

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 metastasis¹. Bone is the most common site for metastasis followed by lung and liver² with spine being the most common site for bone metastasis³. 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 involved⁷. 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 time¹⁷. 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 metastasis¹⁸. 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.

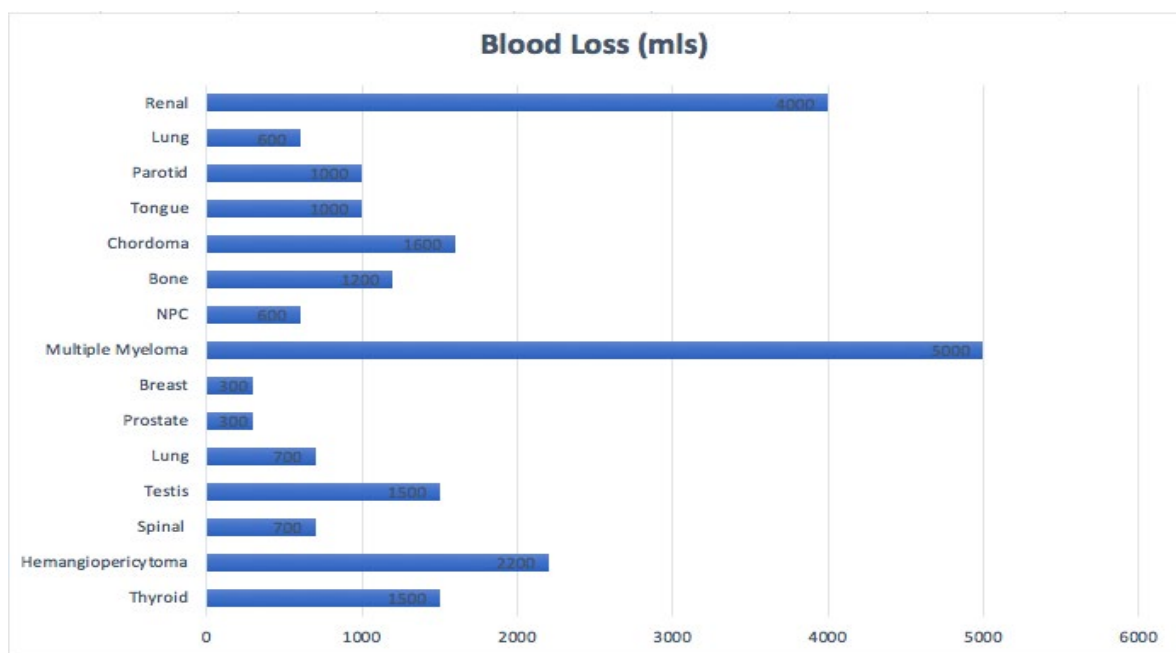


Figure 1

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

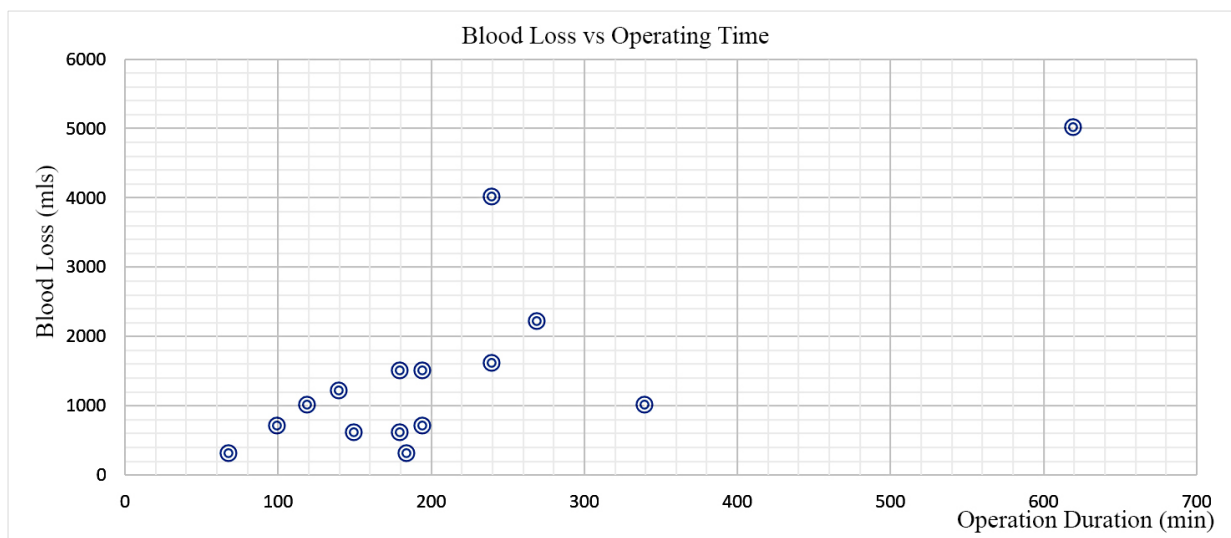
showed there was significant difference in intraoperative blood loss between those who had complete embolisation and those with incomplete embolisation with P value of less than 0.01 (**Table 3**).

Degree of Embolisation (Complete / Incomplete)	Number of Cases	Mean Blood Loss (in ml)
Complete	10	1360
Incomplete	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 2008¹⁹. 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 1800ml²⁰. **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) 28 (control group)	Case control study	EBL: 250 - 2900 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 blush demonstrated in angiogram into 0 until 3, with 3 being the worst which demonstrated severely increased tumoral blush with early arteriovenous shunting²¹. 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 devascularisation²². 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 diameter¹⁶. 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 devascularisation²¹. 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 devascularisation¹⁶. 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 embolisation²⁵.

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 blush 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 vascularity²¹. 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 another¹⁶. 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 embolisation²¹.

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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APPENDIX 1

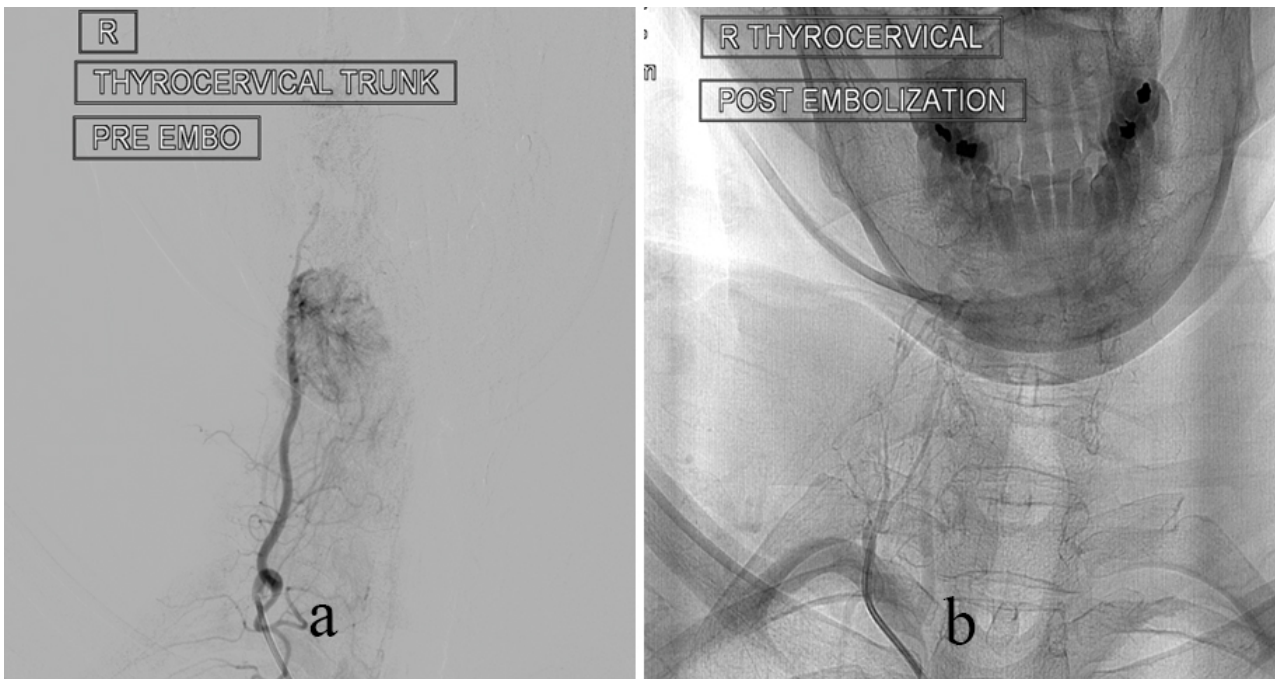


Figure 3

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.

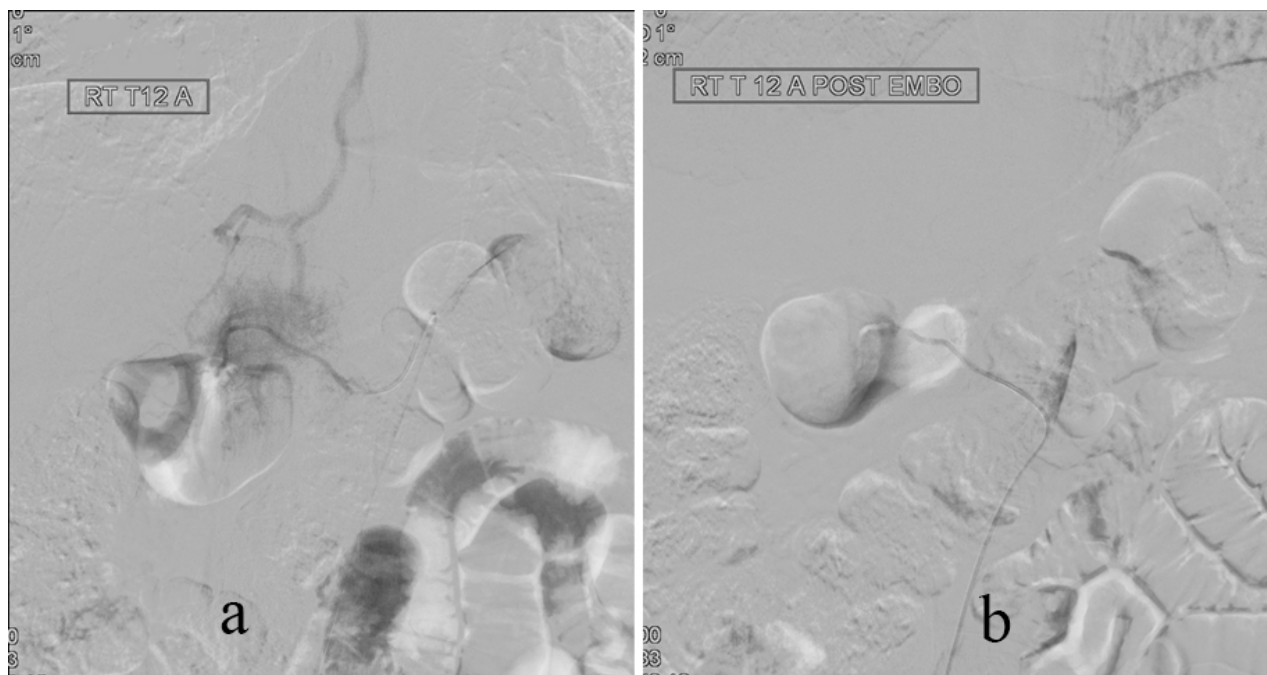


Figure 4

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.

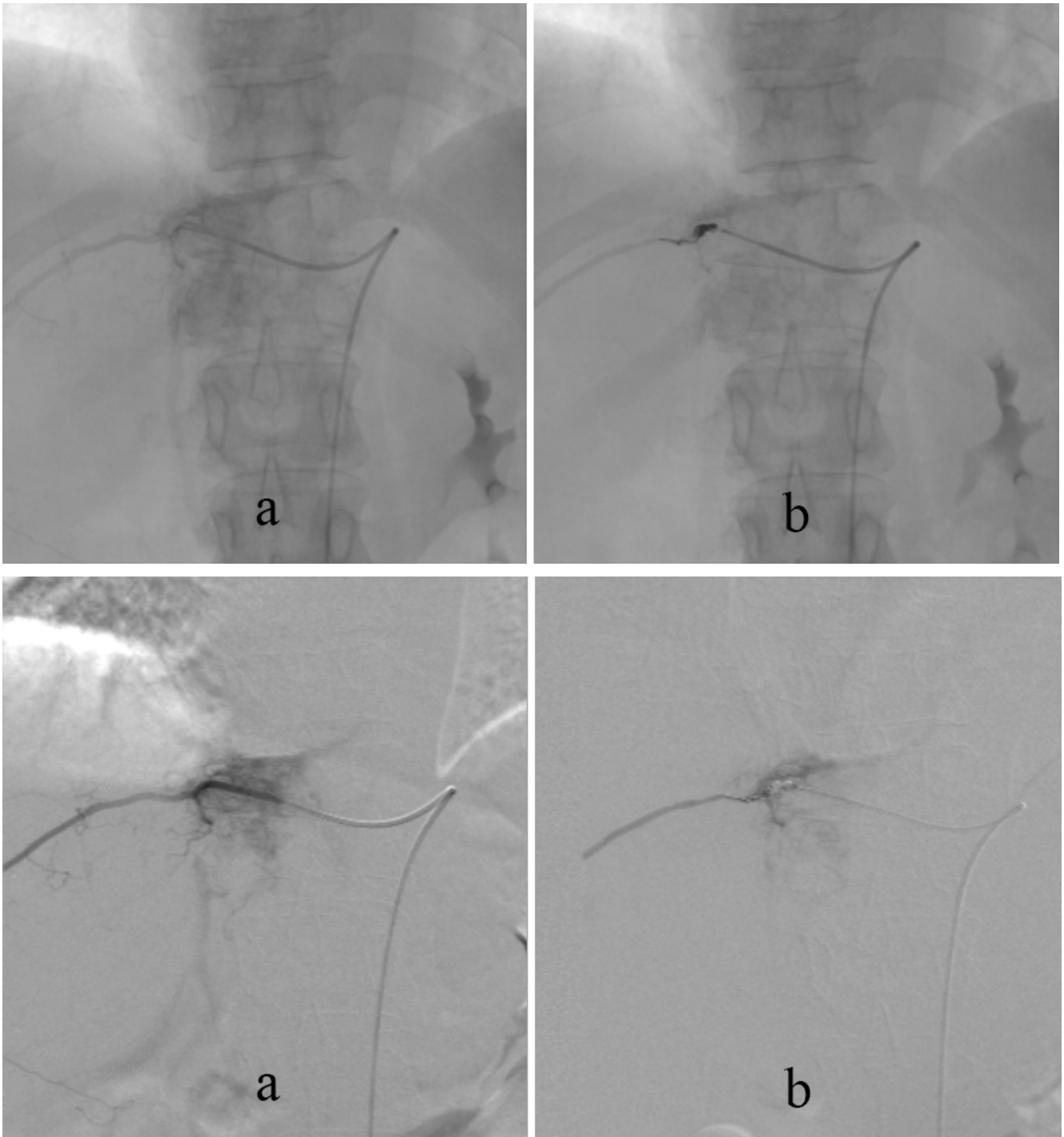


Figure 5

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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