes.

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PRE-OPERATIVE SPINE EMBOLISATION FOR SPINAL TUMORS AND METASTASES: 6 YEARS EXPERIENCE AT PUSAT PERUBATAN UNIVERSITI KEBANGSAAN MALAYSIA

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ABSTRACT

Objective: Our aim is to determine the average intraoperative blood loss in patients who underwent pre-operative spinal tumour embolisation in PPUKM from 2010 until 2016 and to compare with other centres from literature review.

Material And Methodology: 15 patients in PPUKM with spinal tumour and spinal metastatic disease underwent pre-operative embolisation before palliative spinal surgery between 2010 and 2016 in PPUKM. Intraoperative blood loss during palliative spinal surgery was documented obtaining the average and median blood loss. Secondary analyses were made on the amount of intraoperative blood loss in comparison to the embolisation materials, degree of embolisation completion, primary malignancy, level of spinal metastatic involvement and total operating time.

Result: The average and median intraoperative blood loss during palliative spinal surgery were 1480mls and 1000mls respectively, which is comparable with other centre from literature review. Significant difference is noted in intraoperative blood loss between the different embolisation materials used ($P<0.01$). 10 patients had complete embolisation and 4 patients had incomplete embolisation with significant difference in terms of blood loss between these 2 groups with P value of <0.01. There was significant positive correlation between operating time and intra-operative blood loss, whereby the longer the operation, the higher the amount of blood loss.

Conclusion: The average intraoperative blood loss in patients with pre-operative spinal tumour embolisation in PPUKM is comparable to other centres from literature review thus pre-operative tumour embolisation can reduce perioperative haemorrhage. However, larger study is needed to further analyse correlation between these factors in affecting intraoperative blood loss.

Keywords: Pre-embolisation, intraoperative blood loss, spinal tumour, palliative spinal surgery

1. INTRODUCTION

Spinal tumour consists of primary and secondary (metastasis). Primary bone tumour accounts about 0.5% of all newly diagnosed tumour, and 5% out of these tumours arises from the spine. Nonetheless, the most common spinal tumour is metastasis as two-third of cancer patients will develop bone metastasis[1]. Bone is the most common site for metastasis followed by lung and liver[2] with spine being the most common site for bone metastasis[3]. Body of vertebra is the first to be involved, but destruction of pedicle is the most common finding in plain film. Thoracic and lumbar spines are the common area to be involved[4,5,6]. D. Togawa and K. U. Lewandrowsky (2006) suggested that the cervical spine is the least to be involved.

They also found out that more than 50% involved multilevel, 10% to 38% have multiple, non-contiguous segments involved[7]. Spinal metastasis may cause pain, instability, and neurological injuries with loss of control of urinary and rectal sphincters. Symptomatic spinal cord involvement occurs in about 18000 cases per year.[8]

In terms of prognosis, once the cancer has spread, rarely it can be cured. Even if cure is no longer possible, palliative treatment of the spinal cancer may be able to help patient to live longer and improve quality of life. Among the main treatment goals of surgical intervention in spinal metastasis are; to provide spinal stability, to relieve symptomatic pain and to obtain histological specimen for diagnosis. [9,10,11] Currently, some orthopaedic surgeons even advocate vertebral body resection and stabilisation as preventive measure for imminent spinal instability and/or supplementation for radiation therapy.[12]

Previous palliative surgery for spinal tumours was laminectomy however the result of solely laminectomy alone was unfavourable[13,14]. Thus, most cases are currently treated by direct decompression and stabilisation with instrumentation. These changes in approach have improved the surgical outcome. Unfortunately, the main documented drawback of these procedures is excessive and sometime life-threatening bleeding.[15,16]

Spinal tumour embolisation has been proven to be a safe procedure and able to reduce intraoperative blood loss and reduce operating time[17]. However, there are several studies showing no significant difference between pre-operative embolisation with non-pre-embolisation cases. Berkefeld J, et al 1999 suggested that pre-operative embolisation does improve surgical outcome but this depends on the type of primary tumour16. Clausen C et al 2015 suggested that preoperative embolisation of spinal metastasis, independent of primary tumour, does not reduce intraoperative blood loss or blood transfusion, but able to reduce the operative time. Small reduction in blood loss has been demonstrated in the management of hypervascular spinal metastasis[18]. This study is intended to see the effect of pre-operative embolisation in spinal metastatic surgery, particularly in the local setting, as our institution has started this service since 2010.

2. MATERIAL AND METHODS

Subject and Procedures: This retrospective study was performed in the department of radiology, Pusat Perubatan Universiti Kebangsaan Malaysia (PPUKM). Data was retrieved from RIS (Hospital Radiology information system) as well as from patient database file from department of record. Data were taken from January 2010 until December 2016.

Cases for pre-operative spinal embolisation tumour were filtered from the database of interventional unit of PPUKM from the mentioned dates. Inclusion criteria's were mainly to include all patients who have gone through pre-operative spinal embolization that was done within the selected time frame. From the list obtained, cases were reviewed further through the post-operative notes to determine the tumour type and intra-operative data. Multiple parameters were taken into accounts including the demographic data, type of spinal tumour / site of primary tumour for spinal metastasis, materials used during embolisation, completion of the embolisation, type of spinal surgery, intra-operative blood loss, duration of the operation and intra- or post-operative blood transfusion. Complete embolisation is defined by achieving more than 90% tumour devascularization post embolisation. This is judged based on images post embolisation as well as post embolisation report.

Statistical analysis were done using multiple statistical test as well as Statistical Package for Social Sciences (SPSS) software to see the average intraoperative blood loss in the spinal surgery, in those who have went through pre-operative spinal embolisation. Comparison were made with the average blood loss seen in the literature review cases. The other secondary objectives for this study include the difference of average blood loss based on the tumour types, materials used during embolisation, operative time and completion of embolisation.

3. RESULTS

A total of 24 patients were eligible for this study based on the inclusion criteria, however, 9 patients were excluded due to unavailability of written records in the database. From these 15 subjects, 9 were male and 6 were female. Age of subjects were ranged from 22 until 70 years old. Median and mean age were 54 and 52 years old respectively. 10 of our subjects were Malay and 5 were Chinese. Intraoperative blood loss in our patient ranged from 300 – 5000ml.

Average blood loss was 1480ml whilst median blood loss was 1000ml. From ***Figure 1***, the highest intraoperative blood loss (5000ml) was recorded in patient with multiple myeloma which had metastasized to T12, L1 and L5 vertebrae. Other primary tumours with spinal metastasis that had large amount blood loss in our study include renal cell carcinoma (4000ml) and hemangiopericytoma (2200ml). Primary spinal bony tumour was only multiple myeloma which occurred at T12/L1 and L4 levels. The rest of the spinal tumours were metastatic disease.

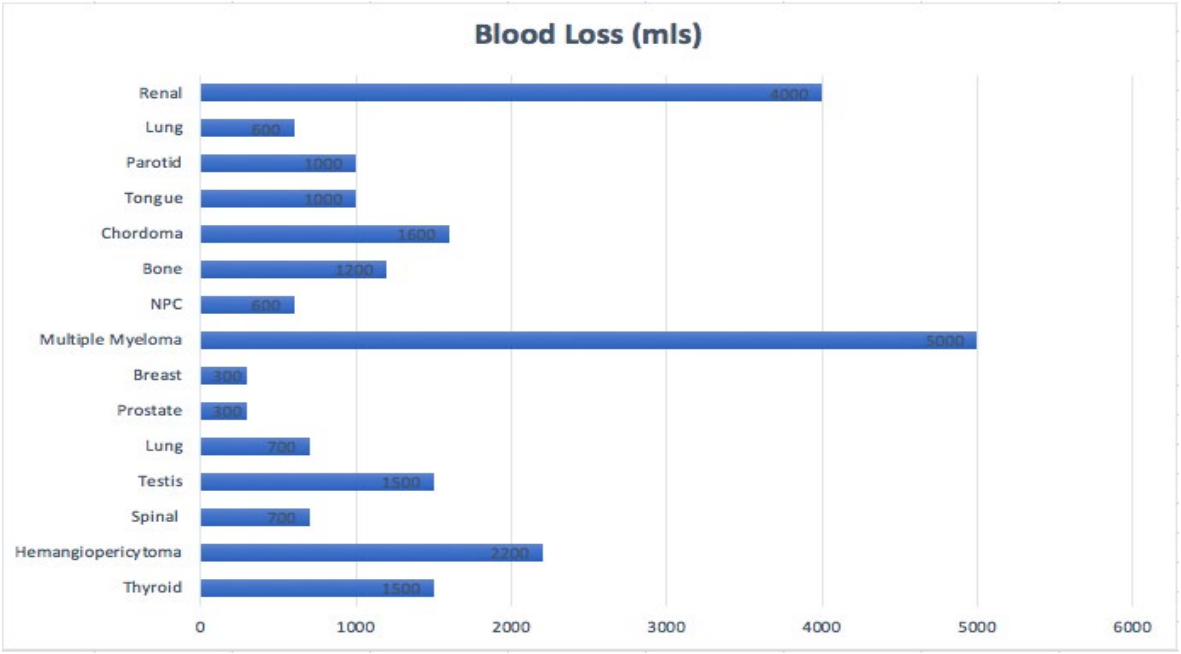


Figure 1

In our perioperative embolisation, multiple types of embolic materials were used in order to devascularized the spinal metastases prior to the surgery. Gelfoam, polyvinyl alcohol (PVA) particles and coils were the materials that were frequently used for embolisation. In some of the cases, these materials were combined in order to achieve better or complete devascularisation. Out of 15 patients, 5 patients were embolised using PVA, 4 patient embolised using combined embolic agents, 3 patients had coils, 2 patients had Gelfoam and remaining 1 patient had temporary embolization via balloon-assisted vertebrectomy for C2 chordoma. One way ANOVA test showed there was significant difference in blood loss between patients that used different embolic materials. ***Table 2*** summarised the usage of embolic materials and their relation with the intraoperative blood loss

Embolic Agent	Cases	Average Blood Loss (in ml)
PVA	5	1660
Combined	4	1950
Gel foam	2	1250
Coils	3	666
Stent	1	1600
P Value		0.00019

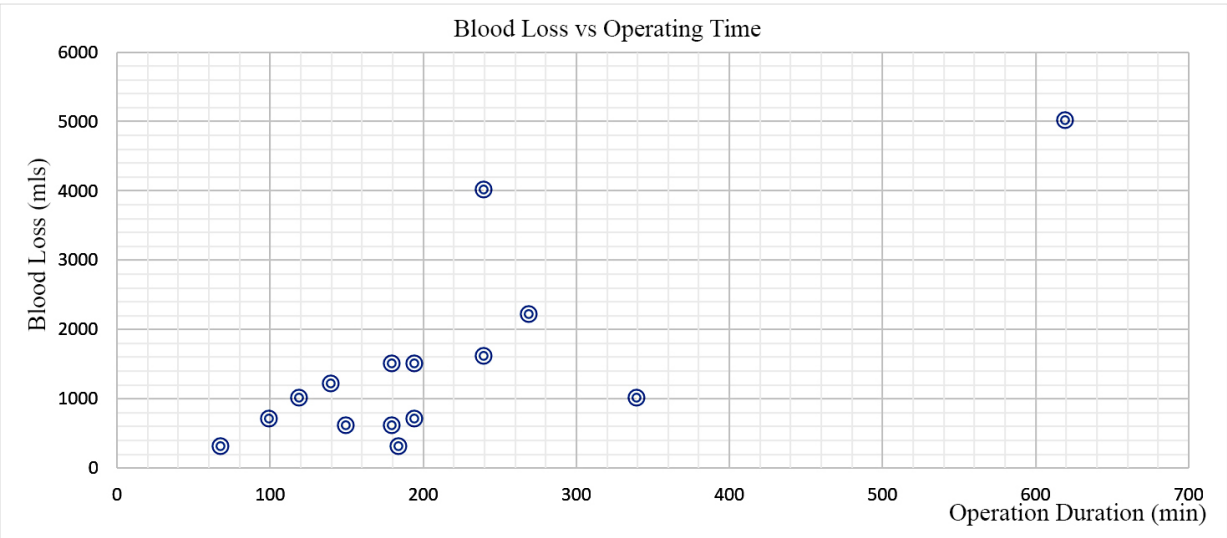
Table 2

The degree of tumour devascularisation has significant role in intraoperative blood loss. From our study, there was 10 patients had complete embolisation with another patient had on- table balloon-assisted vertebrectomy. The remaining 4 patients did not achieve complete embolisation. T-test showed there was significant difference in intraoperative blood loss between those who had complete embolisation and those with incomplete embolisation with P value of less than 0.01 (***Table 3***).

Degree of Embolisation (Complete / Incomplete)	Number of Cases	Mean Blood Loss (in ml)
Complete	10	1360
Incompete	4	1900
P value		0.0017

Table 3

We also studied the relation between operating time and the amount of intraoperative blood loss. Operating time ranged from 68 min (1.1 hour) to 620 min (10.3 hours). Average operating time was 214 min (3.6 hours) and median operating time was 185 min (3.1 hours). Pearson correlation test showed positive correlation between the amount of blood loss and the operating time with Pearson value of 0.78 (***Figure 2***).



Pearson correlation: 0.78

Figure 2

4. DISCUSSION

As mentioned before, average and median blood loss were 1480ml and 1000ml respectively. In 2016, Griessinauer J et al published a systemic review and meta-analysis on multiple studies on pre-operative embolisation done from 1990 to 2008[19]. In this study, it was documented that mean and median intraoperative blood loss ranged from 1100ml to 4450ml. Based on this, our mean blood loss fell within this range.

As of to date, only one case controlled study did a comparison between the amount of blood loss in pre-operative embolised group and non-embolised group. It was published by Roshan Jha et al in 2016 comparing 26 patients who underwent pre-operative embolisation with 28 patients in the control group (without pre-embolisation). The mean estimated blood loss (EBL) for the pre-embolised group was 1300ml and the non-embolised group was 1800ml[20]. ***Table 4*** showed comparison of estimated and mean blood loss from our study in comparison with other studies from literature reviews

.

Ref.	Year	No. of Patients	Type of Study	Result (ml)
Thiex et al	2013	104	Retrospective	EBL: 100 – 15000
Ibrahim et al	2013	18	Retrospective	EBL: 1100 – 2600 MBL: 1400
Kobayashi et al	2012	62	Retrospective	EBL: 250 – 11000 MBL: 2554
Al-Hadithy et al	2011	26	Retrospective	EBL: 100 – 1800
Zhang et al	2009	47	Retrospective	EBL: 705 ±120
Lee et al	2008	6	Prospective	EBL: 200 - 830
Jha R et al	2012- 13	26 (study group)	Case control study	EBL: 250 - 2900
		28 (control group)		EBL: 800 - 6000
Our study	2010 - 2016	15	Retrospective	EBL: 300 - 5000 MBL: 1480 Median: 1000

EBL: Estimated blood loss
MBL: Mean blood loss

Table 4

From the result, we also noted that the highest intraoperative blood loss was in patient who had spinal metastasis from multiple myeloma, followed by renal cell carcinoma and hemangiopericytoma due to their hypervascular nature. This is consistent with literature reviews supporting this finding. Sreejit Nair et al published a study on pre-operative embolisation of hypervascular spinal tumour in 2013. They divided the spinal column tumour according to the tumoral blushed demonstrated in angiogram into 0 until 3, with 3 being the worst which demonstrated severely increased tumoral blush with early arteriovenous shunting[21]. Multiple myeloma, hemangiopericytoma and renal cell carcinoma were categorised under high tumoral vascularity.

Overall, PVA particulate embolic agents were the most frequently used in our patients (5 patients). Theoretically, particle agents would end up and accumulate in the tumour capillary bed thus producing sufficient tumour devascularisation[22]. Pertaining to our study, there were variable size of particles used, mainly from 250 – 350 micron until 355 – 500 micron, depending on the vessel size, type of vessels as well as preference of the operating interventional radiologists based on their experience. According to Berkefeld J in 1999, medium sized particles (150 micron – 250 micron) are considered favourable for occlusion of the capillary bed, because tumour capillaries are theoretically around 200 μm in diameter[16]. If obvious anastomosis with normal spinal cord vasculature was present, larger particles (>250 μm) are preferred, mainly to avoid spinal cord ischemia. Due to limited sample size, we were unable to assess superiority of different particles size over another in this current study.

Combined embolic agent materials were used in 4 patients. Combined materials help in some cases to achieve greater devascularisation. Most common combination in our study was PVA and coils (3 out of 4 cases), whilst combination of gelfoam and coils were only used once. Additional usage of coils with PVA was recommended to occlude ventral branch of feeding artery, hence achieving better tumour devascularisation[21]. However, one must aware that ventral branch occlusion may give rise to complication such as skin necrosis. None of our patients developed such complication which may be explained by presence of rich collateral network which are essential to prevent such occurrence.

Coils were used in 3 of our patients. According to Barkefeld in 1999, coils were preferred embolic material especially by the orthopaedic surgeon as it was believed to cause lesser neurologic impairment than Gelfoam powder. However, recent studies showed that using only coils will give inadequate devascularisation[16]. In our study, coils were used when the feeding artery was large enough to accommodate coils and was deployed to achieve better embolisation completion. In addition, personal preference by the operating interventional radiologist also played important

role in choosing the embolic material. Coils were also used in order to prevent non-targeted embolisation especially in the presence of co-supply or communication with other vital structures. Although from our study, statistical data using ANOVA test showed significant difference in intraoperative blood loss in patients with different embolic materials, we were unable to determine the superiority of one embolic agent over another. A further in depth study with larger sample size is essential in order to achieve this.

Gelfoam slurry was only used in two patients. It, theoretically gives better tumour penetration if injected slowly over longer period due to its liquified nature. This theory are supported by reports of superior penetration during the treatment of vascular malformation[23,24]. However, the possibility of non-targeted embolisation is known to be high with Gelfoam. Santillan in 2011 mentioned that liquid embolic materials have the ability to achieve greater penetration of tumour vasculature however, it was more difficult to control and may result in advertent embolisation [25].

As mentioned earlier, only two patients in our study were solely embolised using Gelfoam. In the first case, the patient was diagnosed with left orbital hemangiopericytoma with C5 spinal metastasis. He was embolised with Gelfoam because selective cannulation of the feeding arteries were difficult. In fact, we were unable to embolise one of the feeding artery arising from the left vertebral artery.

The second case of solely Gelfoam usage was in a patient with prostate cancer metastasis to multilevel vertebral bodies. In this particular case, there was no significant tumoral blushed seen from feeding artery at T12 level (vertebra that aimed for vertebrectomy). We decided to inject gel foam for temporary embolisation of the small capillary supply. There was no complication following the embolisation. The amount of perioperative blood loss was only 700 ml which is in line with the angiographic findings, likely indicating hypovascular metastasis. In a case with clear cut significant tumoral blush and easily-cannulated feeding artery, gel foam would not be our first line embolic agent.

As mentioned in the result, there was one case that we decided for on-table balloon-assisted C2 vertebrectomy. This patient was diagnosed with C2 vertebra chordoma. Balloon tamponade was used as temporary embolisation during the surgery to help reduce intraoperative blood loss. Documented blood loss was 1600 ml. According to experience publish in All India Institute of Medical Sciences by Sreejet Nair et al in 2013, chordoma has relatively low tumour vascularity[21]. Thus, balloon-assisted technique was sufficient for temporary tumour devascularisation of the tumour by placing balloon within the right vertebral artery. Permanent embolisation is not suitable as compromising vertebral artery was not an option. There were 10 patients who had complete embolisation. From this 10 patients, 3 patients were embolised using combined embolic agent, 4 patient were embolised using PVA only, 2 were embolised using coils and 1 patient was embolised using Gelfoam.

The remaining 4 patients had incomplete embolisation. The main reason for incomplete embolisation was difficult selective cannulation into the feeding artery. Some of the patients had multiple anastomosis with vital structure such as spinal cord and intercostal muscles that resulted in very risky embolisation, hence left non-embolised. From those who had incomplete embolisation, 2 patients were embolised using combined embolic agents, 1 patient embolised using coils and the remaining 1 patient embolised using Gelfoam. Those from completely embolised group were mainly using PVA particles as embolic agent.

We can deduce that embolic materials do not really determine the degree of embolisation. Study done by Barkefeld showed that there was no significant advantage of one embolic agent over another[16]. In fact, the material of choice were depending on the degree of tumour vascularization. Hence, the appearance of feeding arteries in angiogram were the important determinant of embolisation outcome. One way ANOVA test showed that there was significant difference in intraoperative blood loss between those who had complete embolisation and incomplete embolisation. This is similar as reported by Nair et al in his study, where complete embolisation is more effective in decreasing intra-operative blood loss compared to near-complete or partial embolisation[21].

For obvious reason, type of operation plays important role in intraoperative blood loss. Complete removal of vertebral body (vertebrectomy) has shown to achieve superior decompression and long term results in comparison to posterior laminectomy. It is, however, associated with massive intraoperative blood loss, especially when dealing with hypervascular metastasis. Nine out of 15 patients in our study underwent vertebrectomy, and mean blood loss for those underwent this procedure was 1511 ml. Detail discussion on the technical aspect of the operation is not within scope of this study, nonetheless, we analysed the relation between duration of surgery and amount of blood loss. Pearson correlation test showed Pearson value of 0.78 indicating strong positive correlation; the longer the duration of surgery, usually indicate more complex operation resulting in more blood loss.

5. CONCLUSION

From our study, we conclude that pre-operative embolisation has significant role in reducing intra-operative blood loss especially in hypervascular spinal tumour and spinal metastasis. Our result is comparable with literature review done in other centres. Further study with larger sample size will give better evaluation of pre-operative embolisation impact on spinal surgery. It will also give better opportunity to assess multifactorial aspects that can affect the efficacy of embolisation.

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I would like to thank you to my teachers, family and patients, those who helped to accomplished my study

APPENDIX 1

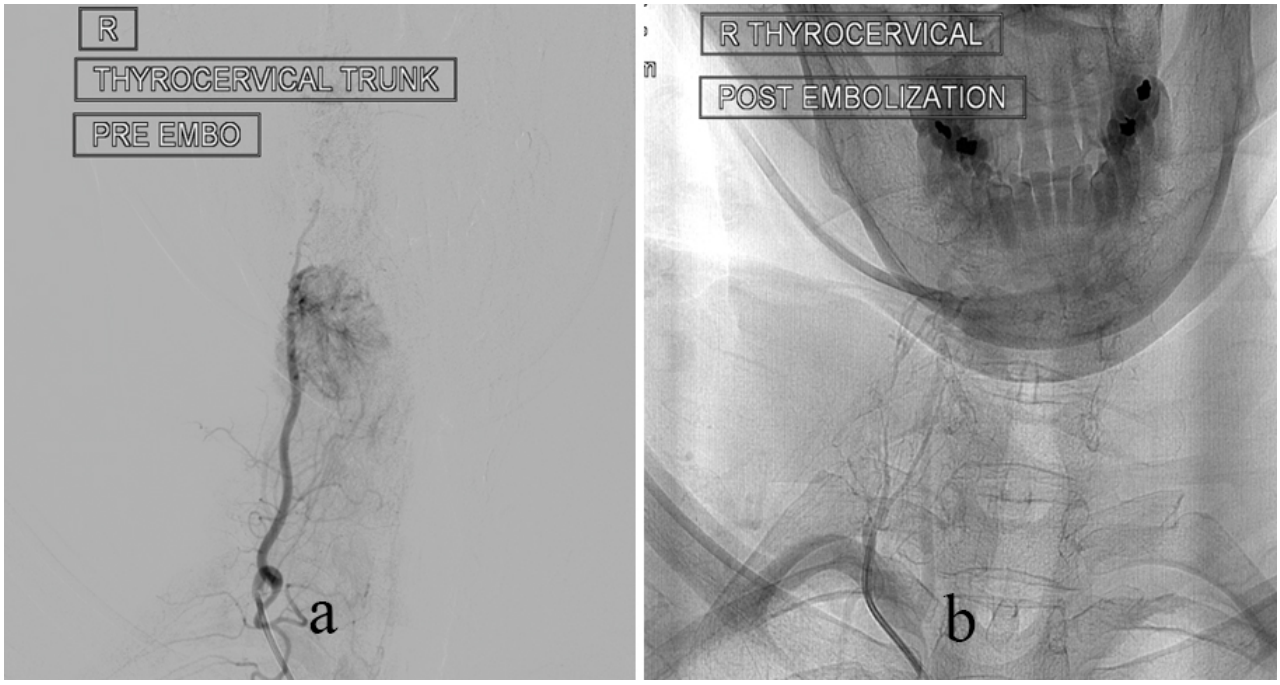

Figure 3

53-years-old, Malay lady with left orbital hemangiopericytoma with C5 spinal metastasis since 2008. Presented with 2 months history of right upper limb radiculopathy with weakness. ***Figure 3(***a) There is tumoral blushed at the C5/C6 region, from the right thyrocervical trunk whom was embolized using gelfoam with tip of catheter distal to the feeder. ***Figure 3***(b) Post embolisation of the right thyrocervical trunk shows resolved tumoral blush from this feeder artery. The tumour also has other 3 feeder arteries, which also embolised except the one from left vertebral artery. Blood loss was recorded at 2200 ml.

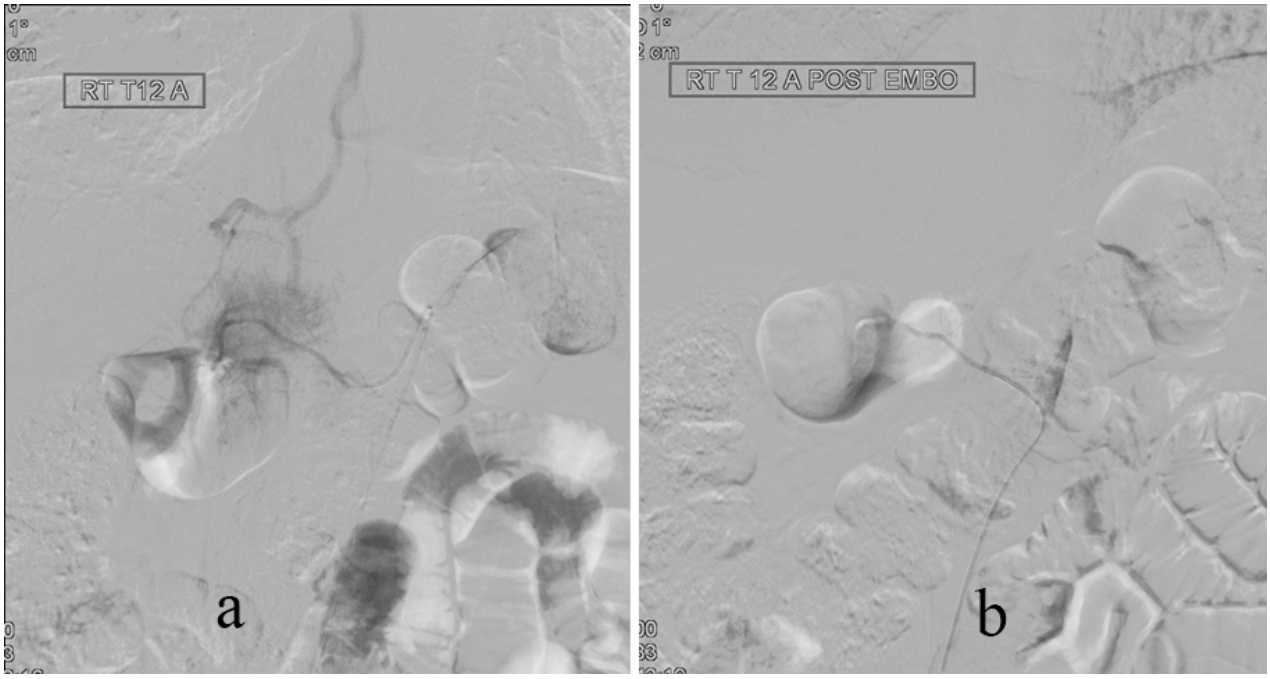

Figure 4

66-years-old, Chinese gentleman underlying prostate cancer with cervical, thoracic and lumbar metastasis. ***Figure 4***(a) Tumoral blush seen from the right T12 spinal arteries. ***Figure 4***(b) Post embolisation using gelfoam shows complete resolution of tumoral blushed post gelfoam injection.

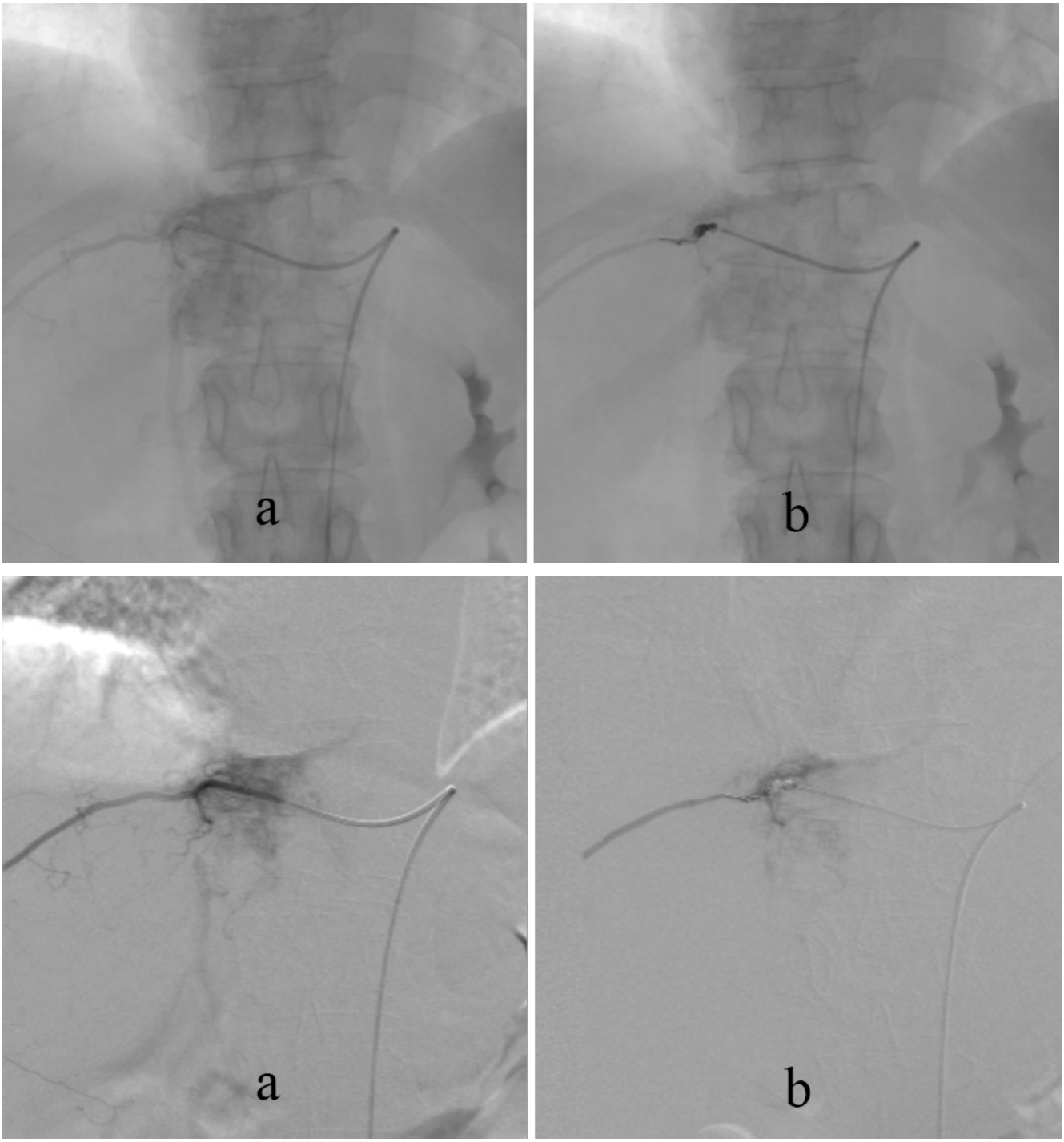

Figure 5

47-year-old, man gentleman, with primary lung bronchogenic carcinoma, with T9, T11 and T12 spinal metastasis. ***Figure 5***(a) Tumoral blushed at the right T11/T12 region. ***Figure 5***(b) Post embolisation with coil showed reduction of tumoral blushed. This patient had incomplete embolisation. Blood loss intraoperative documented at 700ml.

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TRANSVERSE-SIGMOID SINUS DURAL ARTERIOVENOUS FISTULA PRESENTING WITH RECURRENT TRANSIENT ISCHAEMIC ATTACK: A TECHNICAL CASE REPORT

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ABSTRACT
Intracranial dural arteriovenous fistulae (DAVF) are uncommon and account for approximately 1% of all strokes. All transverse-sigmoid sinus DAVFs require treatment because of the low rate of spontaneous regression and frequent association with aggressive neurologic symptoms. Endovascular embolization which aims for permanent obliteration of the lesion is now the primary treatment modality for all DAVFs. We present a 56-year-old patient with long standing history of intermittent transient ischaemic attack (TIA)-like symptoms. Magnetic resonance (MR) angiography revealed right transverse-sigmoid sinus DAVF and bilateral vertebral arteries occlusion. The patient's symptoms completely resolved upon successful trans-arterial embolization of the DAVF.

Keywords: Intracranial dural arteriovenous fistula (DAVF), Endovascular embolization, Onyx-18.

1. INTRODUCTION

Intracranial dural arteriovenous fistulae (DAVF) are uncommon and account for about 10–15% of all intracranial arteriovenous malformations and approximately 1% of all strokes[1,2].

All transverse-sigmoid sinus DAVFs require treatment because of the low rate of spontaneous regression and the more frequent association with haemorrhagic and non-haemorrhagic aggressive neurologic symptoms. Untreated DAVFs of the anterior cranial fossa or the tentorium have 91% risk of hemorrhage [3,4].

Endovascular embolization is now the primary modality of treatment for all DAVFs. Other treatment options available include surgery and radiosurgery. The aim of the treatment is for permanent and complete obliteration of the lesion with resolution of clinical symptoms [5].

We present a patient with a right transverse-sigmoid sinus DAVF and bilateral vertebral arteries occlusion that presented with long standing recurrent intermittent TIA-like symptoms which completely resolved upon successful transarterial embolization of the DAVF.

2. CASE REPORT

A 56-year-old Indian male was admitted with a few year history of intermittent transient memory loss, upper and lower limb numbness, amaurosis fugax, slurring of speech, giddiness and vertigo. These symptoms had increased in severity about 4 weeks before the admission. No associated loss of consciousness, weakness or headache noted.

Patient was a non-smoker with no other significant medical history. He had a family history of heart disease. He was on Simvastin 20mg od and Ticlopidine 250mg bd.

On admission, his Glasgow Coma Scale (GCS) was 15/15 and his pupils were equal and reactive. He was apyrexial with all the vital signs within normal limit (pulse-90bm, blood pressure (BP)-130/90 and oxygen saturation (SpO_2)-99% on room air). Neurological examination was unremarkable and no bruit was heard over the carotid regions.

Clinically, all the blood investigations were within normal limit. Chest radiograph and echocardiogram were also normal. Carotid Doppler study was not requested.

His had a computed tomography (CT) brain scan done in 2005 which showed a small subcentimeter calcified parasagittal meningioma measuring 0.5 x 1cm. No significant mass effect was seen on the adjacent brain parenchyma.

Magnetic resonance imaging (MRI) done a few days after the admission showed prominent dilated vessels in the right cerebral hemisphere. MRA confirmed the presence of right transverse-sigmoid sinus DAVF with possible cortico-venous reflux into the right temporal lobe and a prominent draining vein to the anastomotic vein of Trolard were noted. These findings were in keeping with Grade 3 Tranverse-Sigmoid Sinus DAVF.

MRI also showed multiple small high signal intensity lesions in FLAIR, T2WI and DWI and low signal in ADC in the left periventricular, both occipital lobes and cerebellum in-keeping with acute infarcts. A coincidental finding of bilateral vertebral arteries occlusion with the posterior circulation being maintained by retrograde flow from both posterior communicating arteries (PCOMs).

Cerebral angiography demonstrated a right transverse-sigmoid sinus DAVF that was fed by petrosquamous branch of the right middle meningeal artery and trans-osseos branch of the right occipital artery. There was evidence of cortical venous reflux into the dilated and tortuous vein of Trolard. Cerebral angiogram also revealed gradual narrowing and occlusion of left distal cervical and right intradural segments of both vertebral arteries which was suggestive of dissection. The posterior circulation was maintained by retrograde filling of the patent PCOMs.

Transarterial cerebral embolisation was performed under general anaesthetic two months after admission**.** 5F 100 cm Envoy guiding catheter was placed origin of the right external carotid artery (ECA) followed by selective cannulation of the the petrosquamous segment of the middle meningeal artery via Sonic detachable microcatheter 1.5F under road mapping. The tip of the catheter was placed within the nidus of DAVF and partially embolized by 3.5ml of Onyx-18 (6% ethylene vinyl alcohol copolymer (EVOH). A 1:3 mixture of Histoacryl to lipiodol were used for embolization of the residual nidus from the occipital branch.

An immediate control angiogram performed post-procedure showed complete obliteration of the nidus and the feeder vessels. The dural sinuses and both intracranial circulation were patent post-procedure.

Cerebral angiogram and MRI done 8 months post-embolization did not show any residual or recurrence of the DAVF. On MRI, the small multifocal infarcts which were seen in the left periventricular, both occipital lobes and cerebellum have also resolved.

There was gradual and continuous improvement of the patient's clinical status.

3. DISCUSSION

DAVFs represent an abnormal connection between the dural arteries or the dural branches of the cerebral arteries which is directly shunted into a dural venous sinus or leptomeningeal veins. Their true incidence is unknown since many remained clinically silent or involutes spontaneously[1].

Most of these lesions are acquired and the commonest predisposing factor appears to be venous sinus thrombosis. Venous thrombosis promotes venous hypertension which opens up microscopic vascular connections within the dura. The multiple fistulous channels that are seen angiographically are thought to represent pathological enlargement of these normal arteriovenous shunts in response to progressive venous stenosis or occlusion thrombosis[2].

There are several major pathophysiological mechanisms of DAVF that cause cerebral disturbances including steal phenomena, arteriovenous shunt, venous hypertension due to impaired venous return, cerebral hypoxia or ischaemia, cerebral compression by dilated venous aneurysm, sinus obstruction and intracranial hemorrhage due to venous rupture[6]. Our patient has DAVF and chronic bilateral vertebral arteries occlusion. The posterior circulation is being supplied entirely by patent PCOMs. The presence of DAVF resulted in steal phenomena and arteriovenous shunting. This further reduced the blood flow to the already imperfectly perfused posterior circulation which in turn causes cerebral ischaemia. These explain the fluctuating neurological deficits presented by the patient and the resultant multifocal infarcts in the occipital and cerebellar regions.

Awad et al[7] demonstrated that the presence of cortico-venous reflux, leptomeningeal retrograde venous drainage, aneurysmic venous extension and galenic venous aneurysm are the most important risk factors for aggressive symptoms which include progressive neurological deficit, increased intracranial pressure and spontaneous intracranial haemorrhage. The overall haemorrhage risk from a DAVF is ~ 1.5% per year[3,4].

The presence of cortico-venous reflux is the ominous sign which warrant urgent intervention and aggressive treatment. These lesions carry increase risk of intracranial haemorrhage with severe neurological complications and generally have poorer prognosis. Spontaneous regression of these AVFs is relatively rare (approximately 5% of cases) and usually occurs following hemorrhagic events[3,4]. Diagnostic angiogram of our patient revealed a Grade 3 DAVF with all the aggressive features including with antegrade and retrograde venous drainage into the deep and superficial venous system, evidence of cortical venous reflux and aneurysmal venous distension. This clearly defined the patient into a high risk category which warrants prompt and definitive treatment.

Treatment of DAVFs depends on on the patient's clinical presentation, lesion location, angiographic features and the natural history of the lesion. DAVFs have been treated with a variety of approaches, including surgical resection, venous clipping, transcatheter embolization, radiation therapy or a combination of these treatments[8].

Endovascular techniques are now frequently used as the first therapeutic option for most DAVFs. Transcatheter embolization can be done via an arterial or venous catheter intervention. If a decision is made to treat DAVFs, regardless of the type of procedure, the goal of treatment is total obliteration of the fistula and closing the venous collector is necessary to achieve an anatomic cure. Otherwise, recruitment of collateral flow and continued risk of hemorrhage are likely[8]. In our patient, complete occlusion of the DAVF was achieved via transarterial embolization using Onyx and Histoacryl.

Onyx-18 is a biocompatible polymer containing ethyl-vinyl alcohol dissolved in an organic solvent (dimethyl sulfoxide). It can be used to treat AVM, aneurysm and DAVFs. Several properties of Onyx make it an attractive permanent embolic agent. It is permanent radiopaque liquid that polymerizes on contact with bloodstream. These allow casting ('plug') of complex vascular networks. It can be injected in a controlled process ("Plug and Push" technique) continuously over a long period of time. It is cohesive but not adhesive: it does not to break off in pieces into the venous system and thereby decreasing the risk of microcatheter retention after embolization. Antegrade filling of the fistula and the retrograde reflux of the Onyx established complete vascular occlusion of the DAVF in just one session. Several studies have shown a low rate of recanalization of Onyx-embolized aneurysms even at the 5-year follow-up[8].

4. CONCLUSION

In conclusion, in our patient the DAVF causes steal phenomena which increased blood flow through a low-resistance DAVF vascular bed and divert flow away from the already critical region of the posterior circulation. These causes the TIA symptoms and cerebral ischaemia seen in this patient. The successful obliteration of the DAVFs resolved the steal phenomena and the arteriovenous shunting from the posterior circulation, which in-turn resulted in gradual improvement and resolution of patient's clinical symptoms.

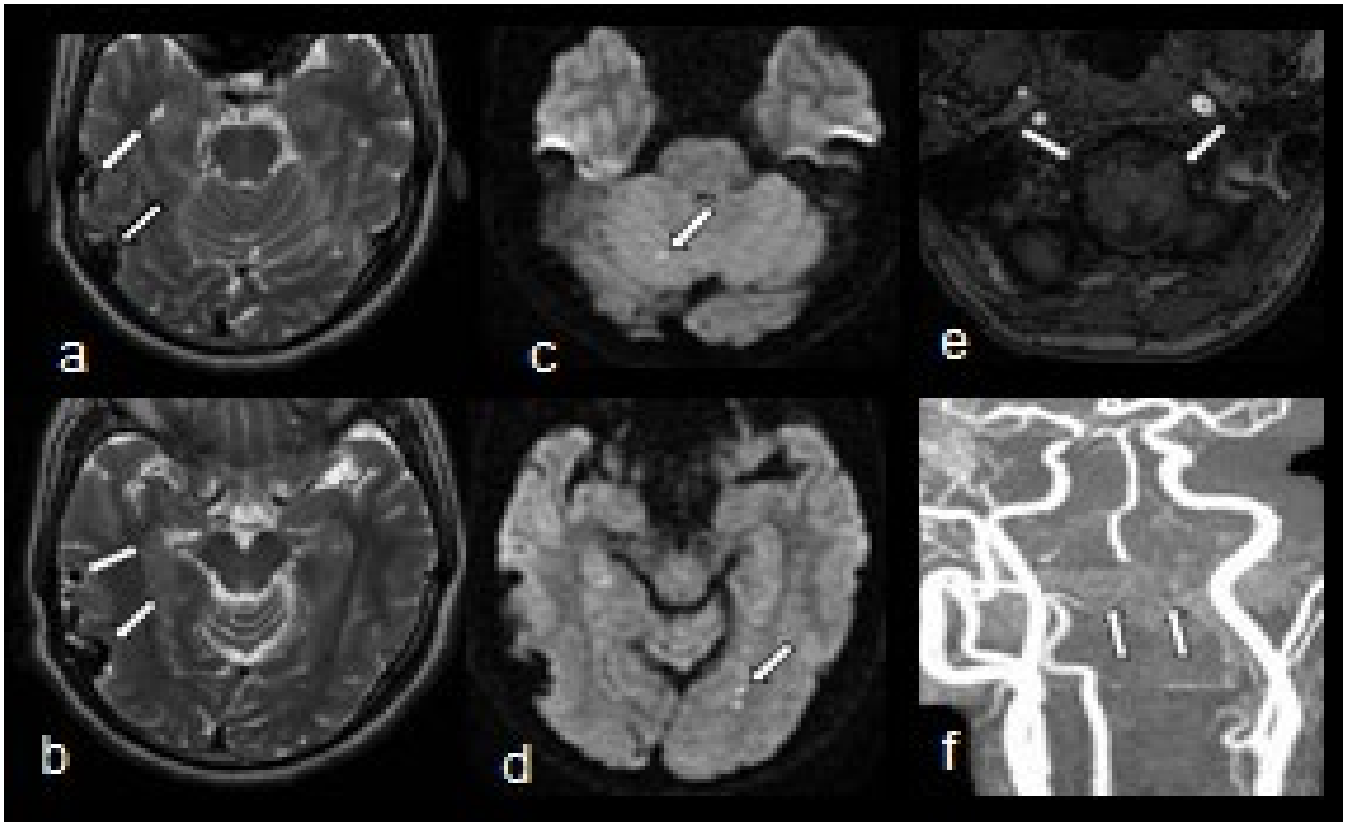

Figure 1- MRI brain images taken 3 days after admission showing:

- *1a and 1b - Axial T2W MRI images showing prominent dilated veins in the right cerebral hemisphere (white arrows).*
- *1c and 1d - Axial diffusion weighted MRI images showing multiple hyperintense foci in the occipital lobe and cerebellum (white arrows).*
- *1e and 1f - Absence of the distal portion of the vertebral arteries bilaterally in-keeping with occlusion (white arrows).*

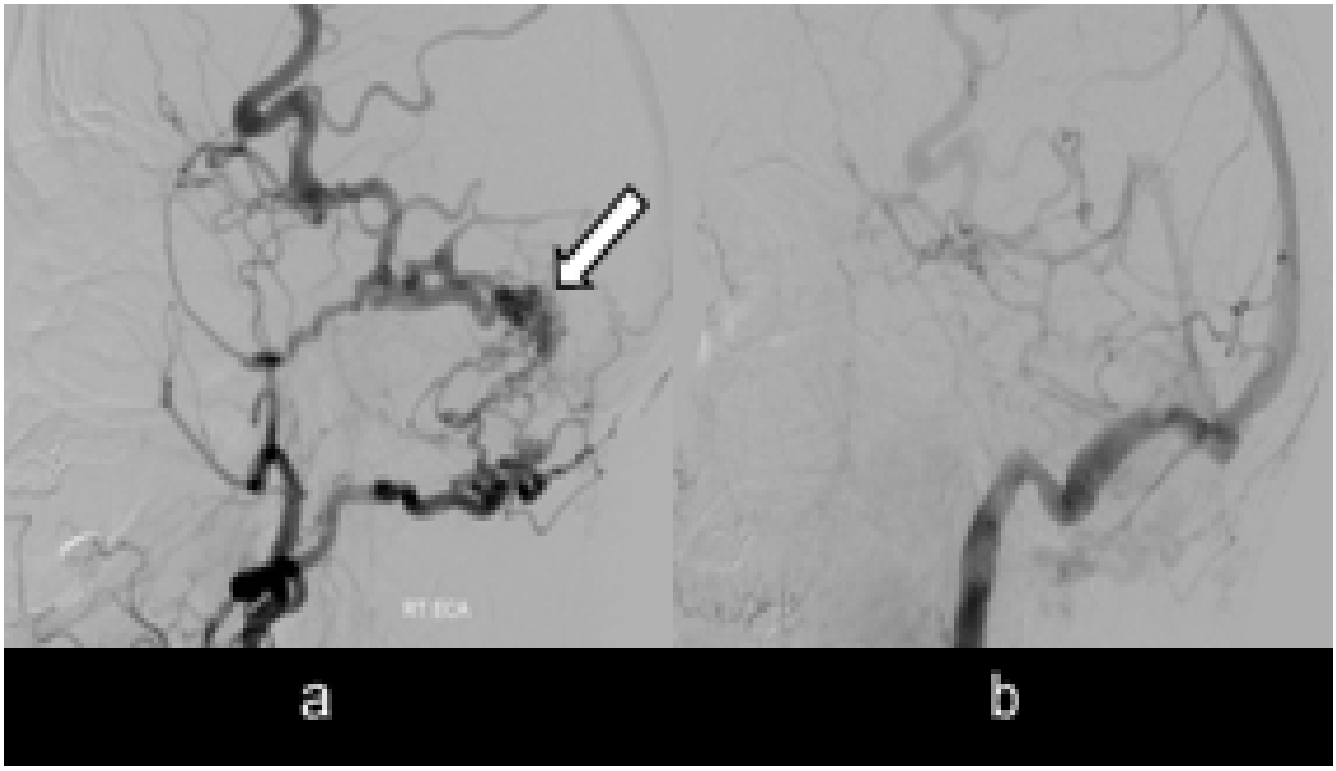

Figure 2:

- *a) Lateral projection of the right ECA angiogram reveals a right transverse-sigmoid sinus DAVF (white arrow) fed by the petrosquamous branch of the right middle meningeal artery and trans-osseous branch of the right occipital artery.*
- *b)There is cortical venous reflux in delayed phase.*

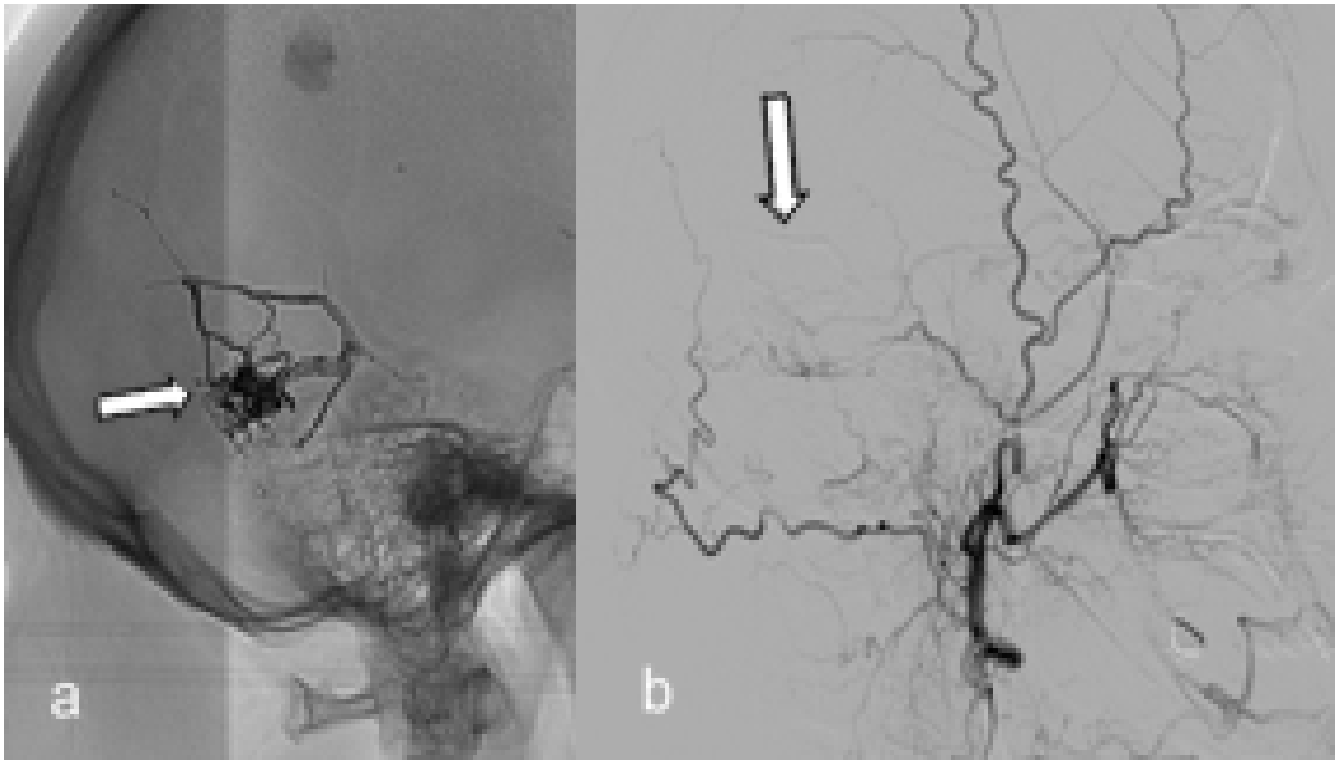

Figure 3:

- *a) Microinjection into the petrosquamous segment of the left meningeal artery filling up the fistula and sinus. Onyx cast filled up the fistula (white arrow).*
- *b) Post-embolization angiogram image showing complete obliteration of the fistula with Onyx (white arrow) with absence of cortical venous reflux.*

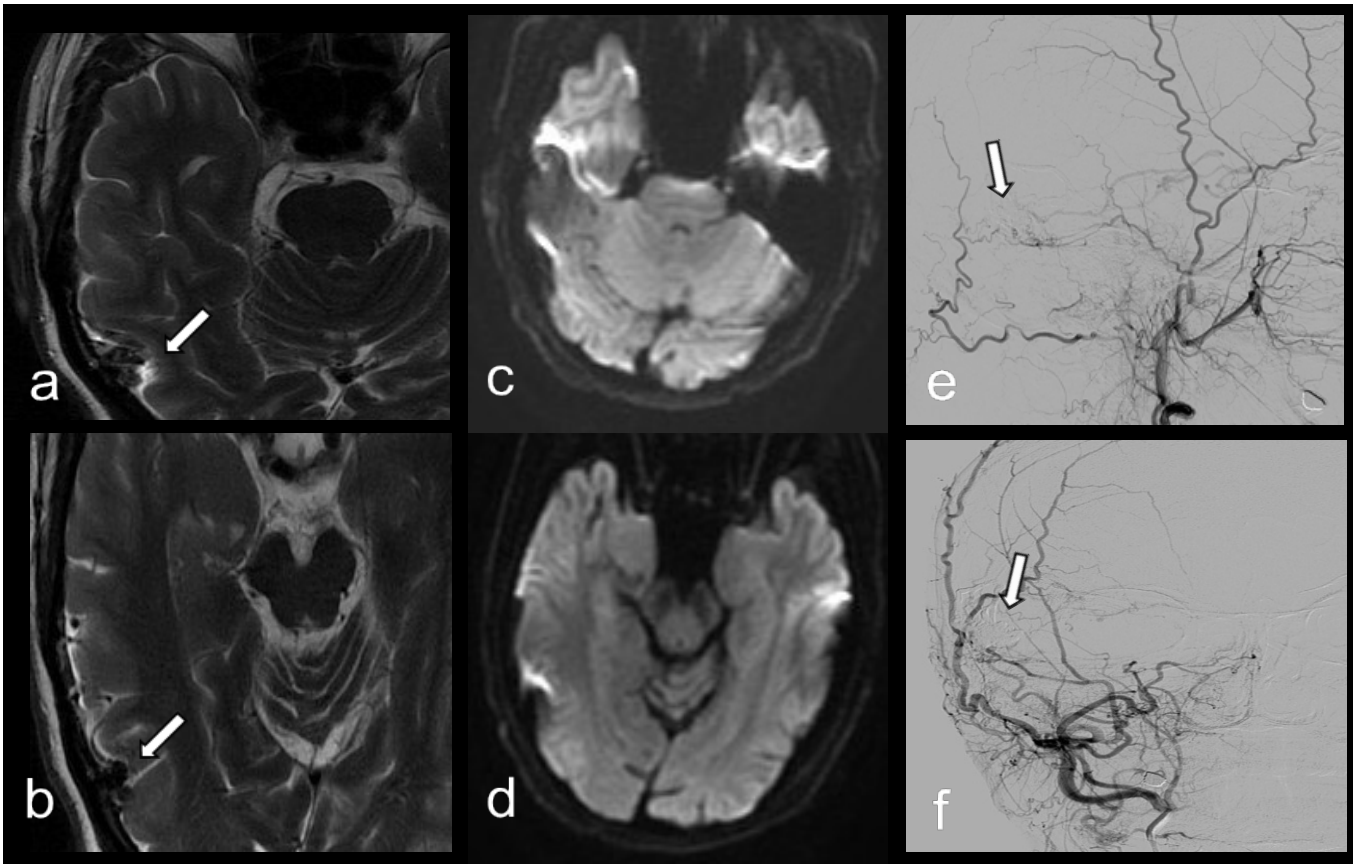

Figure 4 :

- *4a and 4b - Follow-up axial T2W MRI images showing no recanalization of the DAVF.*
- *4b and 4c - Follow-up axial diffusion weighted MRI images showing resolution of the hyperintense areas previously seen in occipital lobe and cerebellum.*
- *4d and 4e - Follow-up cerebral angiogram images showing Onyx cast within the fistula (white arrow) with no evidence of recanalization of the DAVF.*

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STARTING MECHANICAL THROMBECTOMY SERVICE DURING COVID-19 PANDEMIC: OUR EARLY INSTITUTION EXPERIENCE.

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Keywords: Covid-19, Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), acute stroke, mechanical thrombectomy, healthcare workers (HCW)

As we are writing this manuscript in early May 2020, we are still living in COVID-19 (also known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)) pandemic era (1). Malaysia is one of the many countries affected by this global pandemic.

To prevent the spread of COVID-19, National Health Institutions all over the world imposed mandatory usage of Personal protective equipments (PPE) to protect health care workers (HCW) when dealing with high risk patients and COVID-19 positive patients[2]. However, the PPEs are finite and episodic shortages of PPEs are common all over the world[2,3].

During this challenging time, University Putra Malaysia Teaching Hospital (HPUPM) has leapt forward to offer optimum stroke care to the community. The acute stroke patients will be stratified for eligibility for mechanical thrombectomy and thrombolysis treatment in our institution. The criteria used is dependant on institutional practice. At the height of the pandemic, it is difficult to ascertain which patient had contracted COVID-19. Alarming evidence emerged suggesting that one of the central nervous system (CNS) manifestation of COVID-19 is acute stroke. The patient may be asymptomatic or exhibiting COVID-19 symptoms[4]. There are also reports suggesting acute stroke in young and middle-aged adults as a sequela of COVID-19[4]. This manuscript aims to share our experience in starting the mechanical thrombectomy service for acute stroke at the height of COVID-19 pandemic.

Our hospital was launched amid the pandemic, in early 2020. We have a dedicated Emergency Unit catering for stroke named as Regional Emergency Stroke Quick (RESQ) Response Unit. During the current pandemic era, all hospital admissions including the ones via RESQ will be vetted by a special task force in order to assist with the COVID-19 protocol via a special platform so as not to jeopardise the door to needle time.

To reduce staff exposure to COVID-19; all patients are screened for signs and symptoms of COVID-19[5]. Declaration forms are given to the patient or next of kin to be filled (***Figure 1***). This form is formulated based on Infectious Disease Prevention and Control Act 1988-Malaysia[6] and is a prerequisite for admission. Its main purpose is to notify the HCW about the current status of the patient, to identify and predict which patients are at high risk of COVID-19 infection. A rapid test is performed (Sars-COVID-2 Antibody Test- Lateral Flow Method, Wondfo®) which is complementary to the reverse-transcription polymerase chain reaction (RT-PCR) test. A throat and nasal swab for RT-PCR tests is performed in all patients immediately after rapid blood test procedure. This test is mandatory for every patient. The result will be traced the day after (RT-PCR) swab was taken. If there is suspicion of COVID-19, the patient will be transferred to the nearest COVID-19 hospital for further management.

Team members evaluating code red patients should be kept to a minimum and the attending HCW will need to wear full PPE which includes full-body protection coverall suits, N95 mask, eye protection and double-layer gloves for easier doffing (***Figure 2***). This "enhanced" full PPE helps to alleviate any aerosolized events such as coughing, sneezing, CPR, and intubation[2]. The full PPE gives a strong perception of protection among the HCW and consequently will boost HCW morale. However the use of full PPE is not without problems. This coverall protective suit is usually a "non-breathable" type (***Figure 2***). This kind of coverall protective suit will hamper heat and moisture transfer. The HCW wearing full PPE will experience heat stress, body irritation, discomfort and even may restrict movement. Wearing eye

protection such as goggle and face shield will induce fogging, thus reducing the HCW vision. Tight-fitting N95 mask and eye protection will often reduce fog formation.

Neuroimaging with MRI is done once the patient arrives at radiology department. The MRI (3T Ingenia, Philips Medical Systems) protocol consists of Diffusion-Weighted Image (DWI) followed by MR angiography (MRA) and Fluid-attenuated inversion recovery (FLAIR). After the third sequence, a multidisciplinary team will decide for thrombolysis with thrombectomy or thrombectomy alone which will then reduce door to decision time significantly (***Table 1***)

If there are positive pulmonary symptoms such as unequal breath sounda or a slight increase in temperature, we will consider low-dose chest CT at the same time as the CT angiography brain and neck. CT chest may aid in the diagnosis of COVID-19 (7). If there is any suspicion of ground-glass appearance on the low dose CT thorax, we will presume that the patient may have COVID-19 and will be referred to the nearest COVID-19 hospitals[7,8].

If CTA is already performed in the referring hospital and a large vessel occlusion (LVO) is identifies, a special direct pathway to the angiography room is created in order to reduce the exposure to the RESQ and radiology personnel[9,10].

We have a standard MRI room with ceiling mounted air conditioner. The room is neither positive nor negative pressured. HCW who transfer the patient will always be in full PPE and will be inside the MRI room during the examination, with hearing protection device. This is to reduce contamination to the MRI control room and limit the burnt rate of PPE. We covered the gantry table with plastic. However, the head coil will not be covered since it may interfere with the MRI signal, may cause claustrophobia and potentially has suffocation hazard to the patient. Terminal cleaning is mandatory after each case.

Our angiographic room is equipped with positive pressure ventilation and High-efficiency particulate air (HEPA). Due to the presence of positive pressure ventilation, the air will flow from the main angiographic suite to the next adjacent lower pressure rooms. It is important for the person/s inside the control room, scrub area and anteroom with the dual airlock system to wear a proper N95 mask. Door to the angiography room should be kept closed peri and postoperatively. Non-essential objects are removed from the angiographic room to ease post-procedure cleaning and to minimize contaminated surface areas[2].

The angiographic machine especially the angiographic tubes, detectors and other are covered with designated plastics. Terminal cleaning of the room is mandatory after each case. The technologist will clean the angiographic monitor and the machine control apparatus. The cleaning process usually takes up to 1 hour.

To reduce the number of HCW involved during the procedure, the minimum operational HCW in our setting is 4 persons; they are 1 main operator (Interventional Radiologist), 1 operator assistant (Interventional Radiology trainee), 1 staff nurse and 1 radiographer. Social distancing of at least 1 meter in between team members outside the angiographic room is observed. We prefer conscious sedation with local anaesthesia, whenever possible, for our mechanical thrombectomy procedure[11]. Aerosol generating procedures such as high flow oxygen and self-inflating bag are not recommended due to risk of dissemination of the virus pathogen. Precaution to minimize exposure must be taken by the anaesthetic team. Further steps need to be taken such as using powered air-purifying respirator (PAPR), headbox and camera laryngoscope to ease intubation.

The standard technique of mechanical thrombectomy is applied. It is imperative to minimize the procedural time which substantially will also reduce the contact hours of the attending HCW with the patient. We dedicate an area at the anteroom with an airlock system for the operators to doff their PPEs. The HCWs are encouraged to observe each other during doffing procedure to minimize risks of contamination. The clinical waste and disposable equipments will be collected and put into biohazard labeled plastic bags[2].

The patient will then be transferred to ICU with all the receiving staffs protected with PPE. It is important to reduce the time of transfer to prevent contamination to the surrounding. The patient will be transferred via a special isolated lift elevator.

In the ICU, the patient will be placed in an isolation room. All procedures will adhere to COVID-19 protocol for examinations, clinical assessments and nursing care, until their COVID-19 status is known. The swab test done earlier during admission will be traced on Day 1 of admission. Once the result of RT-PCR COVID-19 is negative; the patient will be transferred out from isolation and treated as usual patient.

If the transfer requires maintaining intubation; there is a special designated close circuit portable ventilator. The patient will be placed in the ICU. The management of the patient must adhere to COVID-19 protocol. Once the patient is stabilized, the decision to extubate will be made collectively by the respective departments. Care must be taken during extubation to minimize potential exposure to the surrounding and the HCW.

In conclusion, it is feasible to start an emergency mechanical thrombectomy service during a pandemic. The initiatives taken to ensure the safety of the healthcare worker (HCW) will not compromise patient care.

Conflict of Interest

None declared.

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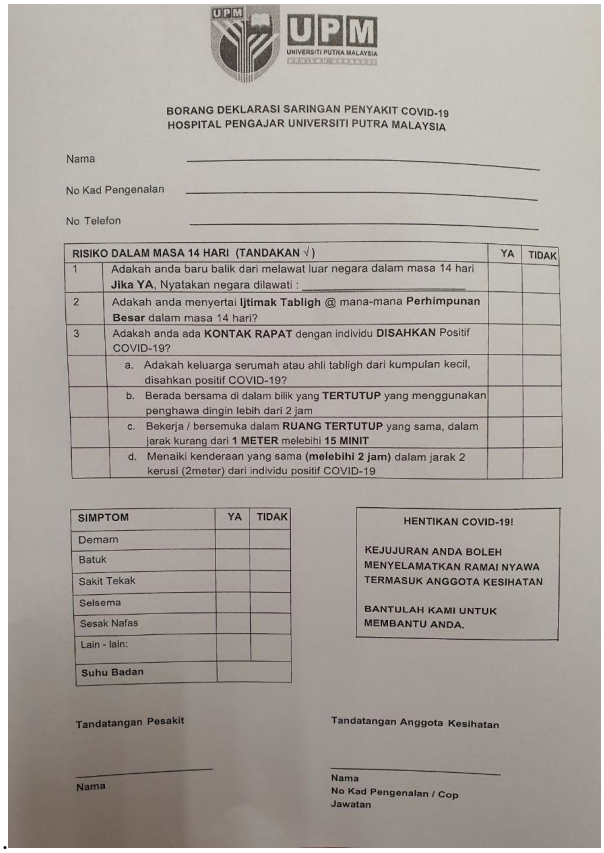


BORANG DEKLARASI SARINGAN PENYAKIT COVID-19
HOSPITAL PENGAJAR UNIVERSITI PUTRA MALAYSIA

Nama

No Kad Pengenalan

No Telefon

RISIKO DALAM MASA 14 HARI (TANDAKAN √)		YA	TIDAK
1	Adakah anda baru balik dari melawat luar negara dalam masa 14 hari **Jika YA**, Nyatakan negara dilawati :		
2	Adakah anda menyertai **Ijtimak Tabligh** @ mana-mana **Perhimpunan Besar** dalam masa 14 hari?		
3	Adakah anda ada **KONTAK RAPAT** dengan individu **DISAHKAN** Positif COVID-19?		
	a. Adakah keluarga serumah atau ahli tabligh dari kumpulan kecil, disahkan positif COVID-19?		
	b. Berada bersama di dalam bilik yang **TERTUTUP** yang menggunakan penghawa dingin lebih dari 2 jam		
	c. Bekerja / bersemuka dalam **RUANG TERTUTUP** yang sama, dalam jarak kurang dari **1 METER** melebihi **15 MINIT**		
	d. Menaiki kenderaan yang sama **(melebihi 2 jam)** dalam jarak 2 kerusi (2meter) dari individu positif COVID-19		

SIMPTOM	YA	TIDAK
Demam		
Batuk		
Sakit Tekak		
Selsema		
Sesak Nafas		
Lain - lain:		
Suhu Badan		

HENTIKAN COVID-19!

KEJUJURAN ANDA BOLEH MENYELAMATKAN RAMAI NYAWA TERMASUK ANGGOTA KESIHATAN

BANTULAH KAMI UNTUK MEMBANTU ANDA.

Tandatangan Pesakit

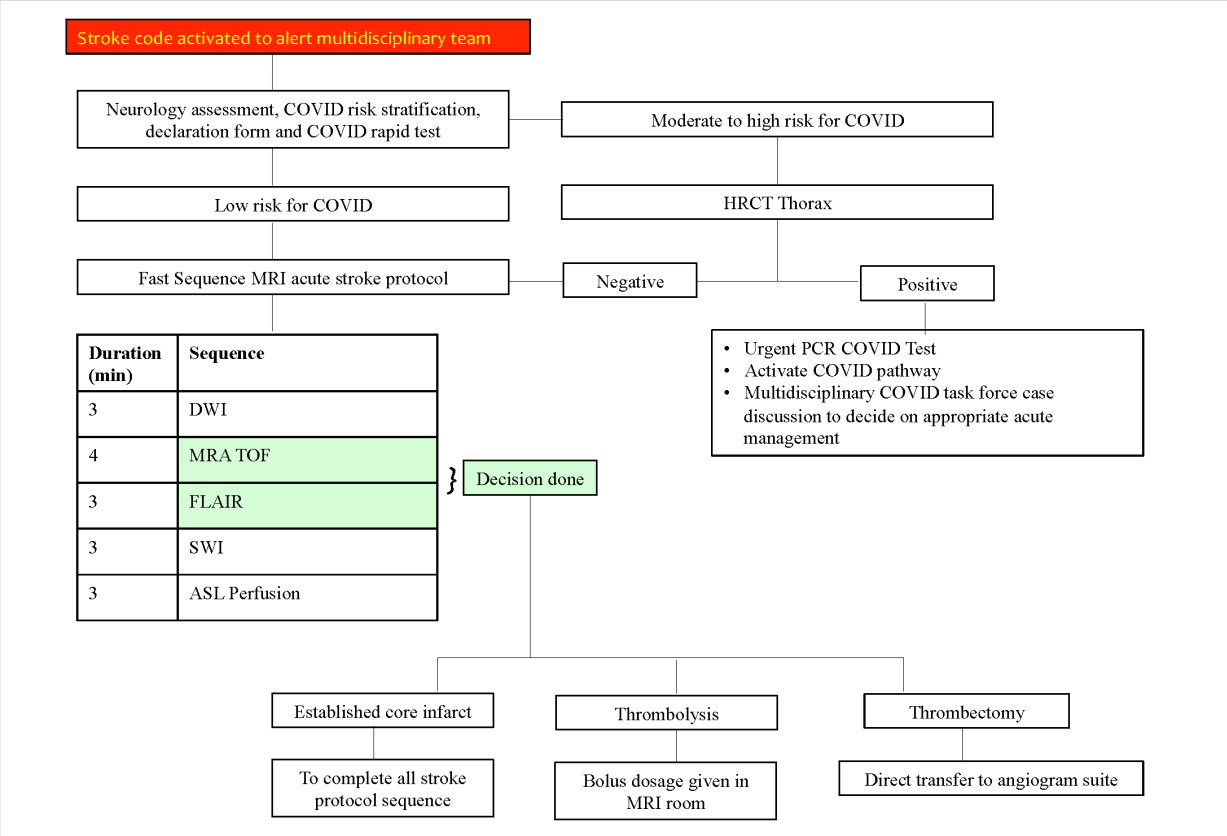
Nama

Tandatangan Anggota Kesihatan

Nama
No Kad Pengenalan / Cop Jawatan

Figure 1. Declaration form to be filled and signed by the patient or next of kin

Figure 2. Full PPE adhered by the Interventional Radiologist team



Duration (min)	Sequence
3	DWI
4	MRA TOF
3	FLAIR
3	SWI
3	ASL Perfusion

Table 1. Our Institutional MRI protocol and its acquisition time

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