# Treatment of spinal metastasis: Interventional options

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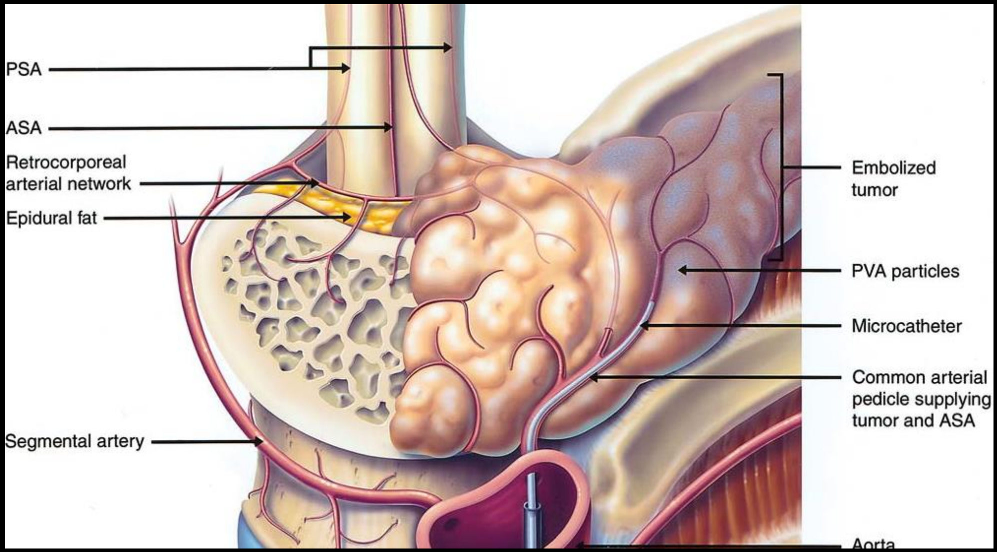
ECMINT 3.1

# Aims

- Review management of spinal metastasis
- Consider treatment options available
- Discuss the role of interventional techniques
- Review selected interventional cases

# Metastatic spinal cord compression

- Compression of the dural sac and contents by tumour
- 95-98% of vertebral tumours are metastases
- Breast > prostate > lung > renal = GI > thyroid
- 70% T/L, 20% L/S, 10% CS



# Typical presentation

- Constant local pain, worse straining* or at night
- Mechanical pain with exercise or position
- Neurological features
- Local mass
- Systemic symptoms

# Neurological features of MSCC

- Pain < 95%
- Motor deficit < 80%*
- Sensory symptoms may precede signs
- Autonomic features
- Cauda equina syndrome

# Evaluation

- Clinical status
- Lab results
- Radiology: plain film, bone scan, CT, MRI
- Histology

NICE guidance

- Pain ?malignancy MRI < 7/7
- Pain ?MSCC MRI < 24h

# Treatment objectives: spinal

Primary aim is to optimise QOL

- PAIN RELIEF
- Maintain or improve neurological function
- Maintain or restore integrity of the spinal column

# Multidisciplinary discussion: MDT

INPUT

- Histology and grading of malignancy
- Primary and remote disease (staging)
- Location / extent of spinal tumour
- Spinal stability
- Neurological function
- Co-morbidities / functional status

OUTPUT

- Best management option

# Harrington 1986

I. No significant neurologic compromise

II. Involvement of bone with minimal neurological impairment, but without collapse

III. Major neurologic impairment without significant involvement of bone

IV. Vertebral collapse with pain resulting from mechanical causes or instability, but with no significant neurologic compromise

V. Vertebral collapse or instability with major neurologic compromise

# Tomita prognostic score

**Table 1** Tomita prognostic score [7]

| | Score 1 | Score 2 | Score 4 |
|---|---|---|---|
| Primary tumour | Slow growth | Moderate growth | Rapid growth |
| Visceral metastases | | Treatable | Untreatable |
| Bone metastases | Solitary | Multiple | |

For each category (primary tumour, visceral and bone metastases) a score of 1, 2 or 4 is allocated according to the table above; these scores are added to provide a total score up to a maximum of 10

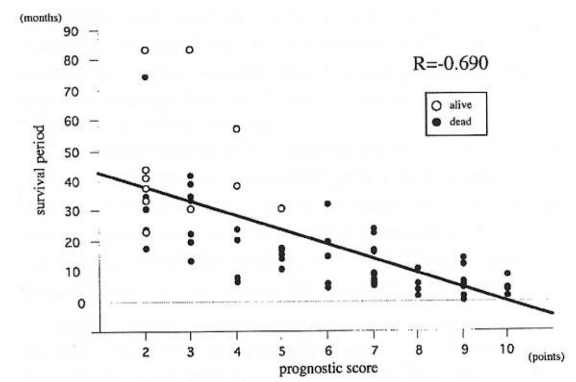
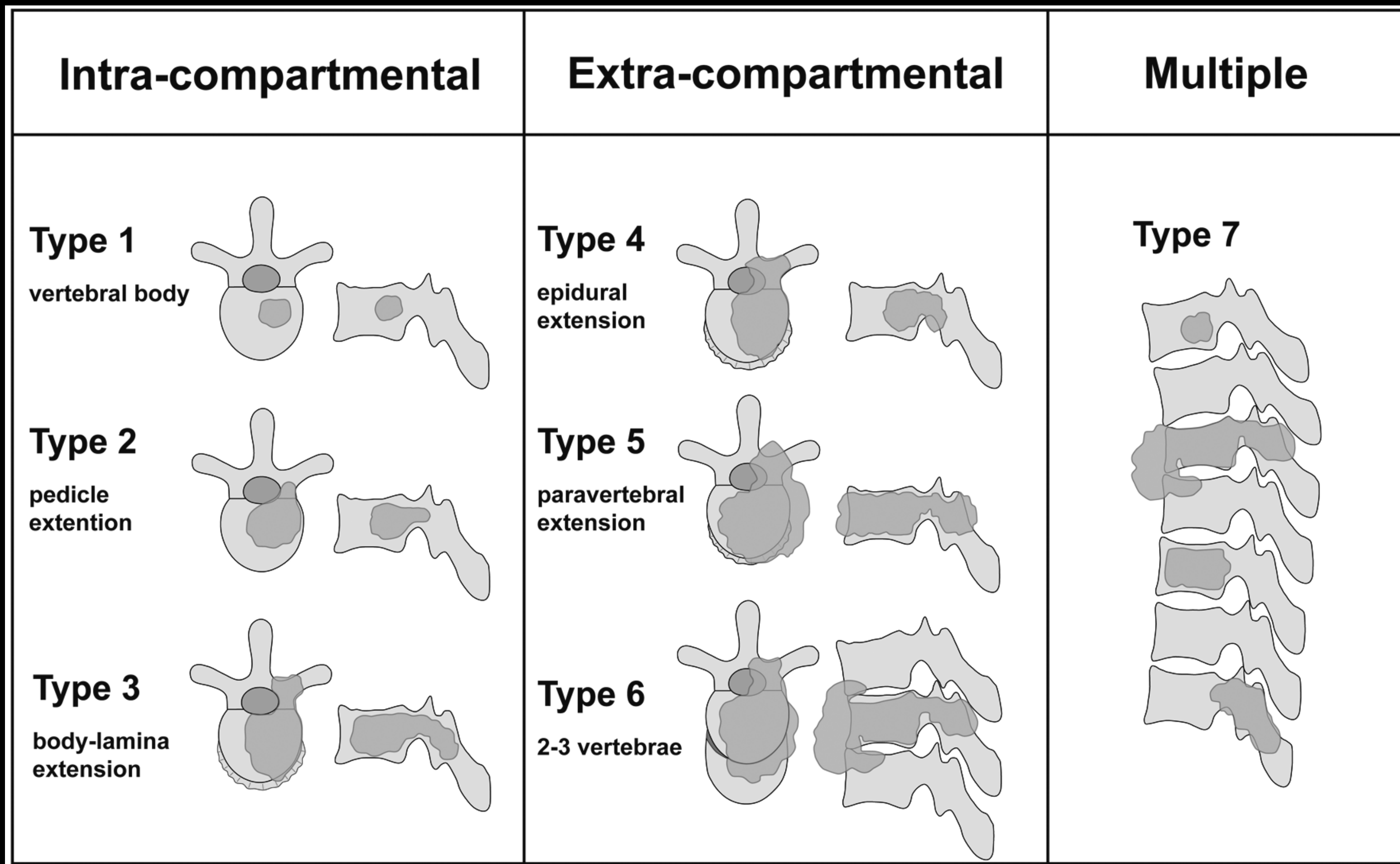



Figure 2. Relation between the prognostic score and the survival period. There was a high-grade correlation between the prognostic score and survival period, with a correlation coefficient of $-0.690$ ($P < 0.0001$).

Tomita K, Kawahara N, Kobayashi T et al (2001) Surgical strategy for spinal metastases. Spine 26:298–306

# Tomita grade




Tomita K, Kawahara N, Kobayashi T et al (2001) Surgical strategy for spinal metastases. Spine 26:298–306

# Tomita grade: prospective application

| Score | Surgery | Average life time |
| --- | --- | --- |
| 2-3 | Wide excision | 38m |
| 4-5 | Maginal / intralesional resection | 21m |
| 6-7 | Palliative surgey | 10m |
| 8-10 | Non-surgical | - |

# Tokuhashi score

| | | |
|---|---|---|
| Able to carry on normal activity and to work; no special care needed. | 100 | Normal no complaints; no evidence of disease. |
| | 90 | Able to carry on normal activity; minor signs or symptoms of disease. |
| | 80 | Normal activity with effort; some signs or symptoms of disease. |
| Unable to work; able to live at home and care for most personal needs; varying amount of assistance needed. | 70 | Cares for self; unable to carry on normal activity or to do active work. |
| | 60 | Requires occasional assistance, but is able to care for most of his personal needs. |
| | 50 | Requires considerable assistance and frequent medical care. |
| Unable to care for self; requires equivalent of institutional or hospital care; disease may be progressing rapidly. | 40 | Disabled; requires special care and assistance. |
| | 30 | Severely disabled; hospital admission is indicated although death not imminent. |
| | 20 | Very sick; hospital admission necessary; active supportive treatment necessary. |
| | 10 | Moribund; fatal processes progressing rapidly. |
| | 0 | Dead |

**Box 1:** Frankel scale[9]

A. Absent motor and sensory function
B. Sensation present, absent motor function
C. Sensation present, motor function present but not useful (Grade 2–3/5)
D. Sensation present, motor function present and useful (Grade 4/5)
E. Normal motor and sensory function.

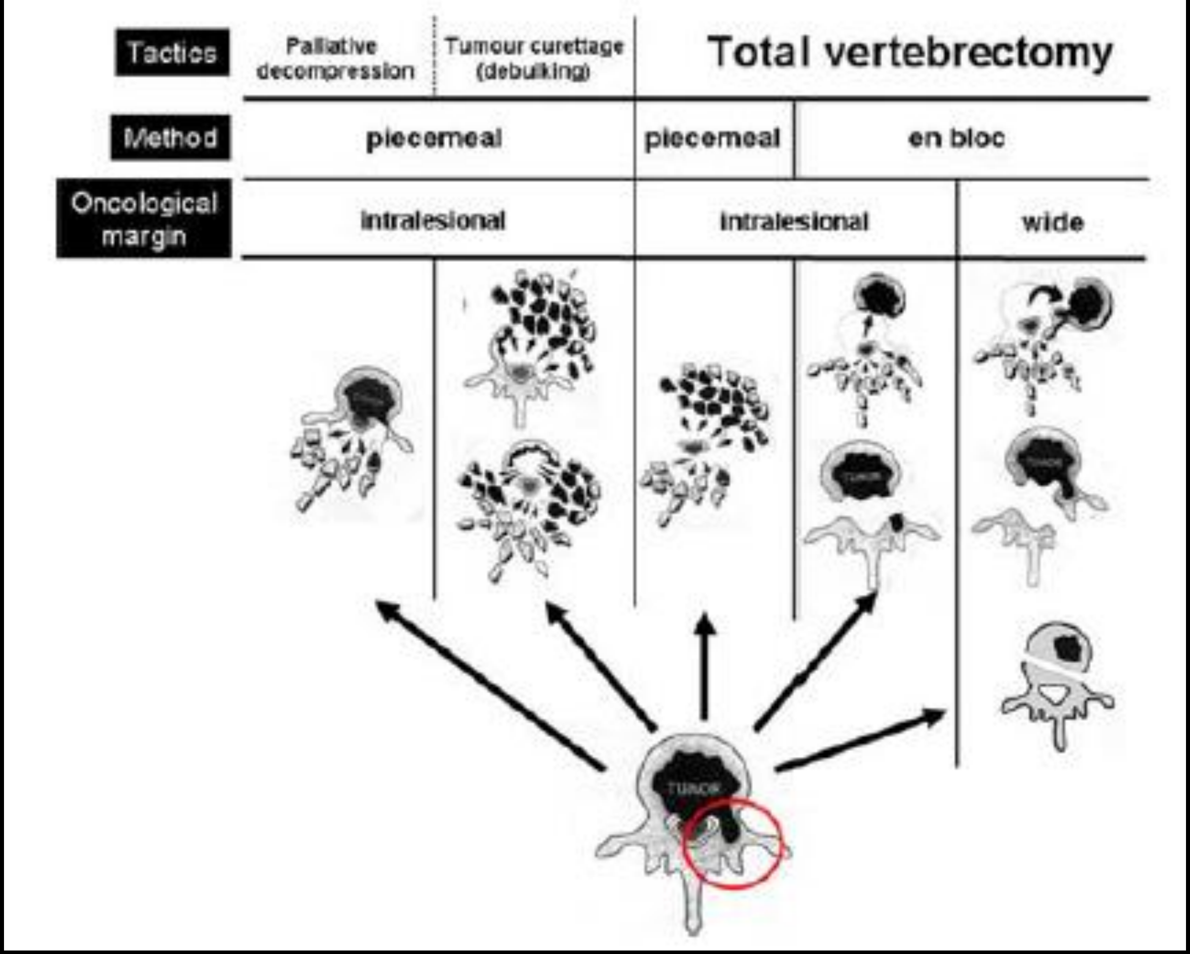
**Table 2** Revised Tokuhashi prognostic score [10]

| | Score 0 | Score 1 | Score 2 | Score 3 | Score 4 | Score 5 |
|---|---|---|---|---|---|---|
| Karnofsky's performance (%) | 10–40 | 50–70 | 80–100 | | | |
| Extraspinal bone metastases | 3 or more | 1–2 | 0 | | | |
| Vertebral metastases | 3 or more | 2 | 1 | | | |
| Visceral metastases | Unremovable | Removable | None | | | |
| Primary site (e.g.) | Lung | Liver | Other | Kidney | Rectum | Breast |
| Palsy | Frankel A, B | Frankel C, D | Frankel E | | | |

Scores for the six individual criteria above are added to provide a total score up to a maximum of 15

Tokuhashi Y, Matsuzaki H, Oda H et al (2005) A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis. Spine 30:2186–2191

# Improving the consistency of documentation of surgical technique



Eur Spine J (2010) 19:215–222
DOI 10.1007/s00586-009-1252-x

REVIEW ARTICLE

# Review of metastatic spine tumour classification and indications for surgery: the consensus statement of the Global Spine Tumour Study Group

David Choi · A. Crockard · C. Bunger · J. Harms ·
N. Kawahara · C. Mazel · R. Melcher · K. Tomita

- Variable surgical approaches and inconsistent documentation confound validation of scoring systems as tools to predict patient outcome
- Consistent use of scoring tools improves data

# Main treatment options

- Palliative
- Radiotherapy
- Chemotherapy
- Surgery
- Interventional

# Palliative Treatment

- Othotics
- Analgaesia, steroids, chemotherapy
- RT for pain
- Nerve root blocks
- Laminectomy

# Relative indications for RT

- No spinal instability
- Stable or slowly progressive deficit caused by (multi-level) soft tissue compression (not bone)
- Radiosensitive tumour (lymphoma, myeloma, seminoma, neuroblastoma)
- Moderately responsive tumour without pain/instability (breast, prostate, lung, colon)
- Less than 3/12 life expectancy
- Poor surgical candidate or adjunct to surgery
- Complete deficit

# RCT confirming benefit of surgery

- Multicentre, non-blinded Sx+RT vs. RT alone
- Primary outcome – ability to walk
- Stopped after interim analysis of 101 patients
- 84% Sx+RT could walk vs 57% RT alone
- 30/7 mortality and LOS same for both groups
- Sx+RT
  - Maintenance of walking longer
  - Maintained continence
  - Reduced steroid and opiate requirements

Patchell RA. Lancet 2005;366:645-648

# Surgical indications

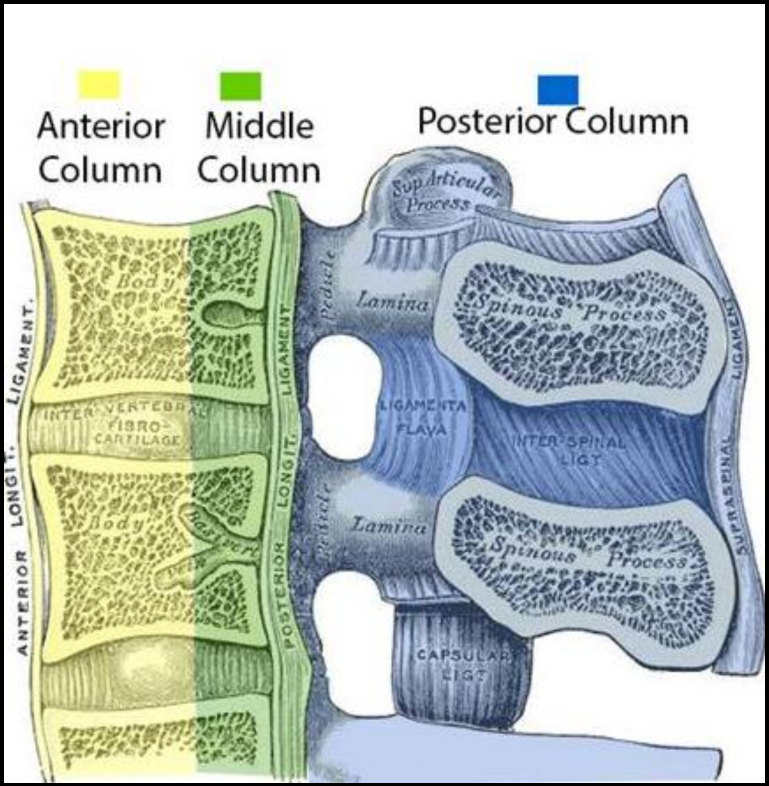
- Symptomatic radio-resistant lesion*
- Pain (impending fracture)
- Spinal instability / deformity
- Neural compression**
- Failure of radiotherapy
- Definitive histology required

# Spinal stability / pathological fracture

Biomechanical relationship between

- Tumour location (related to columns)
- Tumour extent
- Inherent bone mineral density

- Unstable if all columns involved or if >20º angulation



# Criteria for impending collapse

Teneichi, Spine 1997

T1-T10

- 50-60% of vertebral body
- 25-30% of body with costovertebral joint destruction

T10-L5

- 30-40% of vertebral body
- 20-25% of vertebral body with posterior element destruction

# Spinal Instability Neoplastic Scale

SINS score a reliable tool to assess instability

0-6 Stable

7-12 Potentially unstable

13-18 Unstable

Fisher CG. AJR 2014;203:869-874

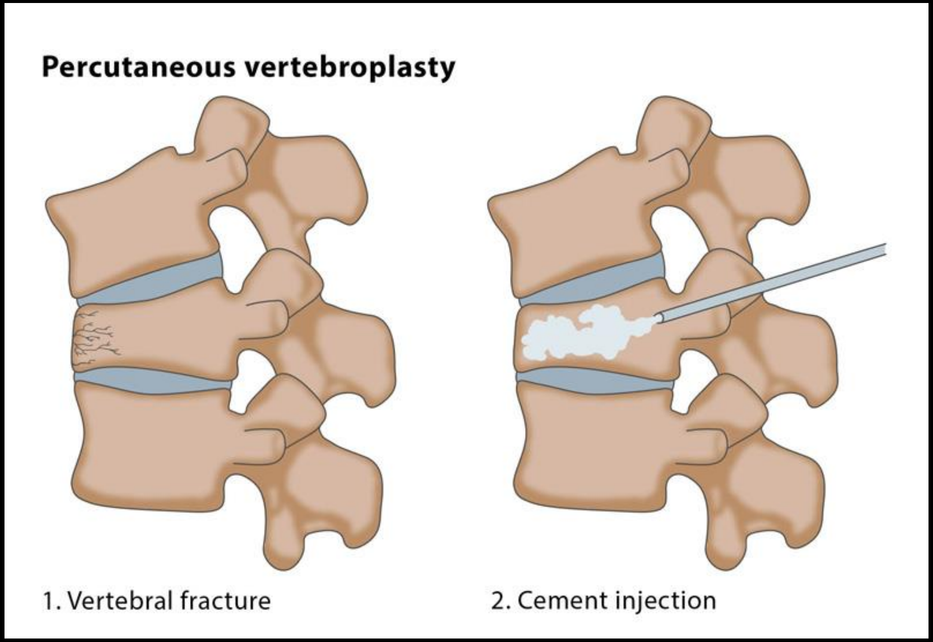
**TABLE I: The Spinal Instability Neoplastic Scale (SINS) Classification According to Fisher et al. [7]**

| Parameters | Score (Points) |
|---|---|
| Location | |
| Junctional (occiput–C2, C7–T2, T11–L1, L5–S1) | 3 |
| Mobile spine (C3–C6, L2–L4) | 2 |
| Semirigid (T3–T10) | 1 |
| Rigid (S2–S5) | 0 |
| Pain[a] | |
| Yes | 3 |
| Occasional pain but not mechanical | 1 |
| Pain-free lesion | 0 |
| Bone lesion | |
| Lytic | 2 |
| Mixed (lytic/blastic) | 1 |
| Blastic | 0 |
| Radiographic spinal alignment | |
| Subluxation/translation present | 4 |
| De novo deformity (kyphosis/scoliosis) | 2 |
| Normal alignment | 0 |
| Vertebral body collapse | |
| > 50% collapse | 3 |
| < 50% collapse | 2 |
| No collapse with > 50% body involved | 1 |
| None of the above | 0 |
| Posterolateral involvement of spinal elements[b] | |
| Bilateral | 3 |
| Unilateral | 1 |
| None of the above | 0 |

Note—The scores for the six radiographic and clinical components were added together to yield a total SINS score ranging from 0 to 18. Reprinted with permission from [7]: Fisher CG, DiPaola CP, Ryken TC, et al. A novel classification system for spinal instability in neoplastic disease: an evidence-based approach and expert consensus from the Spine Oncology Study Group. *Spine (Phila Pa 1976)* 2010; 35:E1221–E1229.
[a]Pain improvement with recumbency, pain with movement or loading of spine, or both.
[b]Facet, pedicle, or costovertebral joint fracture or replacement with tumor.

# Surgical spinal stabilisation

- Pedicle screws and rods
- Bone implants, titanium mesh cages
- Vertebroplasty



# Surgical aims

- Mechanical stabilisation (pain relief)
- Prevent or alleviate neural compression
- Oncological palliation or cure

Mostly palliative with a view to improving QOL

# Surgical options by spinal location

- C1-C2 Posterior stabilisation
- C3-C6 Anterior corporectomy / reconstruction
- C7-T2 Posterior fixation
- T2-T5 Posterior trans-pedicular or costotransversectomy
- T6-L5 Anterior, Posterior or combined

# Tailor treatment to account for:

- Ability to tolerate the procedure (malnutrition, pre-op radiotherapy, steroids, immune status, comorbidities)
- Life expectancy over (3/12?)
- Patient and family's wishes

Surgery vs. less invasive options

- Percutaneous treatment, RFA, SRS (lower risk of wound infection, atelectasis, PE)

# Surgery likely to be beneficial

- Single level compressive lesion
- High life expectancy
- Palliative role to improve QOL
- Resection offers disease-free survival

# Timing of surgery

- Decompression more likely to be effective if
    - Onset gradual
    - Deficit incomplete
- Like RT, prompt treatment required for rapid onset symptoms
- Emergency surgery not justified if para or quadraplegic for more than 24hours (NICE)
- Complete deficit is not a contraindication to surgery

# Bleeding at surgery influenced by multiple variables

- Spinal level (lumbar > blood loss)
- Extent of tumour
- Vascularity of tumour
- Coagulopathy
- Surgical technique
- Extent of surgery
- Preoperative embolization?

# Rational for trans-arterial embolisation

- Spinal surgery for vascular tumours associated with major blood loss
- Embolic agents block tumour blood supply
- Approach: particle embolisation of microcirculation +/- regional vessel occlusion (coils, NBCA, Onyx)
- Proceed to surgery within 48 hours

# Evidence for benefit of embolisation

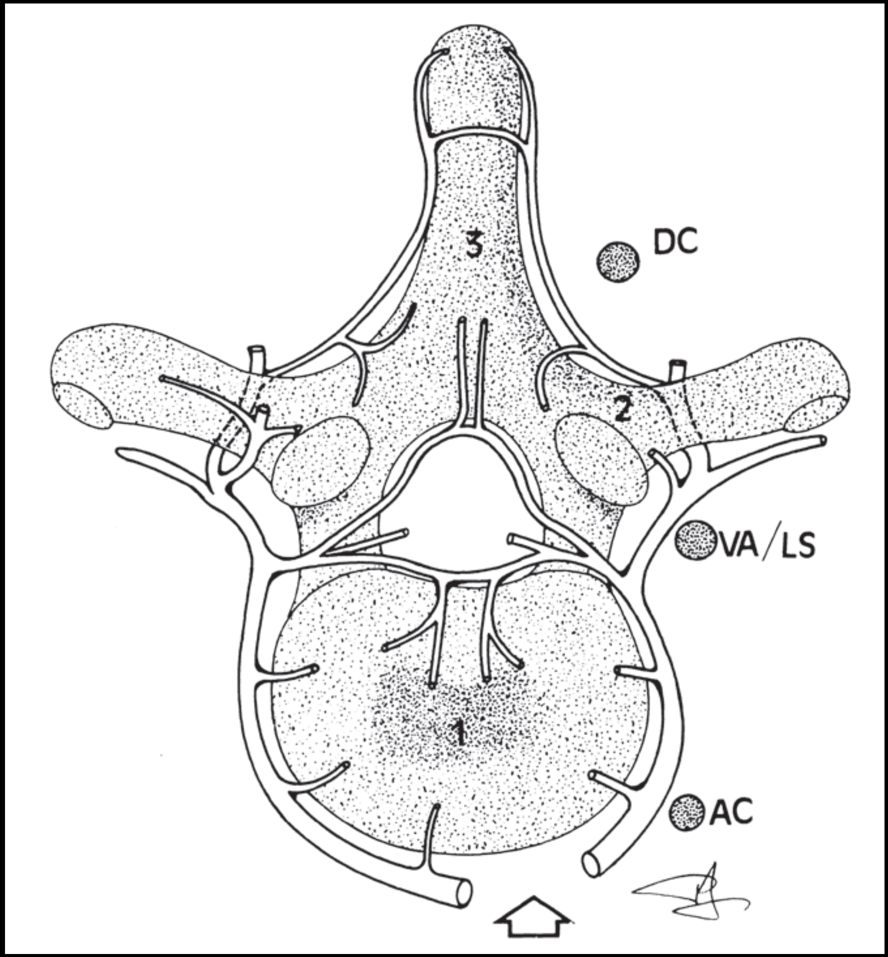
- Retrospective case series
- Small (poorly matched) cohorts
- Limited numbers (with subgroups)
- Poor or no definition of tumour extent
- Different techniques / materials
- Variable criteria for tumour vascularity, completeness of embolisation and or surgery

# Limited evidence and no RCT but an impression that it helps!

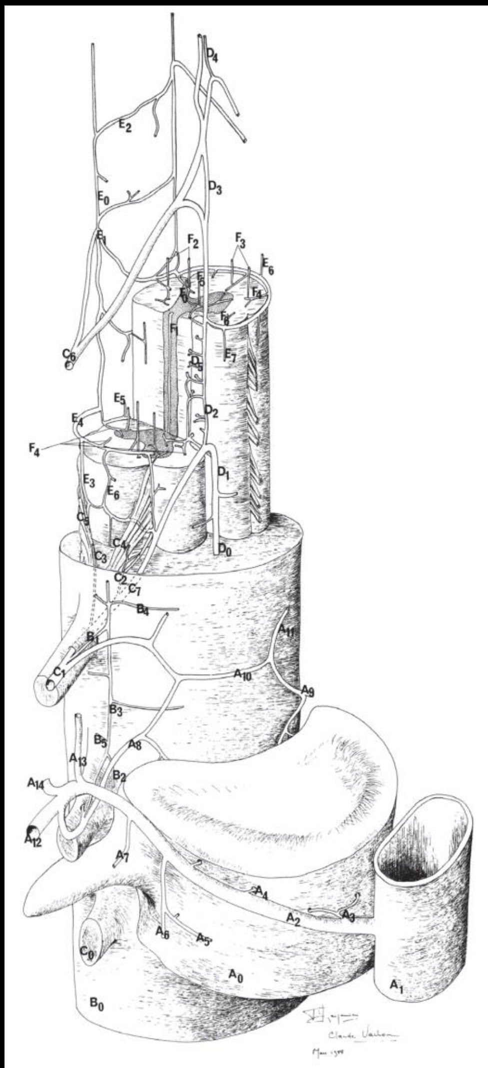
- Reported data indicates trend to less bleeding after embolization bias?
- Is surgical experience consistent with this?

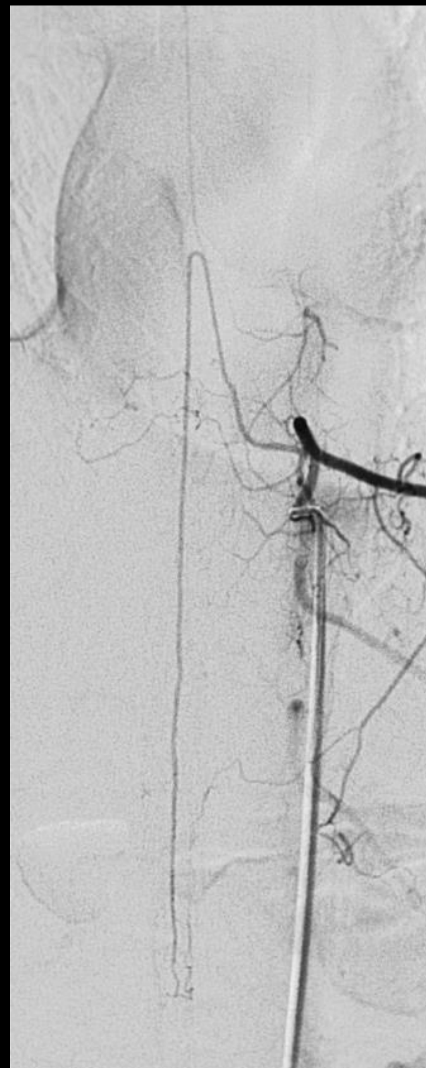
- Personal experience of RCC, recorded surgical blood loss equivalent or higher after embolisation but…
- Trends to shorter surgical procedure times and longer patient survival

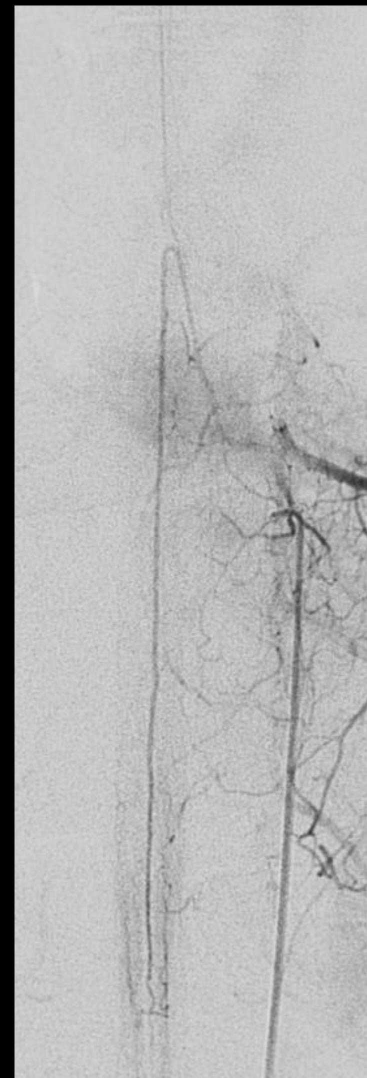
# Anatomy revision



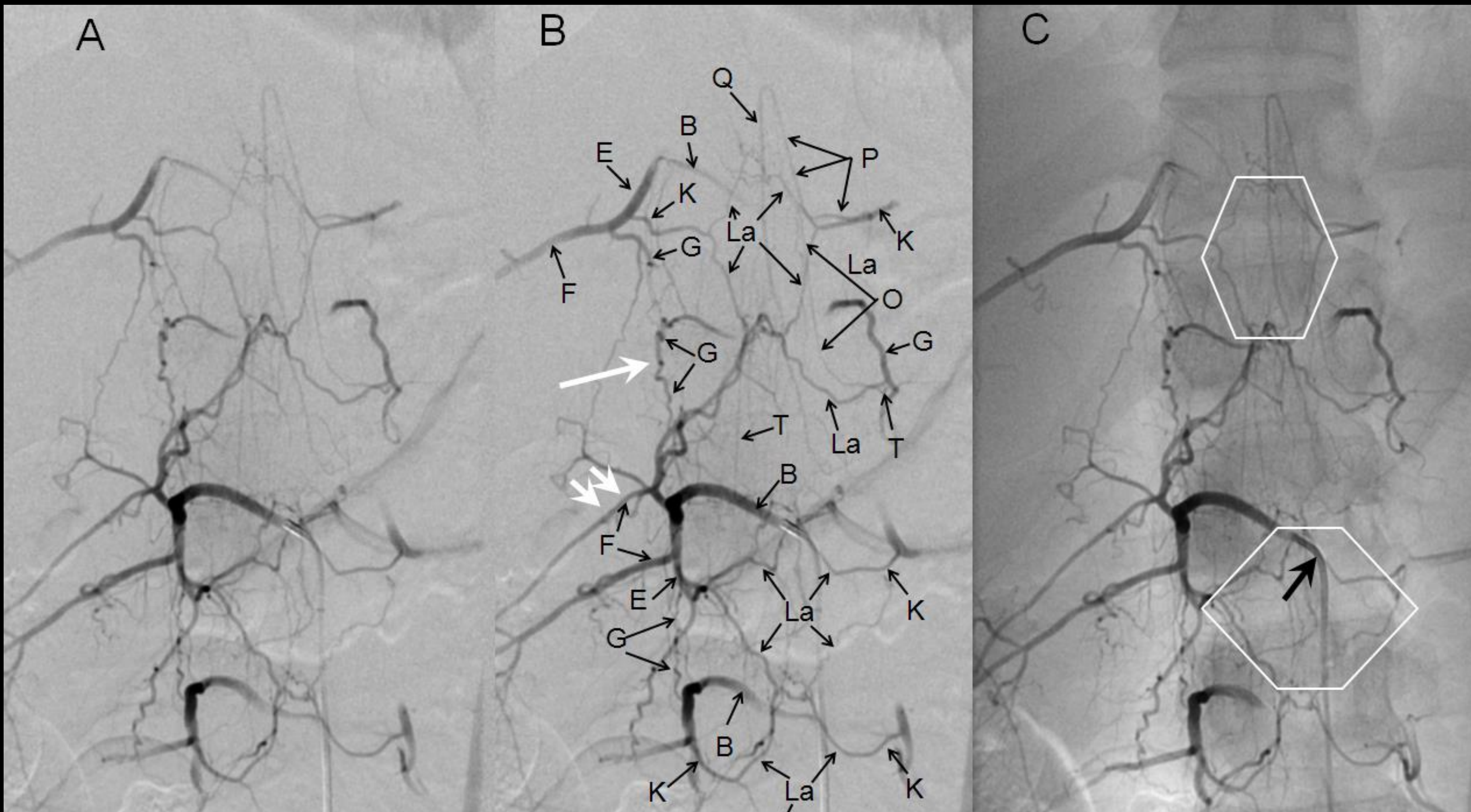
# Normal ASA run





# Example of collateral circulation



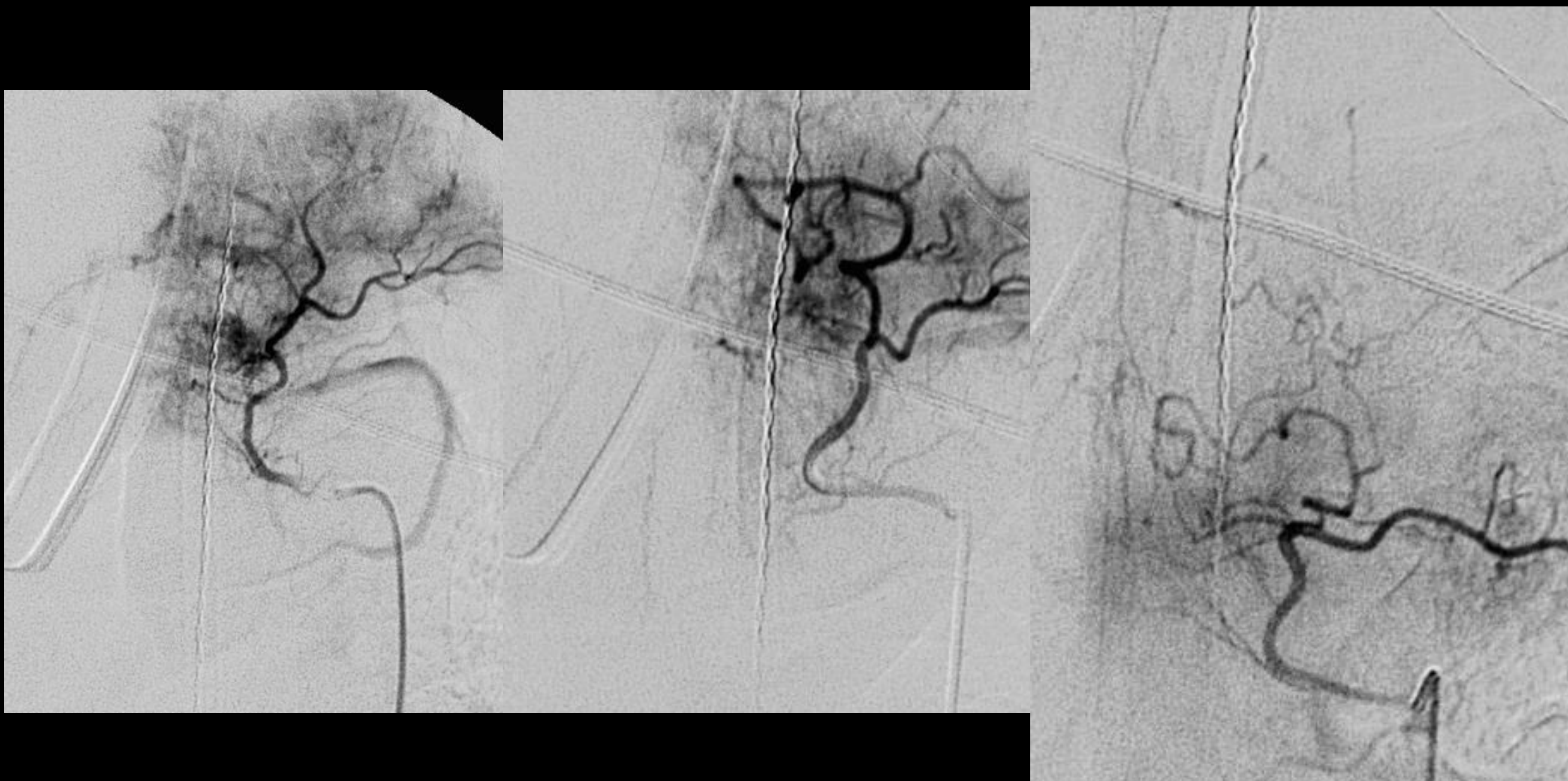
# Consider medical issues

- Neurological deficit
- Baseline cardiovascular function
- Renal function (contrast dosage)
- Coagulation status
- Allergies (contrast media)
- No routine requirement for antibiotics (consider for DM or urinary catheter)

# Steps in typical case

- Identify the normal anatomy (cord supply)
- Define the tumour supply
- Assess collateral circulation (levels)
- Gain stable access to tumour supply
- Optimise microcatheter position for selective embolisation
- Select materials (PVA 3-500u) and embolise
- Continuously re-screen anatomy (Cx)

# Case 1: RCC at T2
# Left T2, T3 and T4

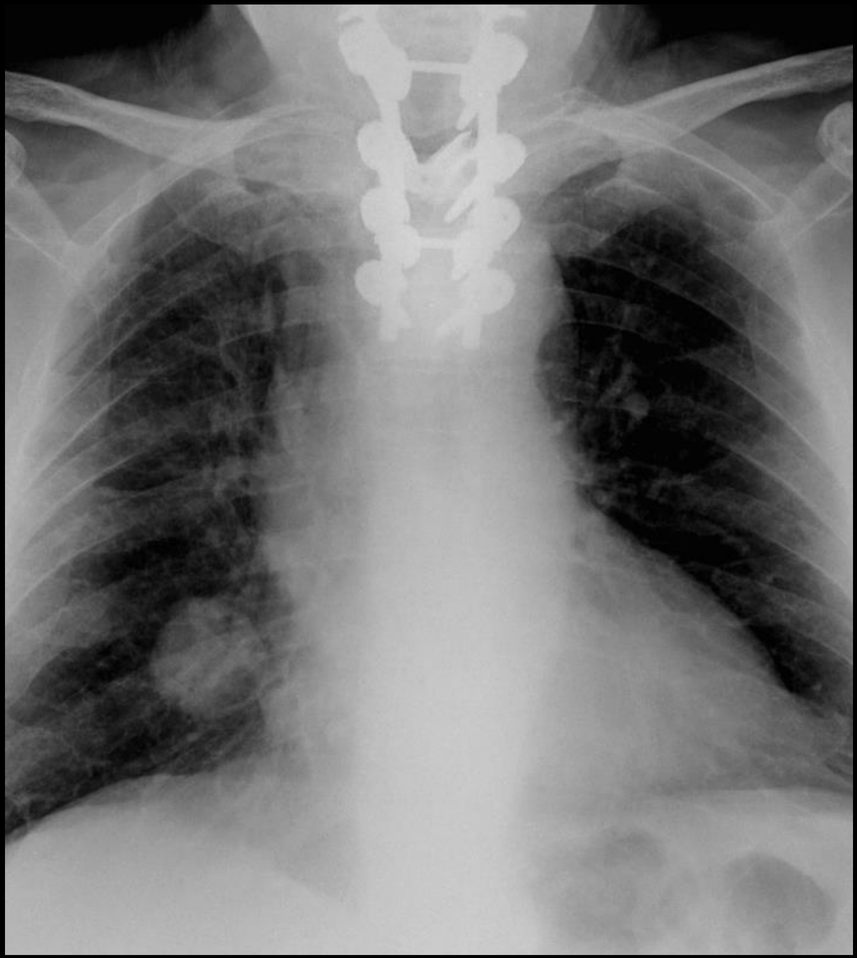


# Embolise Y/N?

- ASA at left T4
- Possible RM from VA at C4 with poor demonstration of ASA from above down
- Prominent para-spinal collaterals from T2 to T4
- Decision: no embolisation

# Outcome

- Partial resection and augmentation
- Posterior stabilization
- Preserved function
- CXR at 1/12
- RIP at 3/12



# Case 2: RCC metastasis at T4

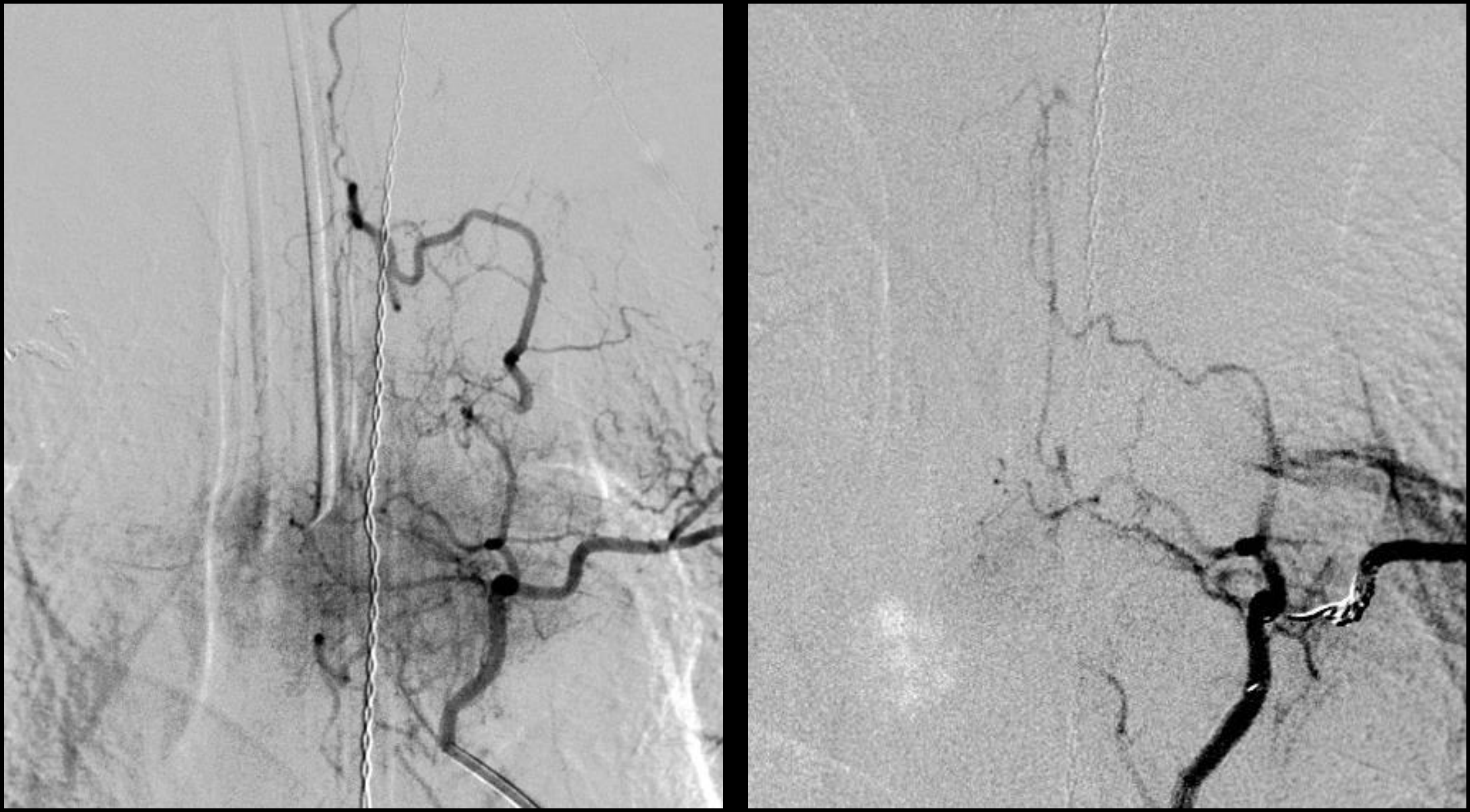
## Cord compression and partial sensory level at T10

## ASA from right VA and left T6

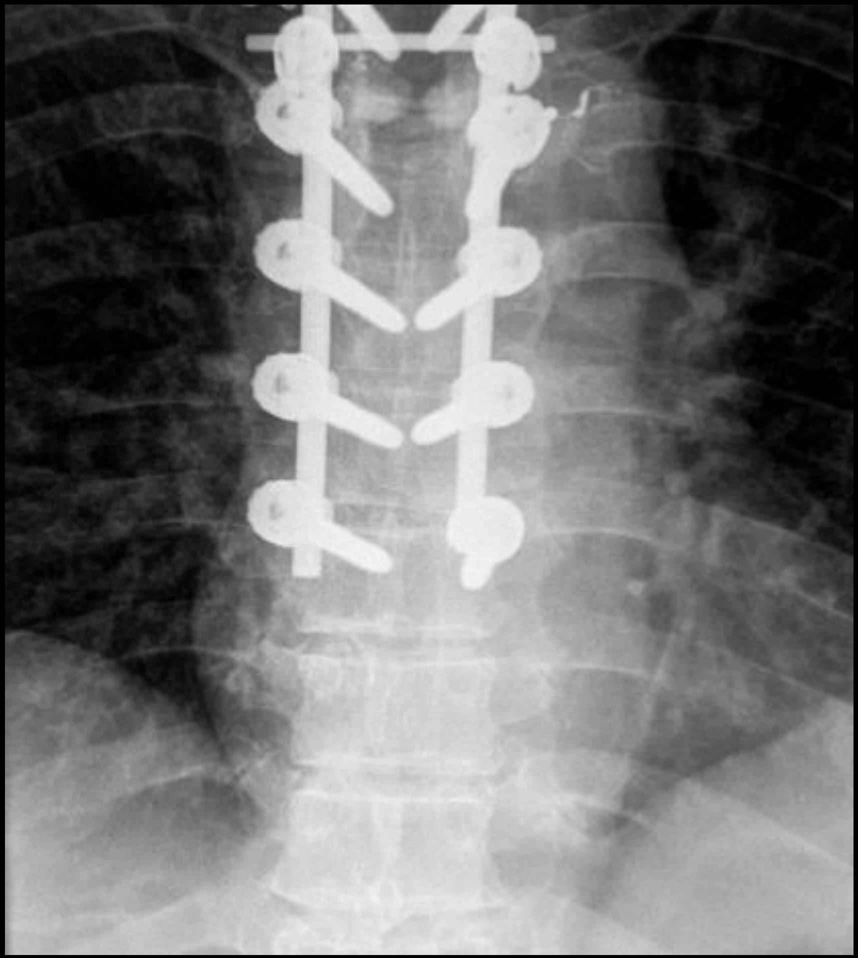
# Right T3/T4 intercostal

# Particles then NBCA

# Left T4 RP vessel *after* particles



# Cement augmentation, laminectomy and posterior stabilisation (Tomita 7)

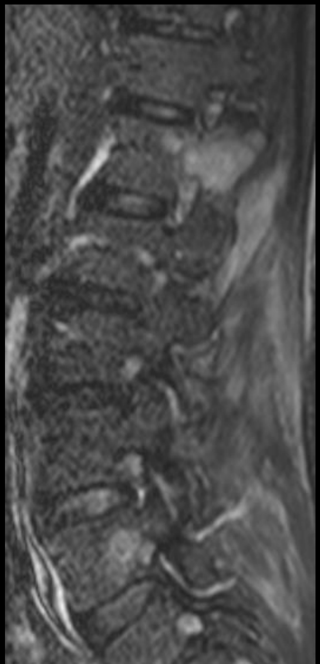
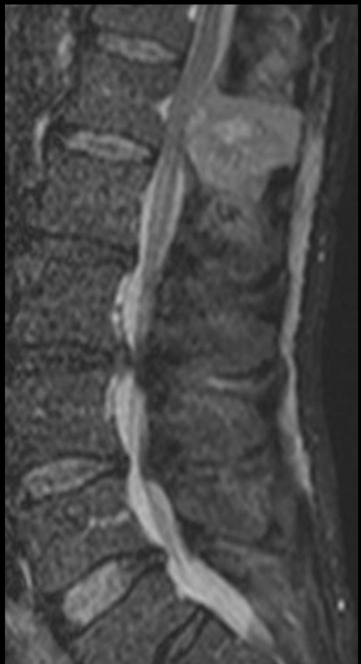


# Surgical feedback

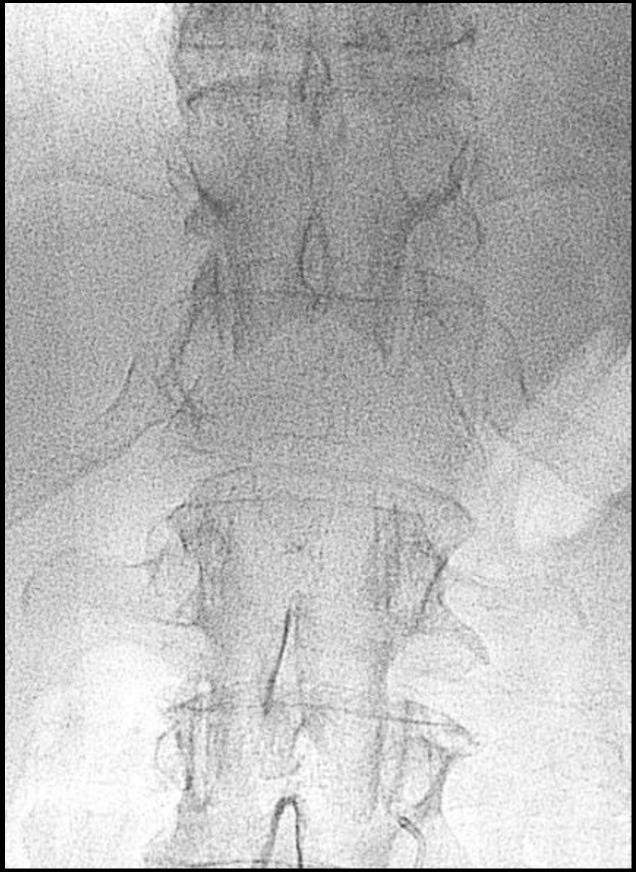
- Tumour debulked
- EBL 1,000ml ‘not much’ from tumour
- Stable neurology diminished PP to T10

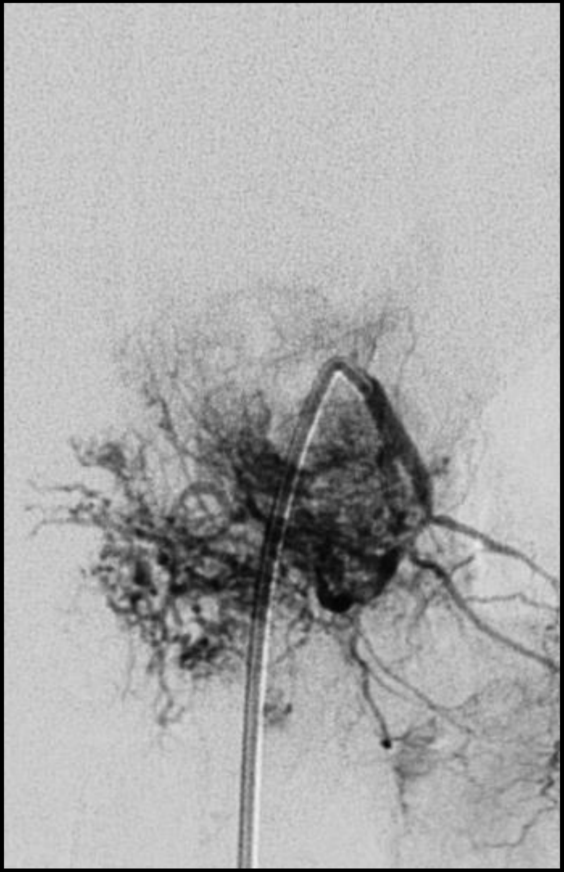
# Case 3: RCC at T12

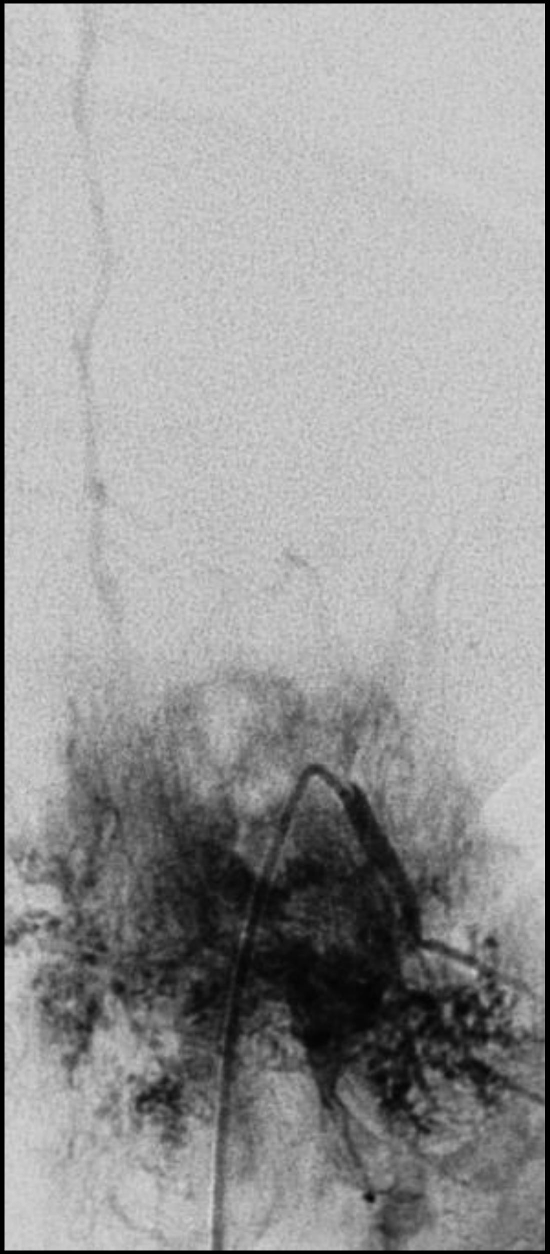
- Back pain, L2 weakness and weight loss
- CT right RCC, lung nodules, spinal metastasis with large posterior mass at T12


ASA off Rt T9
Lt T12 A-V shunting

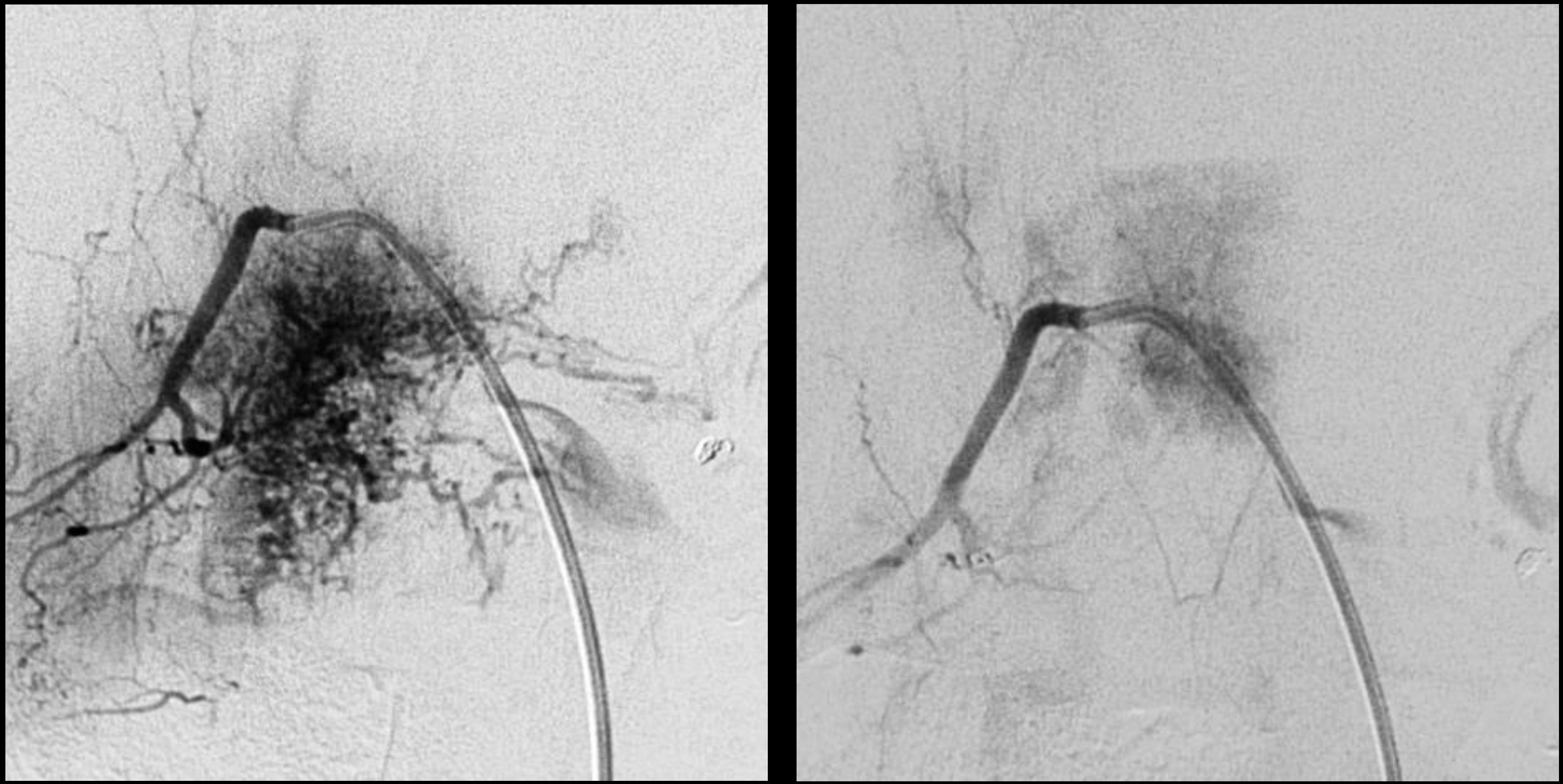




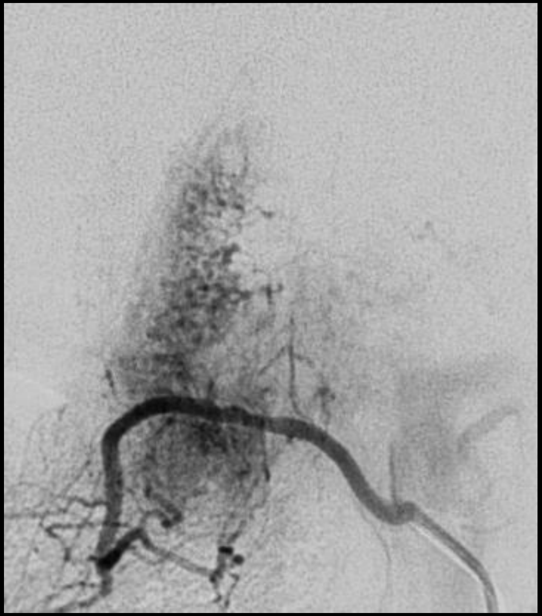


# Lt T12: 350-500u PVA

# Rt T12 pre/post

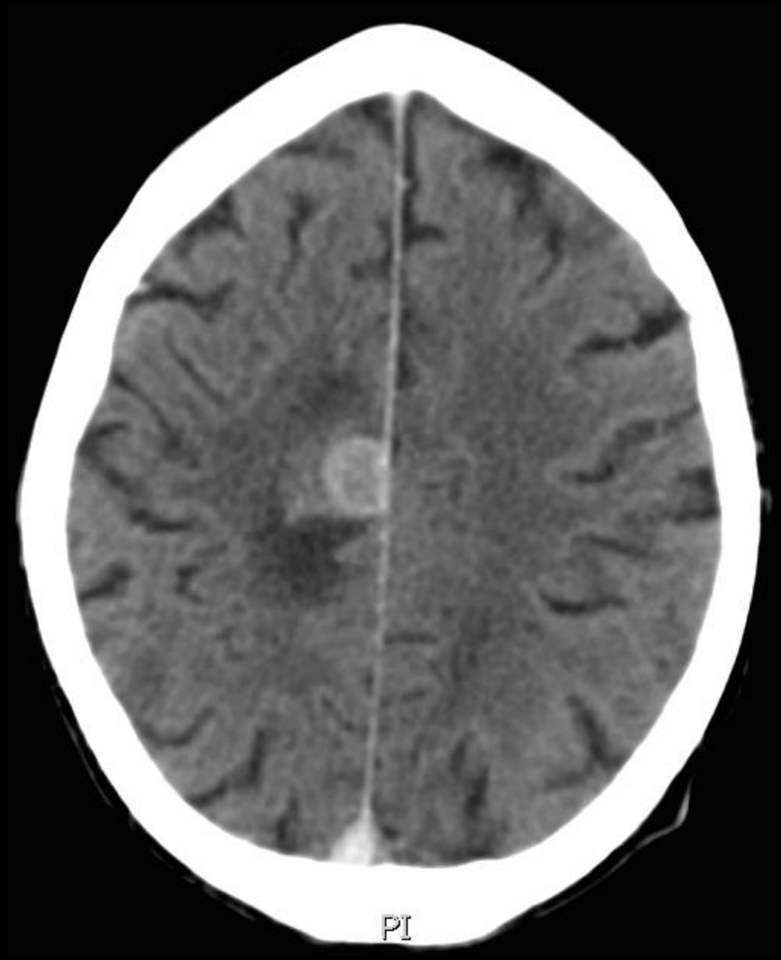


# Lt T11 and Rt L1



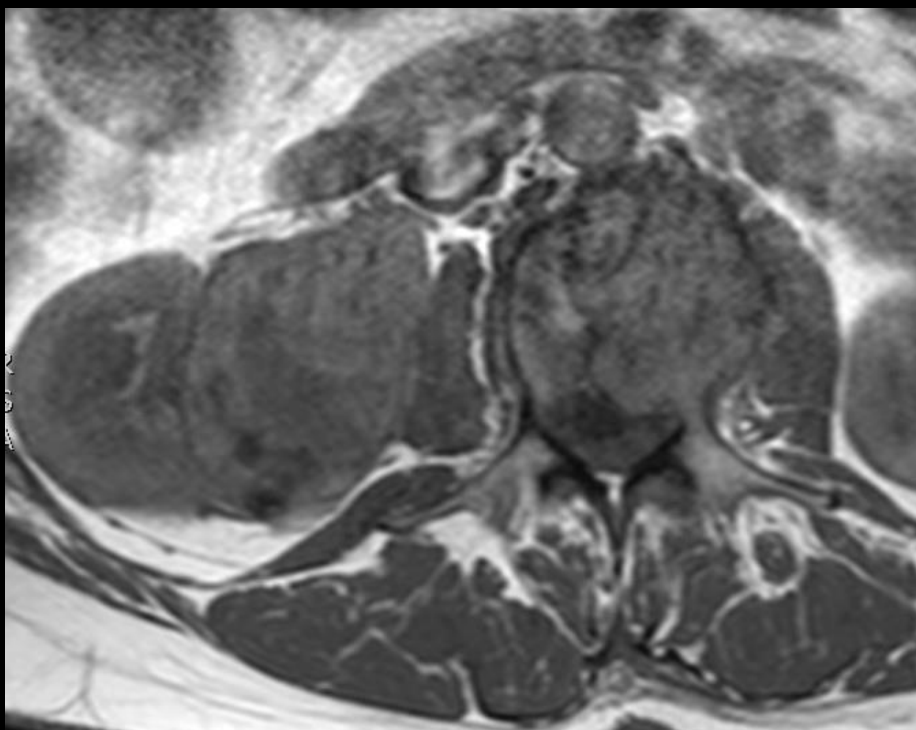
# Outcome

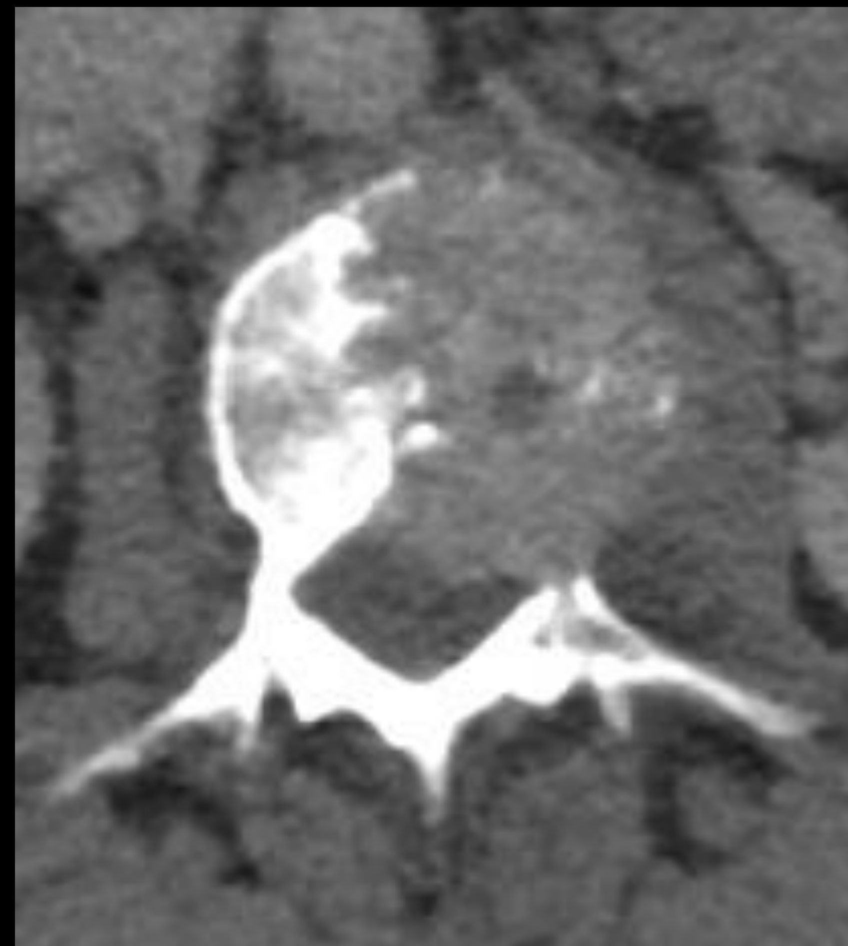
- Uncomplicated embolisation and spinal surgery
- Day 4 post-op confusion



# Case 4: L2 met RCC – axial pain

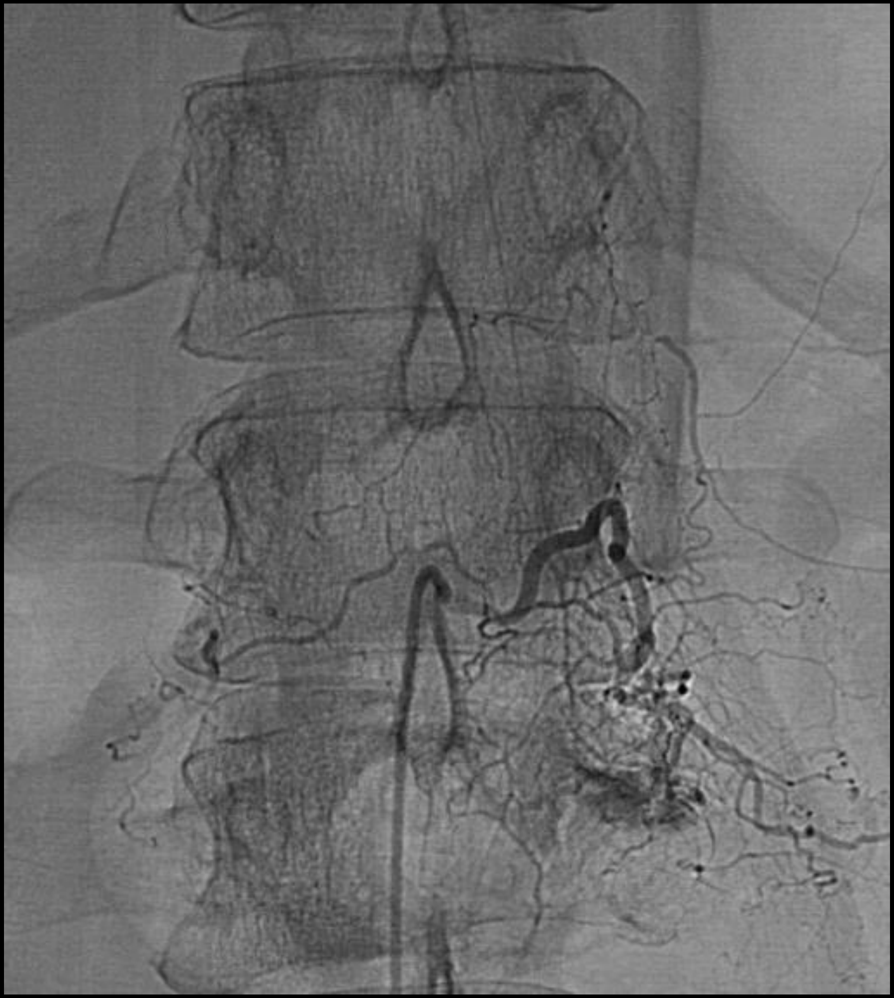
# L2 met RCC – Tomita 5

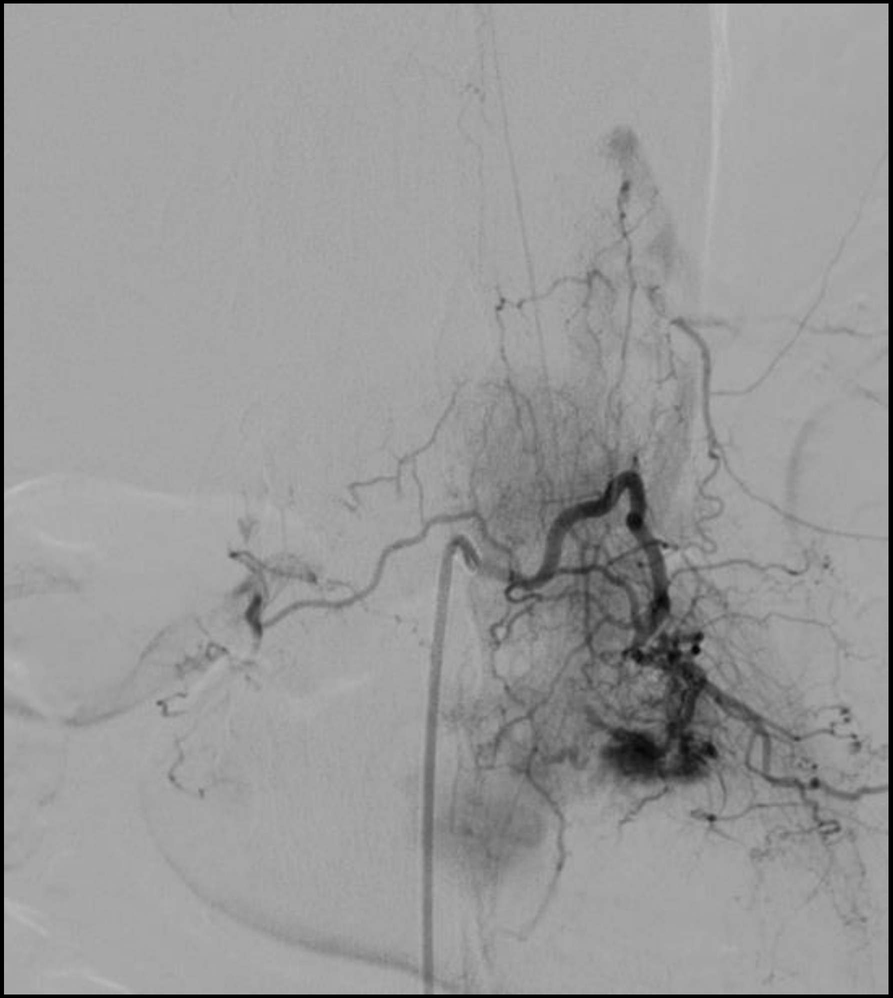




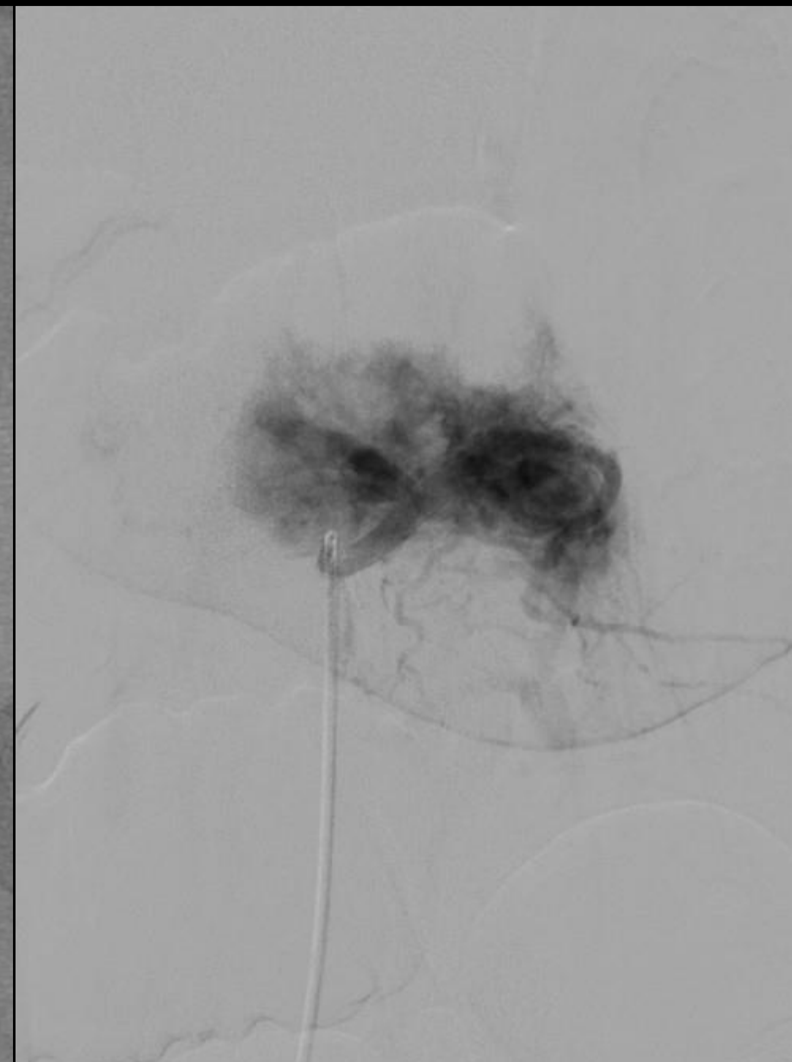
# ASA left T11

# Left L1 supply and RP artery

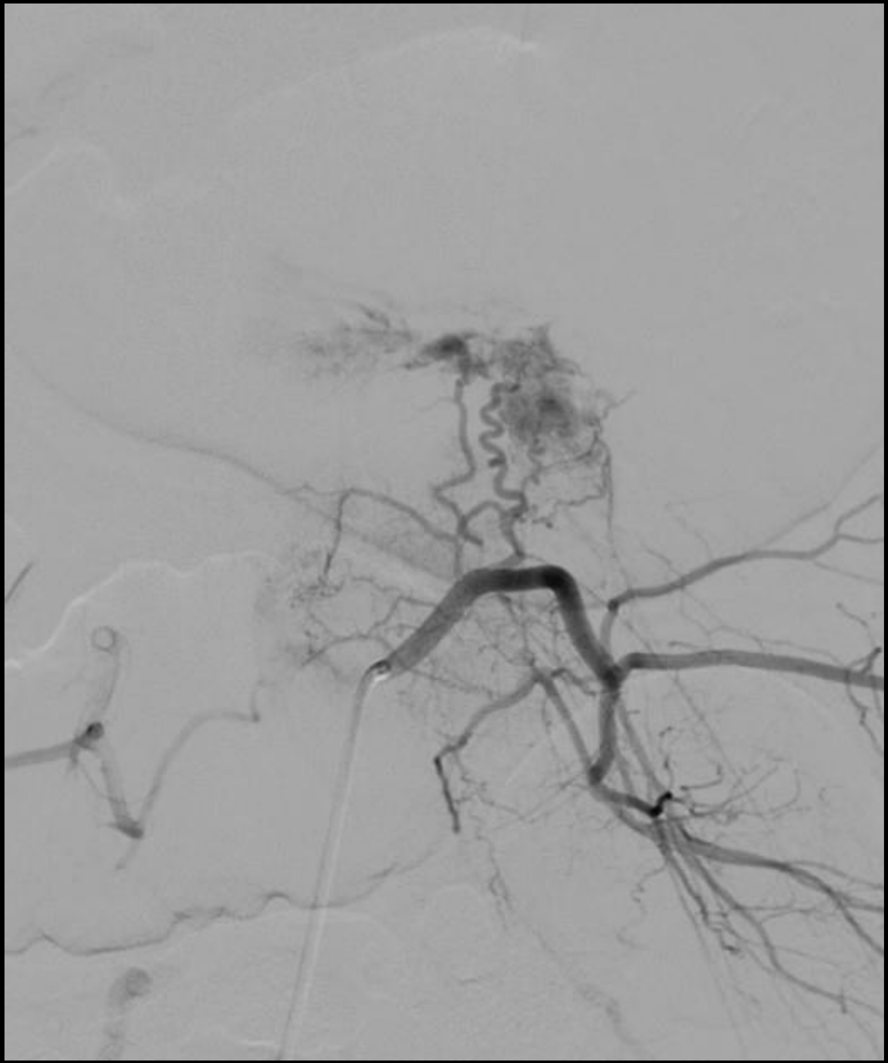




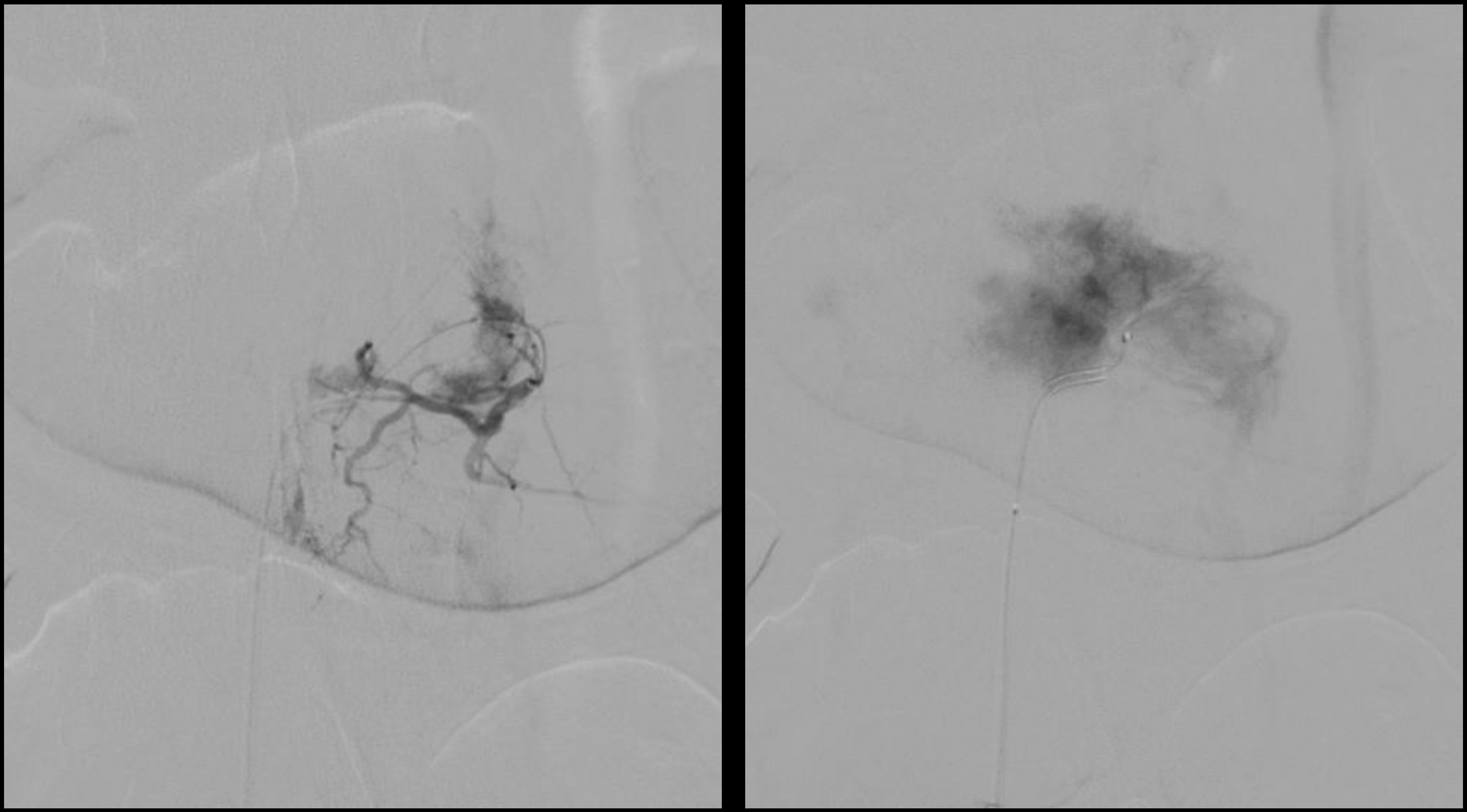
# Left L2 supply



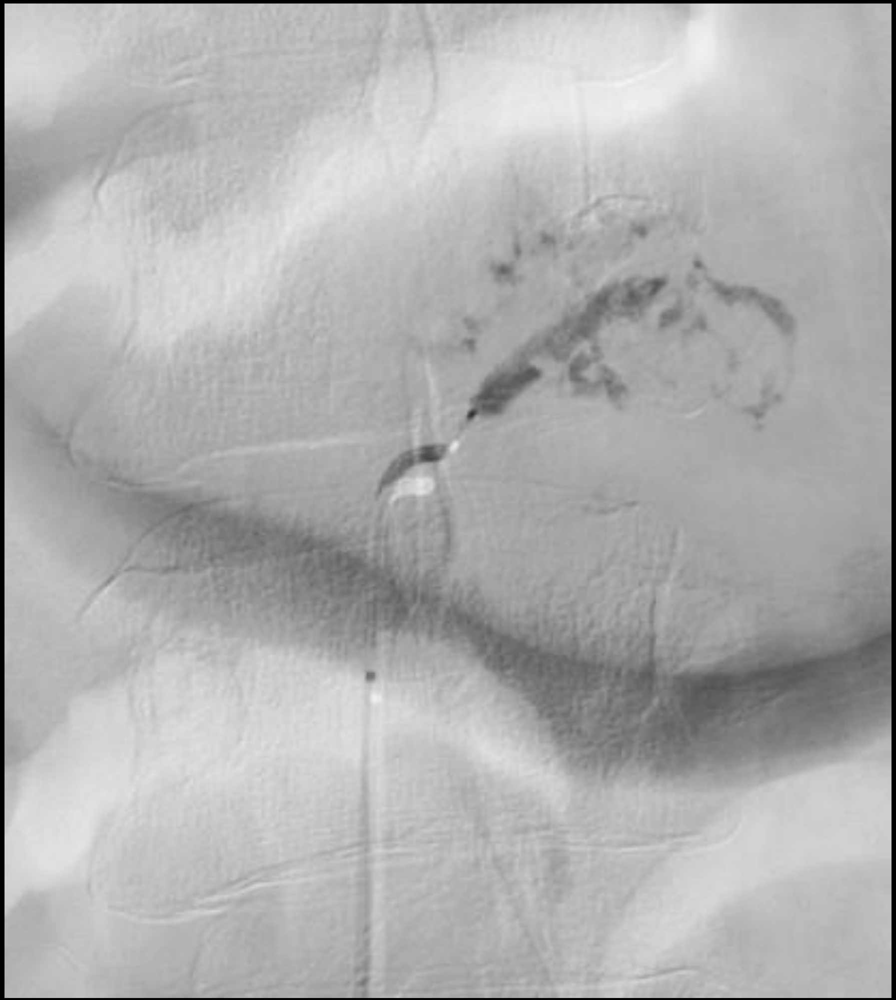
# Right L2 and left L3



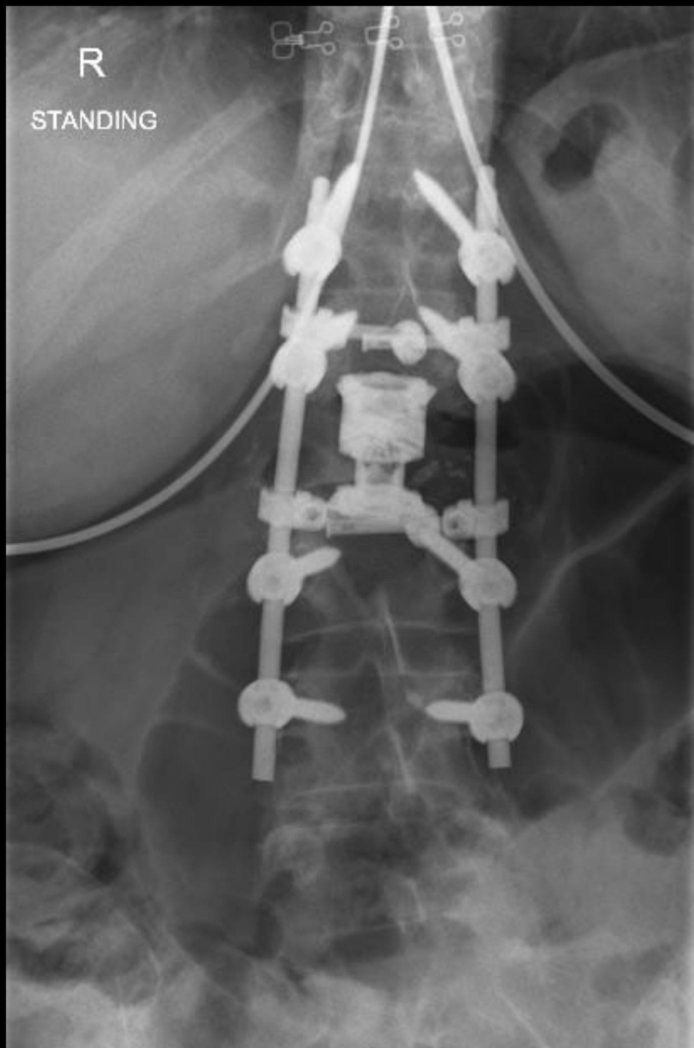
# Microcatheter distal then proximal



# 30% NBCA to lumbar artery



# Piecemeal excision and stabilisation



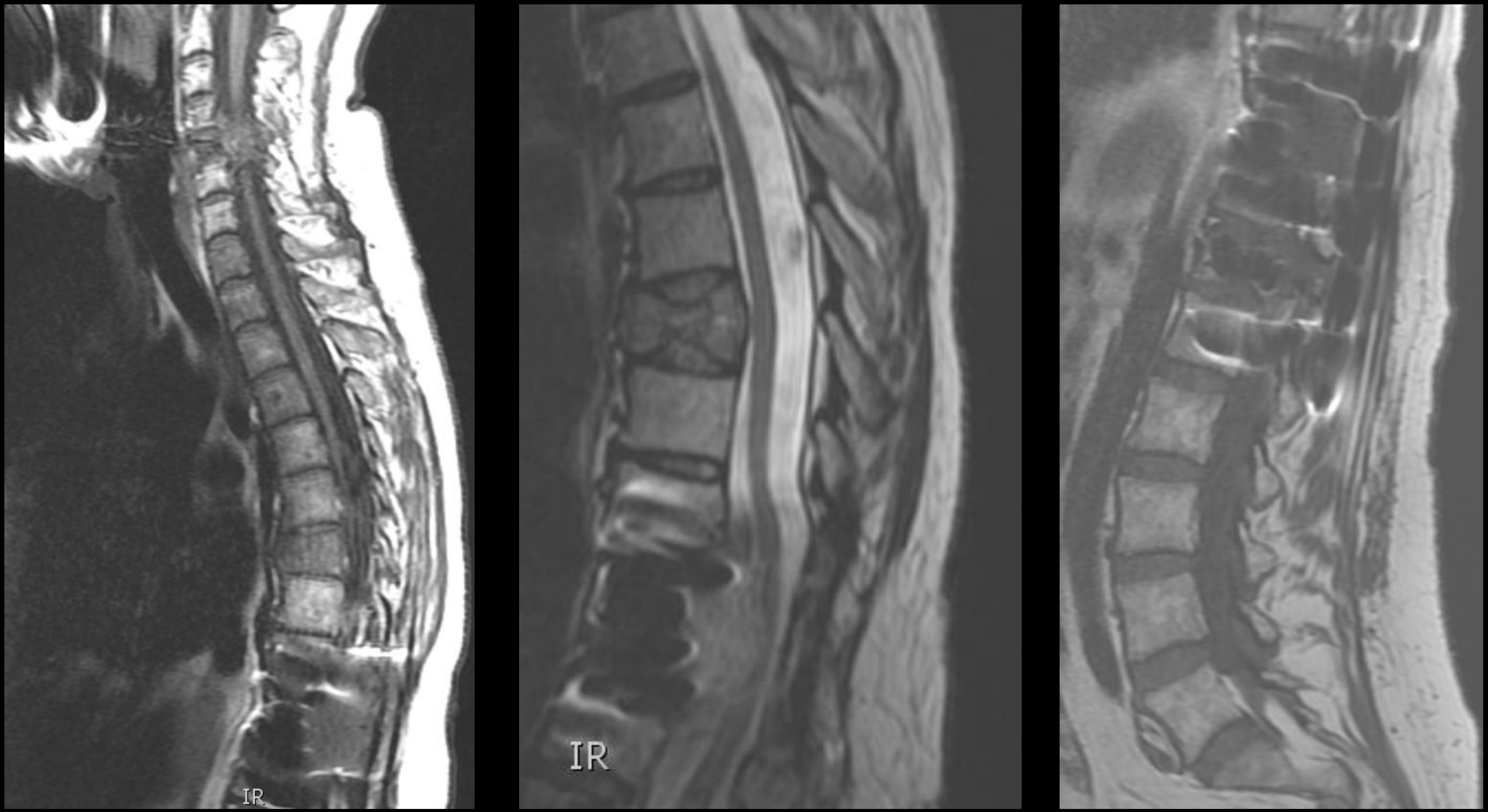

# Surgical feedback

- 5.5 hour procedure
- EBL 2,800 ml
- ‘Not much’ tumour bleeding
- Pain free and neurologically in-tact

# Complex cases

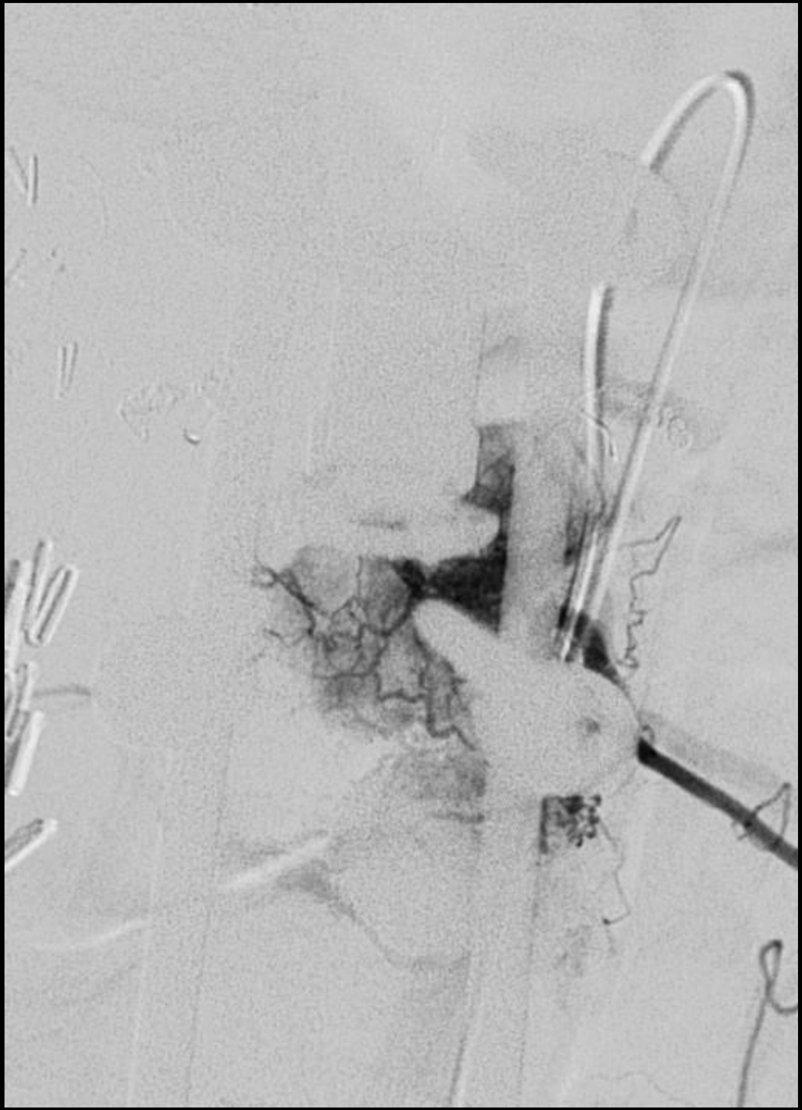
- Difficult access: atheroma, tortuosity, target vessel stenosis or occlusion
- Re-treatment after previous surgery

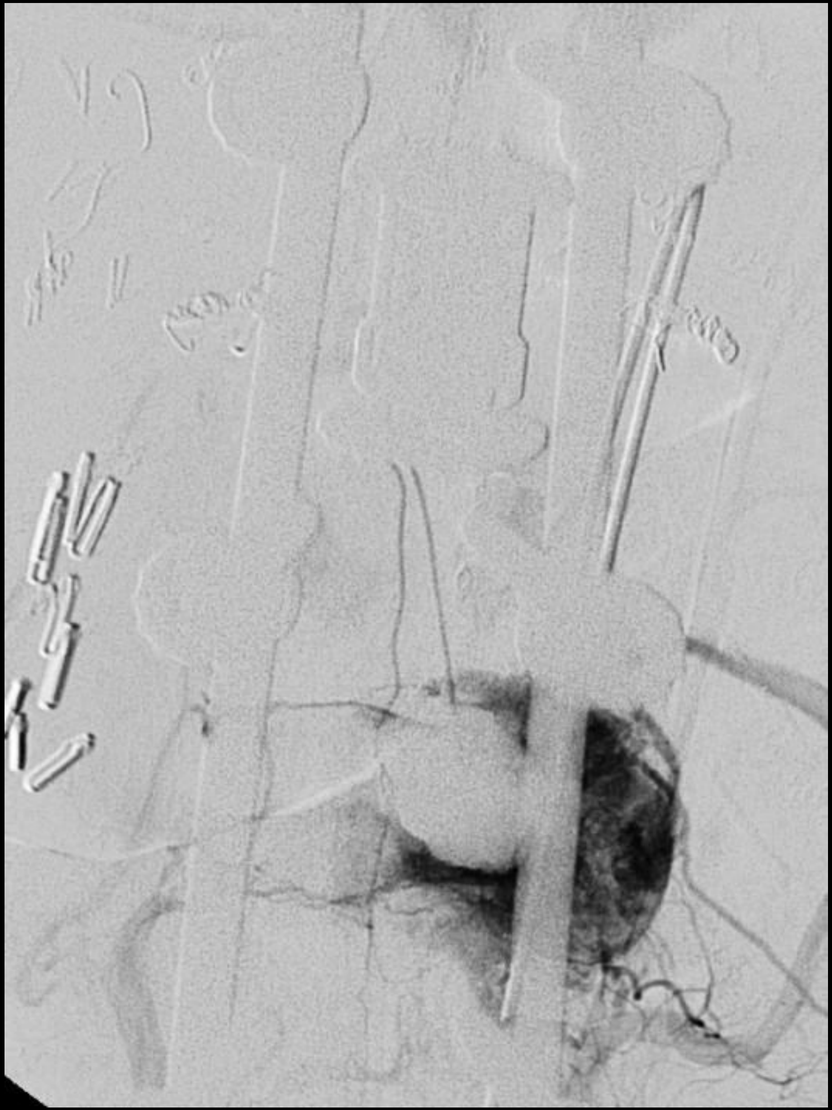
# Paraganlionoma: lesions at C5, T7, T10, T12



# Spinal angiogram – LT T9 RP supply

# Spinal angiogram – LT T11 and T12 RM supply





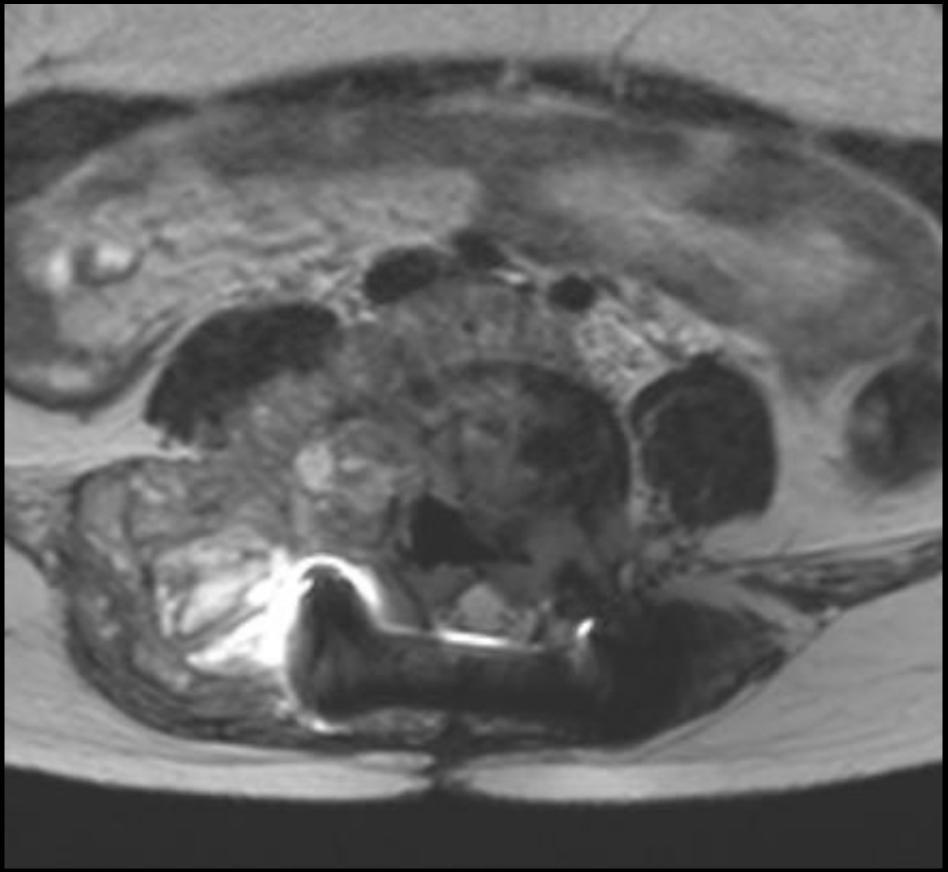
# 2-stage treatment metastatic RCC

- 36 F
- Metastatic RCC lung and bone
- Expansile L5 mass

# Initial treatment

- Embolisation
- Posterior stabilisation
- Partial de-bulking
- Vertebroplasty
- Treat RCC

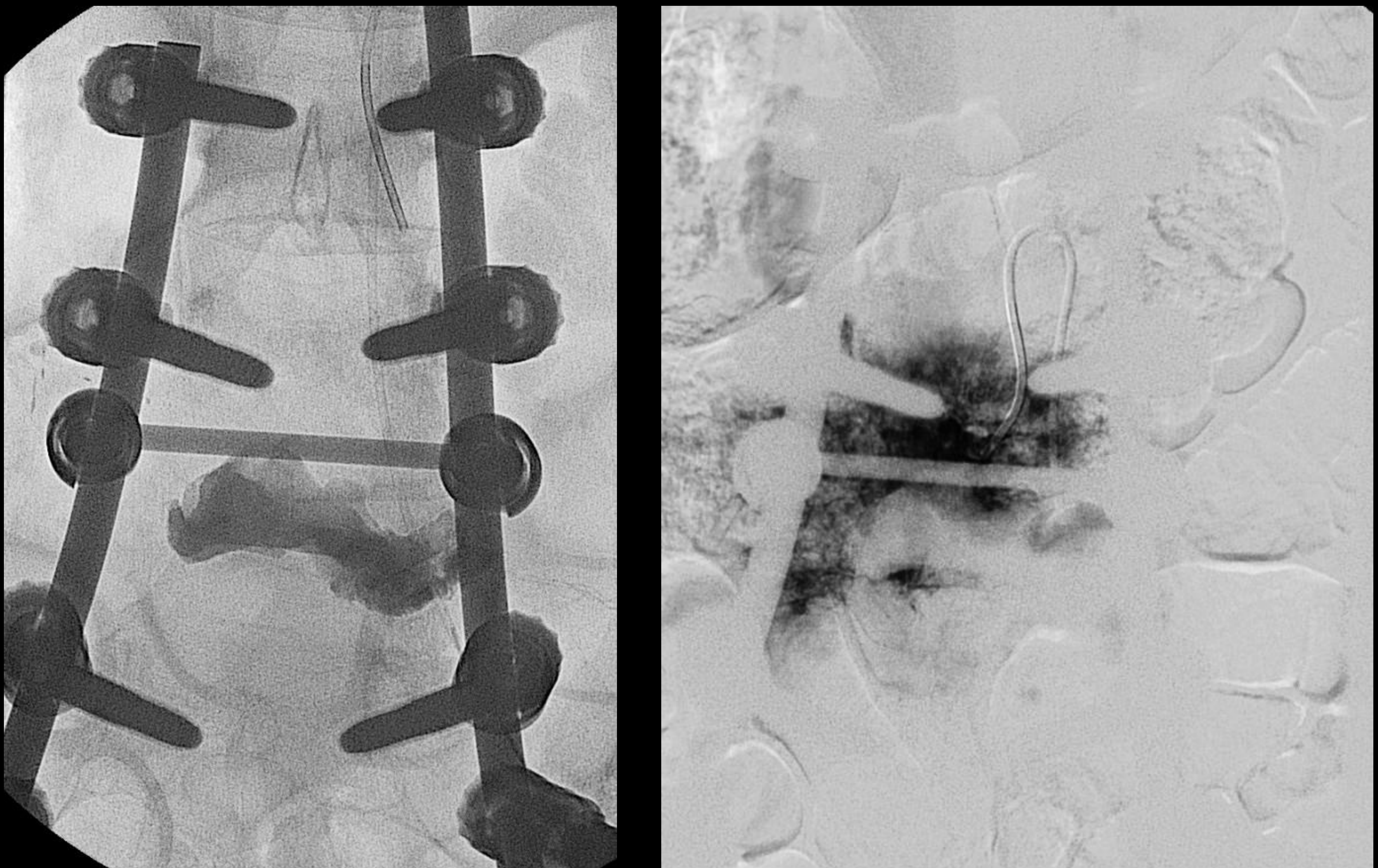
# Good clinical response to therapy



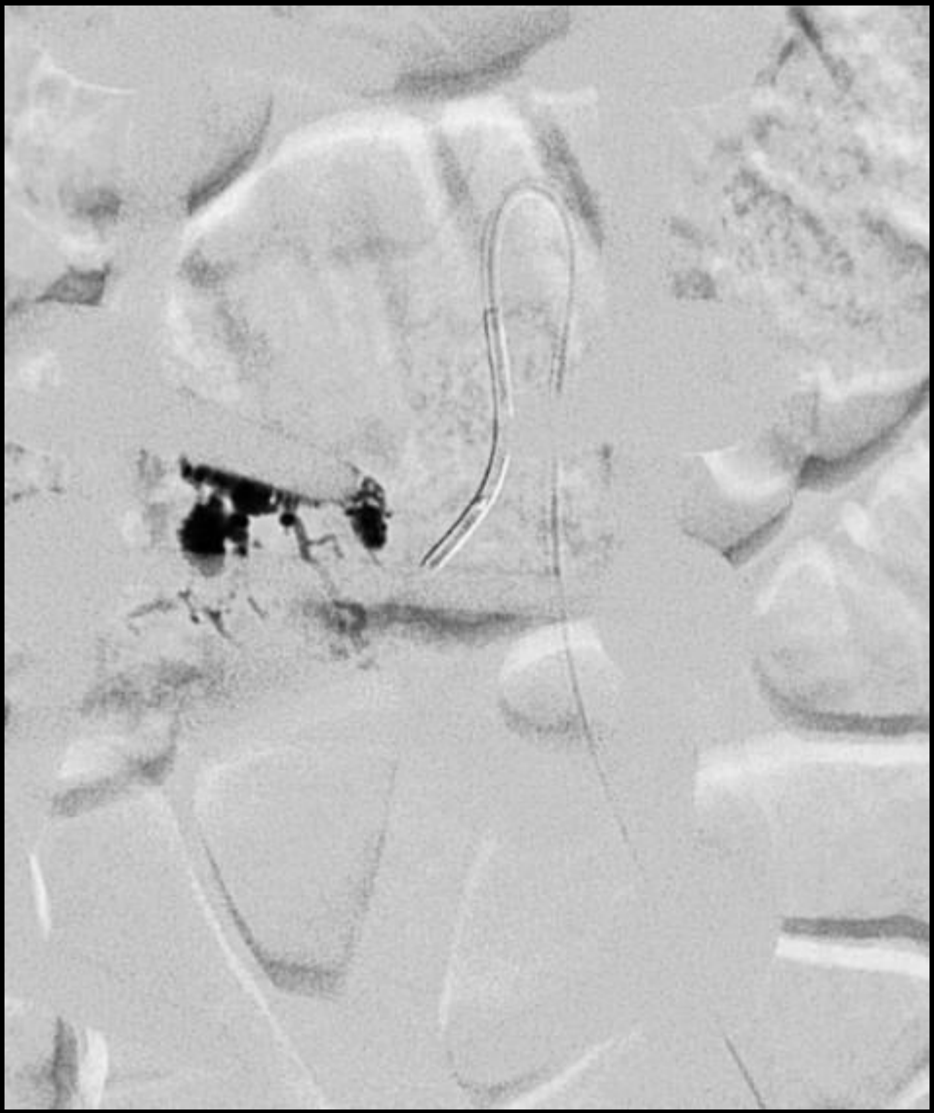
# $2^{nd}$ stage treatment

- Embolisation
- Vertebrectomy

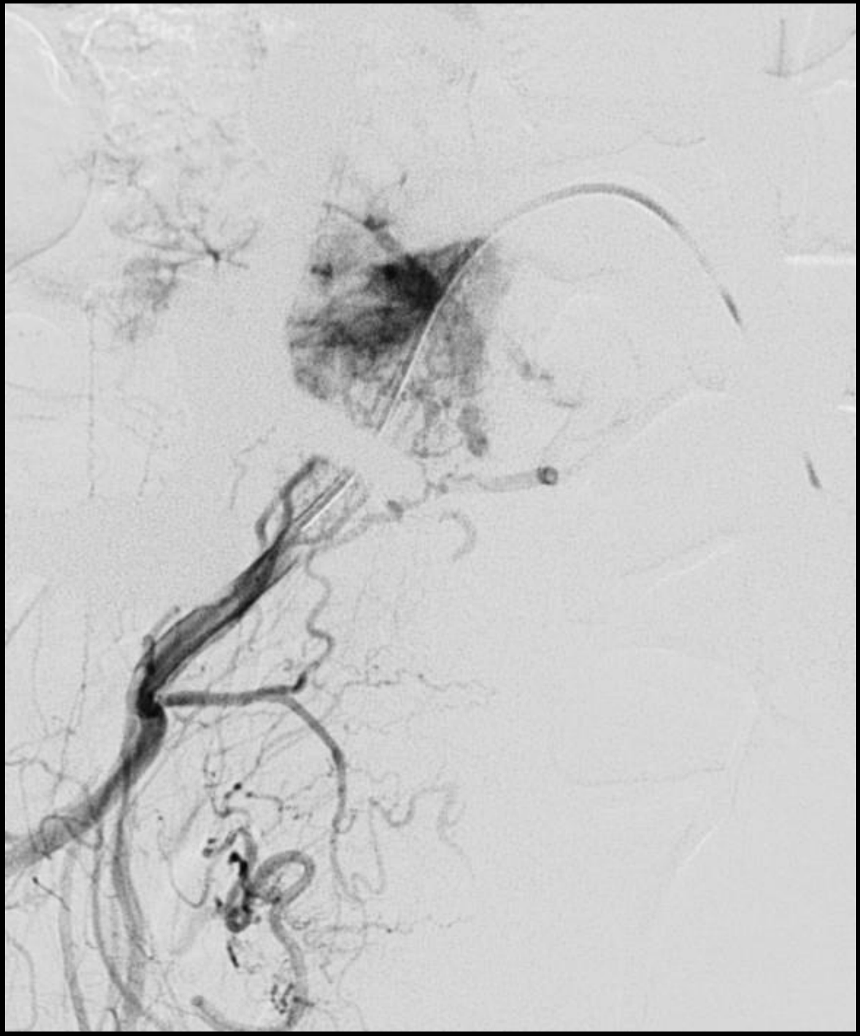
# E2 (Tomita 6)



# E2 - ES 7-900 micron via 4F then NBCA



Treated multiple pedicles, BUT multiple shunts into dysplastic venous channels at the end of the procedure



# $2^{nd}$ surgical procedure

Surgeon advised of multiple persistent shunts in posterior vertebral body draining to the epidural veins

Blood loss at surgery

- Anterior vertebral body = 500ml
- After removal of cement = 4000ml

# Discussion points

- No specific literature related to re-embolisation of recurrent spinal metastasis
- Recurrent disease after previous surgery, vertebroplasty or RT may be technically difficult to embolise:
  - Limited views (metalwork)
  - Altered anatomy (vessel occlusion +/- new collaterals)
  - Evolution of high flow vertebral or epidural A-V shunts
- Endovascular options may be limited

# Curative resection for multi-level recurrent RCC

Initial treatment

- T8 RCC
- ASA supply from Rt T10 and Lt T6
- Tumour supply from Rt T8 embolised
- Minor supply from Rt T7 and Lt T8 not embolised
- T8 vertebrectomy and posterior stabilisation

# 2 years later, recurrent RCC

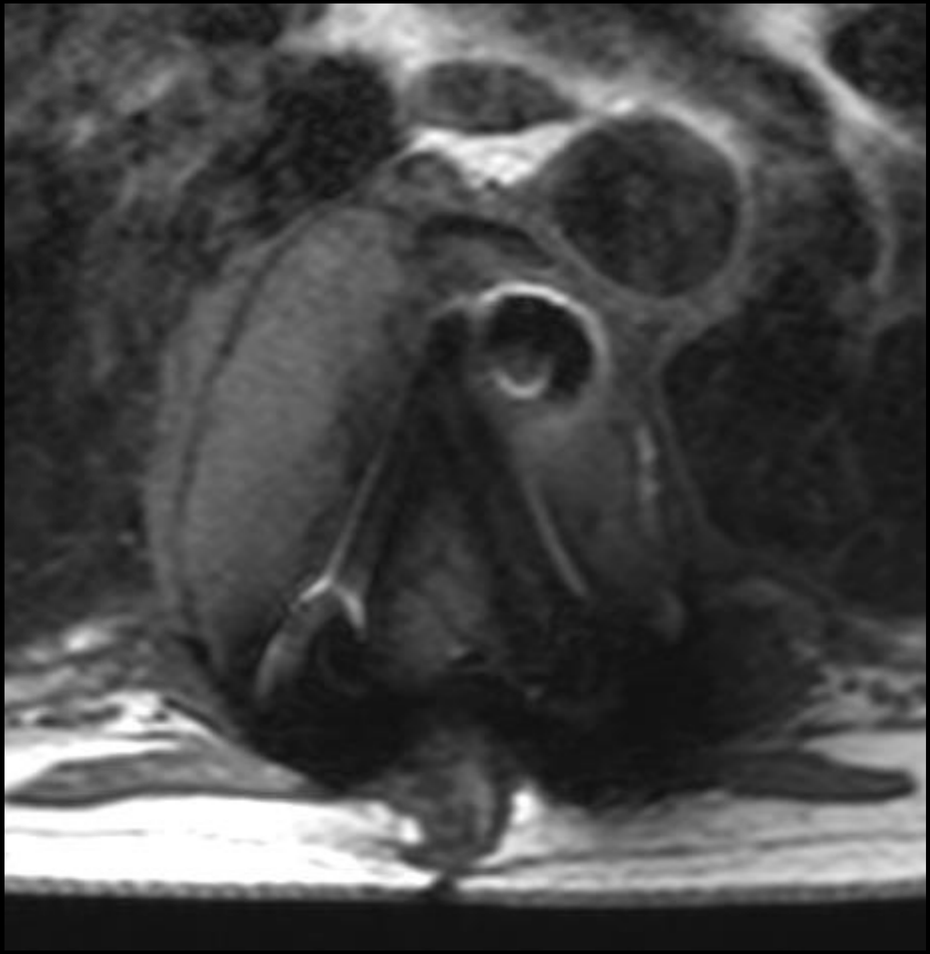
- Progressive recurrent SCC involving 4 adjacent vertebral levels (T6-T9)
- Limited response to chemotherapy and RT
- Posterior fixation loosened and painful
- Isolated disease (PET CT otherwise clear)

# Screws at T6,7,9,10
# Cage at T8


# Axial extent of disease

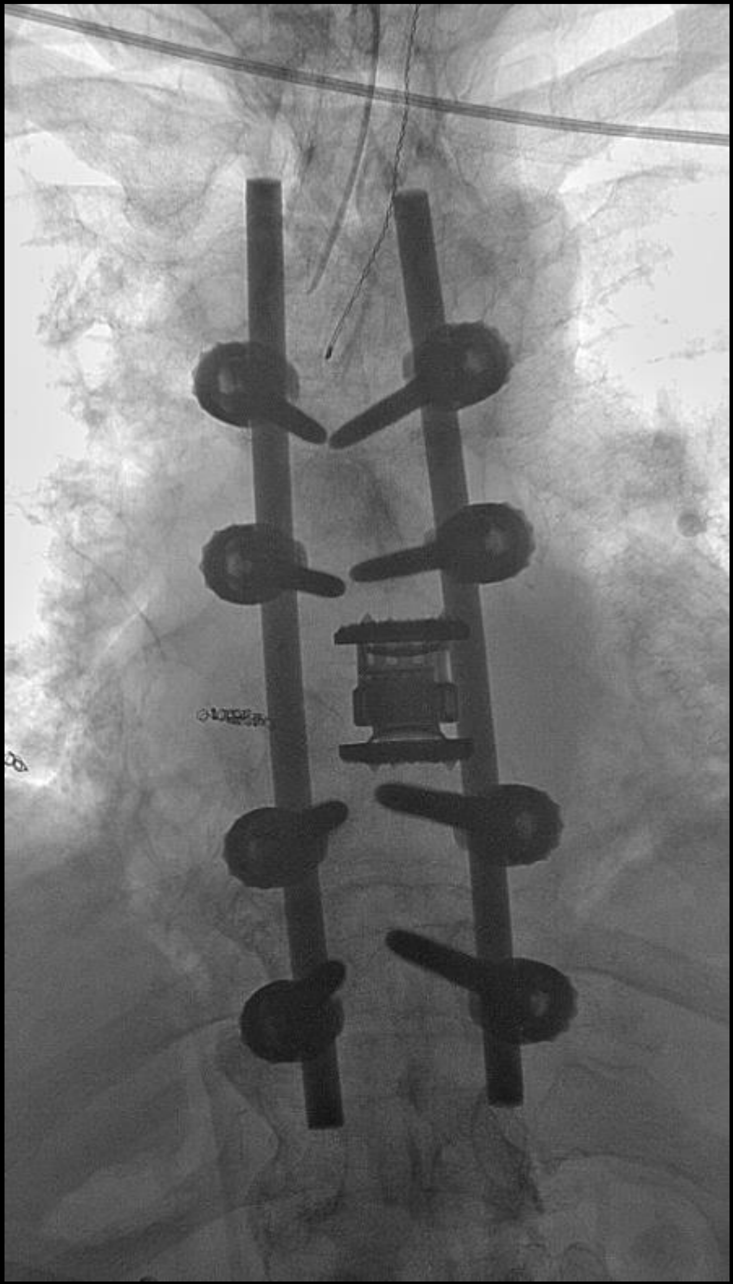
- Spinal, epidural
- Paraspinal, pleural
- Para-aortic

- Tomita 6+



# MDT discussion

- Revision surgery required
- Potential for curative en-bloc resection including T6-T9
- ASA supply at operative level  T6 (main supply at T10)



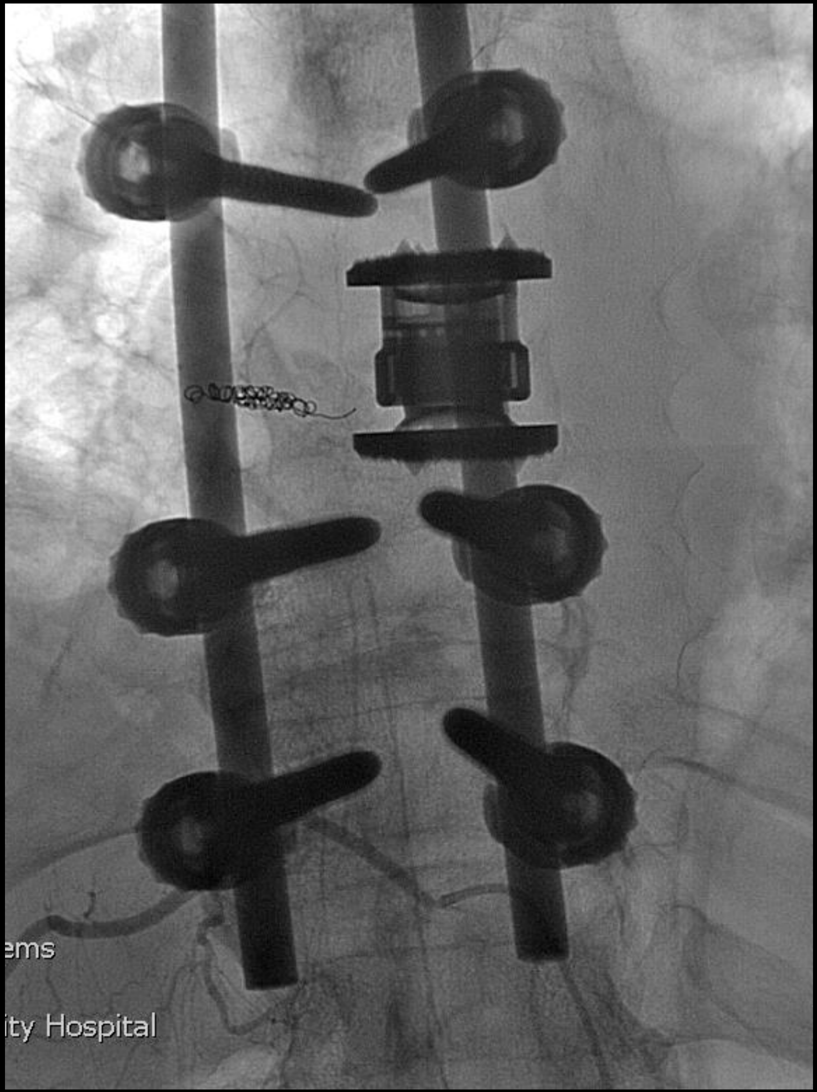
# Surgical plan

- Thoracic: costal and pleural margin with local lung resection
- Vascular: mobilisation of thoracic aorta and azygous (risk of avulsion of intercostal artery)
- Spinal: section of T5/6 and T9/10 discs, preservation of Rt T10 ASA supply (sacrifice of Lt T6 ASA) and re-do spinal stabilisation
- Neurosurgery: repair of thecal sac
- Plastics: wound closure

# Interventional plan

- Definition-of and preservation of ASA supply
- Embolisation of T7 to T9 pedicles
- Position aortic stent to cover intercostal artery origins and enable intercostal artery transection at reduced risk

# ASA supply: Rt T10, Rt VA **and** Lt Asc cervical a. at C7




Lt T6 (no ASA seen)    Lt T5 and T4 RP

# Right

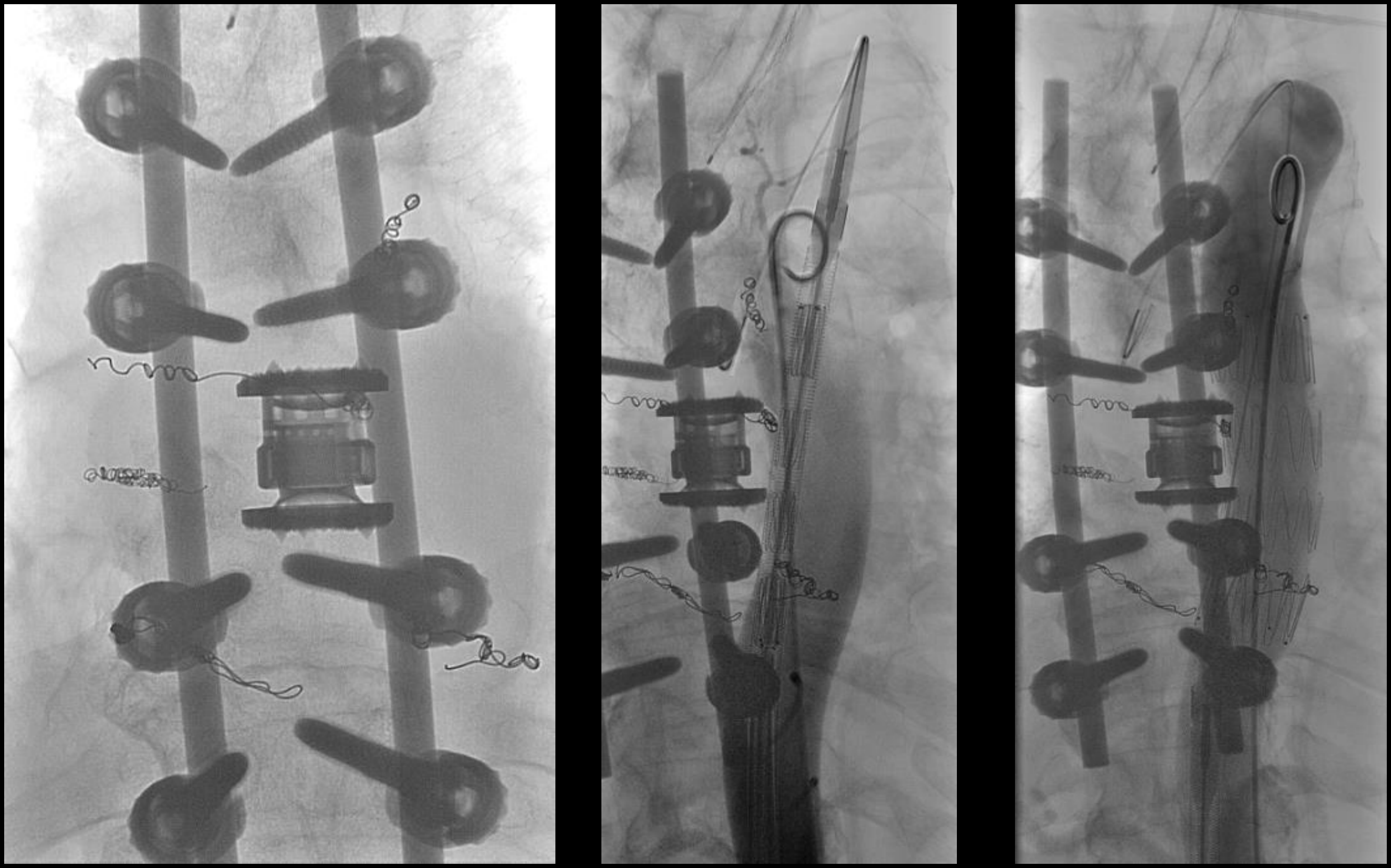
- T6 NV
- T7 P+C
- T8 Occluded previously
- T9 C
- T10 main ASA supply

# Left

- T6 C (ASA not seen)
- T7 NV
- T8 NV
- T9 P+C

- P = 350-500u PVA
- C = fibred coils
- NV = not visible ?RT

# 30 x 82 stent-graft deployed covering T6 to T9 intercostal arteries



# Surgical procedure

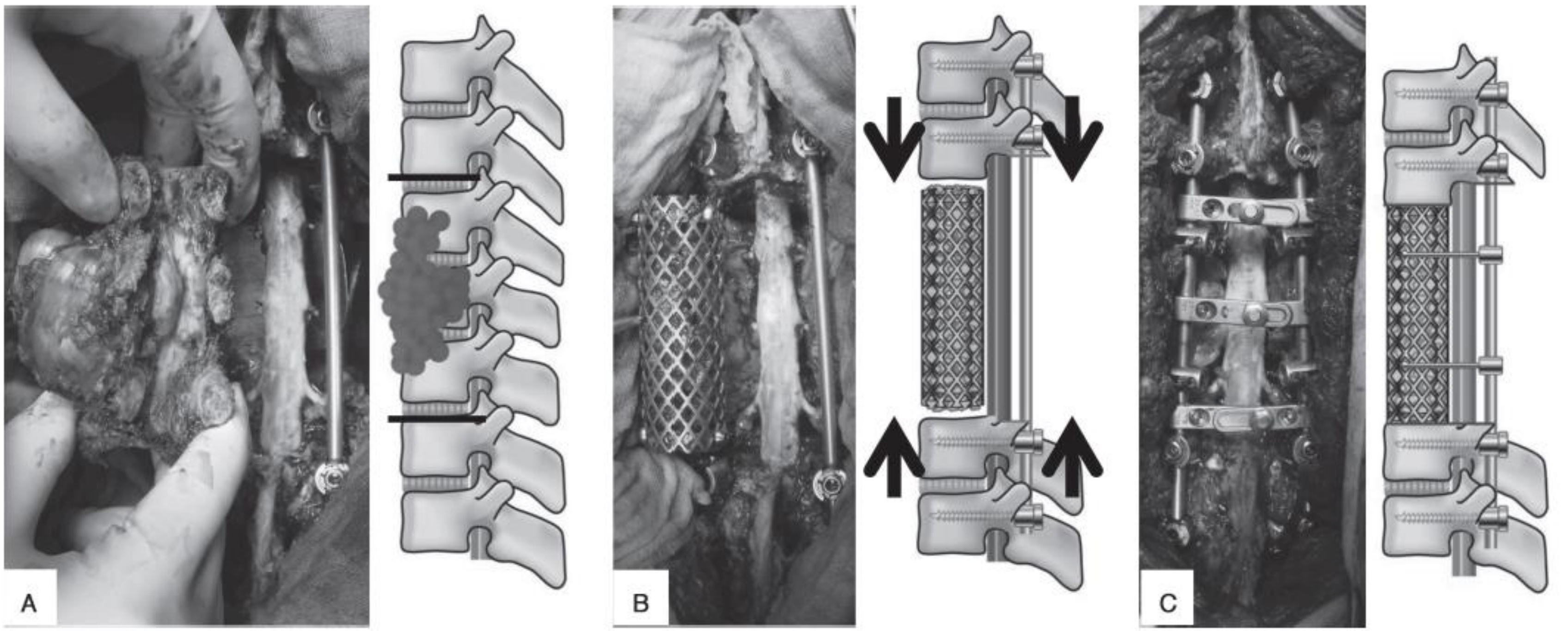
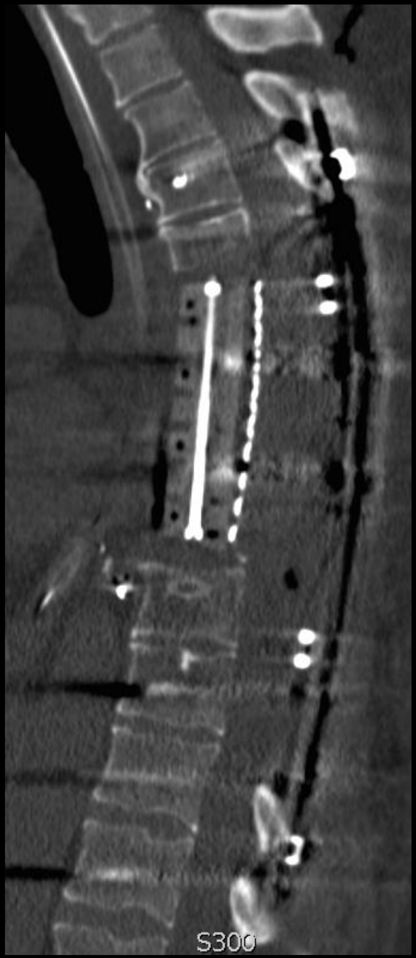


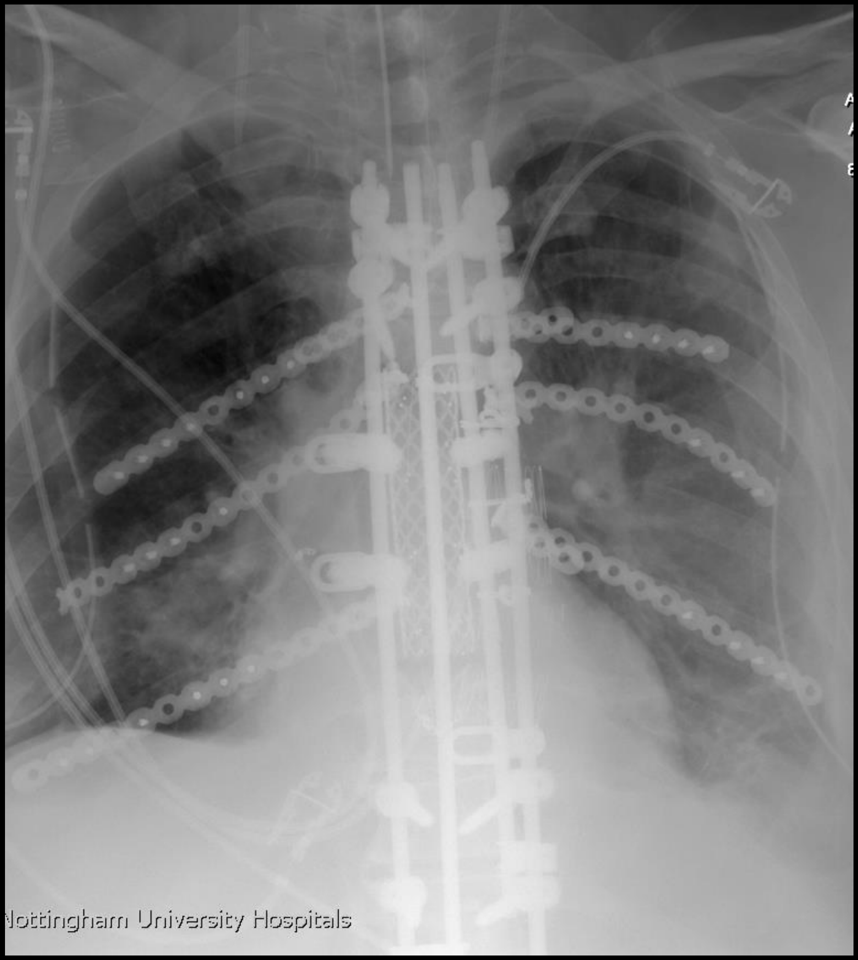

**Figure 1. A**, *En bloc* corpectomy was performed after pedicle screw fixation. **B**, Anterior reconstruction was done with a titanium mesh cage (MOSS-Miami; DePuy Motech) filled with autograft. To increase spinal stability in reconstruction, the posterior instrumentation was adjusted to compress the inserted vertebral cage slightly. **C**, Application of the connector device made up of threaded rod (diameter: 3 mm) was attached bilaterally between the posterior rods and anterior mesh cage as artificial pedicles.

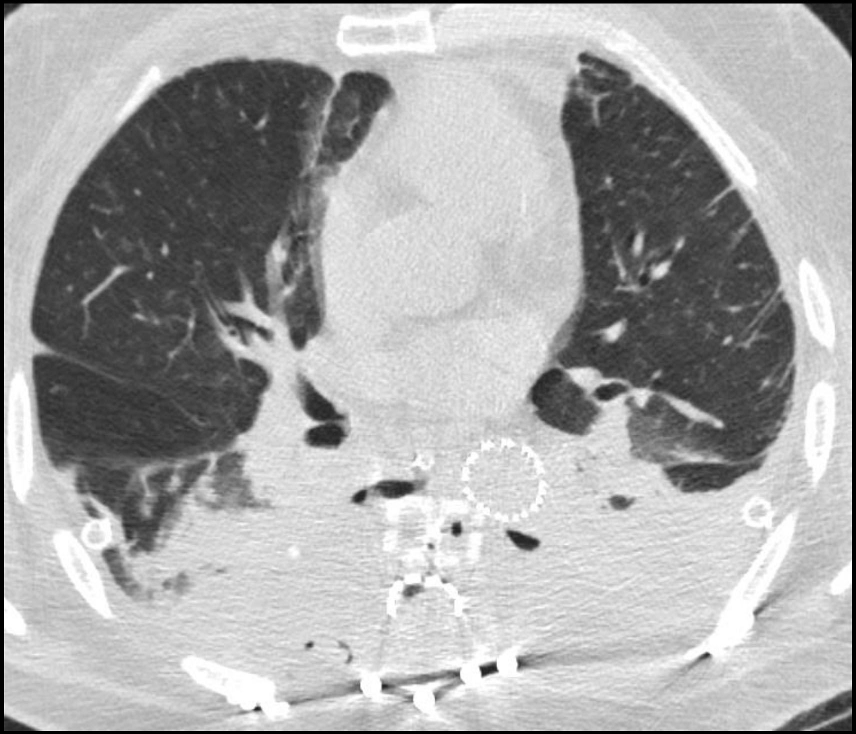
# Surgical procedure

- 32 hour procedure
- Multiple surgical teams
- 26 unit transfusion
- Slow recovery on AICU
- Preserved motor function



# Post-op imaging



# En-bloc resection

- Curative intent
- Usually for primary tumours
- Risks/complications increase with extent and complexity of surgery
- Survival/cure reported

- Patient neurologically stable but had fatal cardiac event at day 10

# Complications of embolisation

- Neurological injury  (rare)
- Bleeding vessel perforation or rupture (rare)
- Vessel occlusion: vasospasm, vessel dissection or thrombus
- Contrast associated: contrast reactions, nephropathy
- Groin puncture: haematoma, pseudoaneurysm or AVF (angioseal)
- Systemic: fluids and prothrombotic state

# Summary

- Management of spinal metastasis should be a MDT process
- Main aim is maintenance or improvement of QOL
- Pre-operative embolisation beneficial for vascular tumours
- Extent of embolisation may be limited by technical difficulty or dangerous anatomy
- Interventional complication rate is low
- Main physiological challenges and morbidity associated with subsequent surgical management

# References


- Berkefeld J. Hypervascular Spinal Tumours: Influence of the Embolisation Technique on Perioperative Haemorrhage. AJNR 1999; 20:757-763
- Choi D. Review of metastatic spine tumour classification and indications for surgery: the consensus statement of the Global Spine Tumour Study Group. Eur Spine J 2010; 19:215-222
- Dennis F. The three column spine and it's significance in the classification of acute thoracolumbar spinal injuries. Spine 1983; 8:817-831
- Georgy BA. Metastatic Spinal Lesions: State-of-the-Art Treatment Options and Future Trends. AJNR 2008; 29:1605-11
- MSCC NICE Full Guideline 2008
- Manke C. Spinal Metastases from Renal Cell Carcinoma: Effect of Preoperative Particle Embolization on Intraoperative Blood Loss. AJNR 2001; 22:997-1003
- Singh K. Current concepts in the management of metastatic spinal disease. The role of minimally-invasive approaches. THE JOURNAL OF BONE AND JOINT SURGERY 2006; Vol 88-B, No 4: 434-442
- Wilson MA. Retrospective Analysis of Preoperative Embolization of Spinal Tumours. AJNR 2010; 31:656-660

# Vertebroplasty

- Increased risks (10%), compared with vertebroplasty for osteoporotic fracture (2%).
- More difficult to deliver PMMA focally within the anterior vertebral body due to tumour tissue (suboptimal stabilisation)
- Greater risk of PMMA extravasation
- Risk of tumour extravasation
- Risk of iatrogenic fracture
- Risk of local haematoma

# Indications for vertebroplasty

- Multiple myeloma
- Multilevel osteolytic MSCC
- Limited pain relief over two weeks after RT
- Prevent vertebral collapse (adjuvant treatment to RT)

# Contraindications to vertebroplasty

- Bleeding diathesis
- Local infection
- Epidural or foramenal disease/stenosis (r)
- Extensive vertebral destruction (r)
- Loss of more than 33% of vertebral body height (r)

# General anaesthetic

- Airway secure for log-roll
- Secure IV access
- Arterial line
- Slack in long-lines (table movement)
- Bladder catheter (IVI volume load and time)
- Temperature management
- No heparin ? steroids