Trans-arterial tumor embolization techniques

Istvan Szikora
National Institute of Clinical Neurosciences
&
Semmelweis University Medical School
Budapest, Hungary

Purpose

- To familiarize with different techniques used for embolization of brain, skull base, head and neck and spinal tumors

Clinical goals

- Preoperative embolization:
  - To assist surgical removal of vascular tumors
    - To make surgical manipulation easy and less traumatic
    - To reduce lesion size:
      - By inducing tissue necrosis (tumors)
    - To reduce blood loss
    - to reduce surgical risks
      - Temporary effect needed
- Palliative embolization
  - To stop tumor growth by embolization without surgical removal
    - Permanent effect needed

General considerations

- Large body of literature on different techniques
  - Reporting on amount of blood loss, time of surgery, etc
  - No scientific evidence regarding clinical efficacy
- No clear guidelines for indication / techniques

Head, neck, and brain tumor embolization guidelines (*Duffis et al, JNIS, 2012*)

- Litrature review 1990 – 2010
  - All relevant articles reviewed
    - Case series and single center non-randomized studies
- Target pathology:
  - Juvenile nasopharyngeal angiofibroma (JNA)
  - Hemangiopericytoma
  - Glomus jugulare and other paragangliomas
  - Metastatic lesions
  - Meningiomas
  - Hemangioblastoma

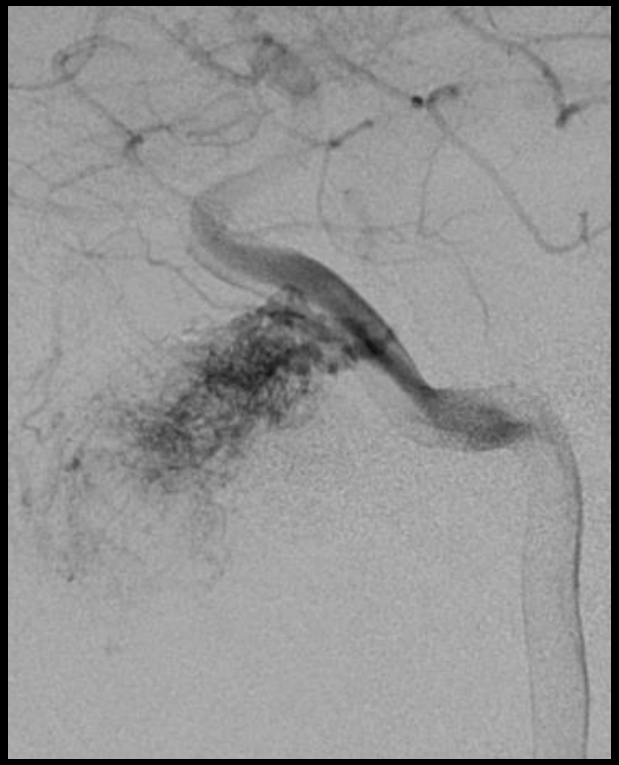
Efficacy of embolization

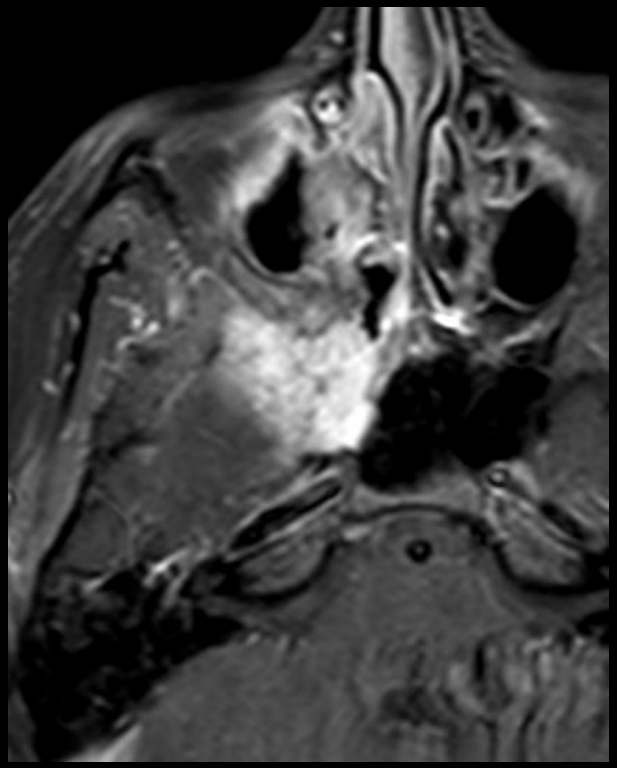
- Contradictory opinions
- No scientific evidence
- Consensus based on literature review
  - Embolization is effective in
    - Reducing
      - blood loss
      - surgical times
      - Recurrence
  - Cost effective
    - Despite additional material and resources

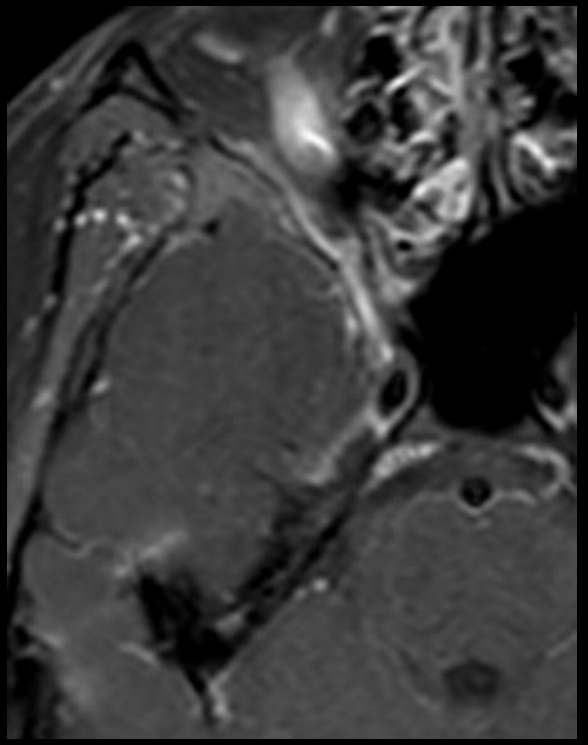
Indication of embolization

- Treatment plan by team decision
  - Skull base surgery, oto-rhyno-laryngology, spinal surgery, INR
- The goal of the treatment must be carefully set prior to the procedure
- Technique / material should be chosen for the purpose of procedure

Pre-operative imaging: CT

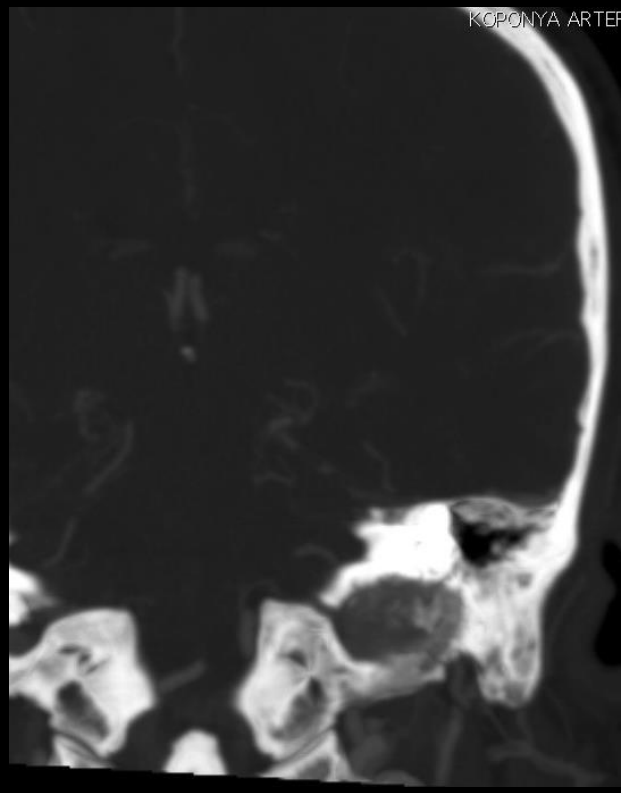






- MRI:
  - Relation of tumor to normal tissue
  - Involvement of vascular structures

Pre-operative imaging: CT



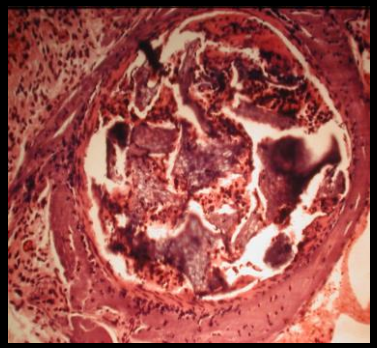
- Evaluation of bone erosion
- Determining route of percutaneous embo

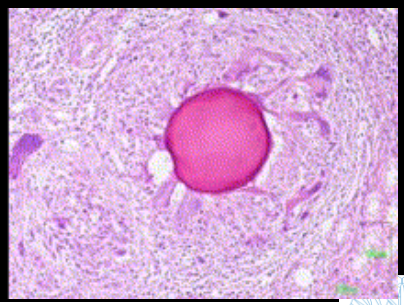
Intra-operative imaging

- Proper visualization is crucial
  - High resolution DSA
  - High quality road map (subtracted fluoroscopy)
  - Simultaneous subtracted and non-subtracted fluoroscopy
  - Biplane
  - Cone beam CT
- Radiation protection:
  - long procedures/fluoroscopy times
  - Radiation protection is crucial
- Selective injections based on anatomy and pathology

Technical options: embolic materials

- Particles:
  - Penetration, efficacy and complications related to particle size
  - Smaller particles - higher efficacy, higher risks





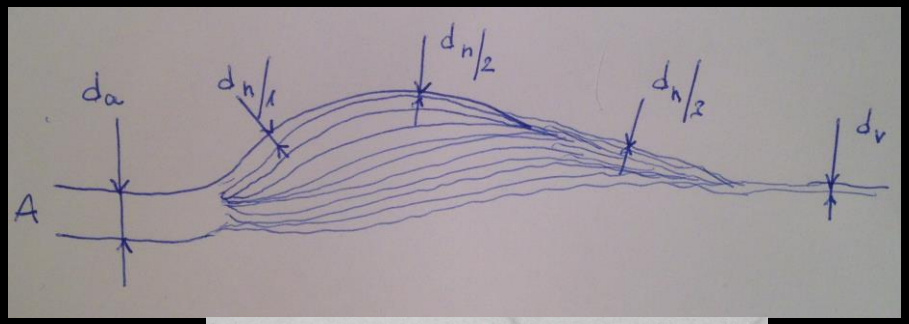
Technical options: embolic materials

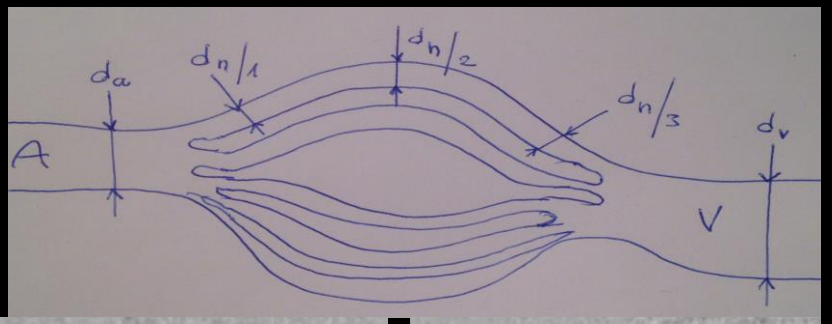
- Embolic materials:
  - Coils:
    - proximal occlusion following tumor bed embolization to prevent early recanalization
    - Occlusion of normal branches to avoid embolization into normal territory
- Liquids:
  - To achieve deep penetration
  - For palliative treatment (long term stability)
  - NBCA, Ethylen-vinyl copolymer, Hydroxyethyl methacrylate, etc.

Technical options: access route

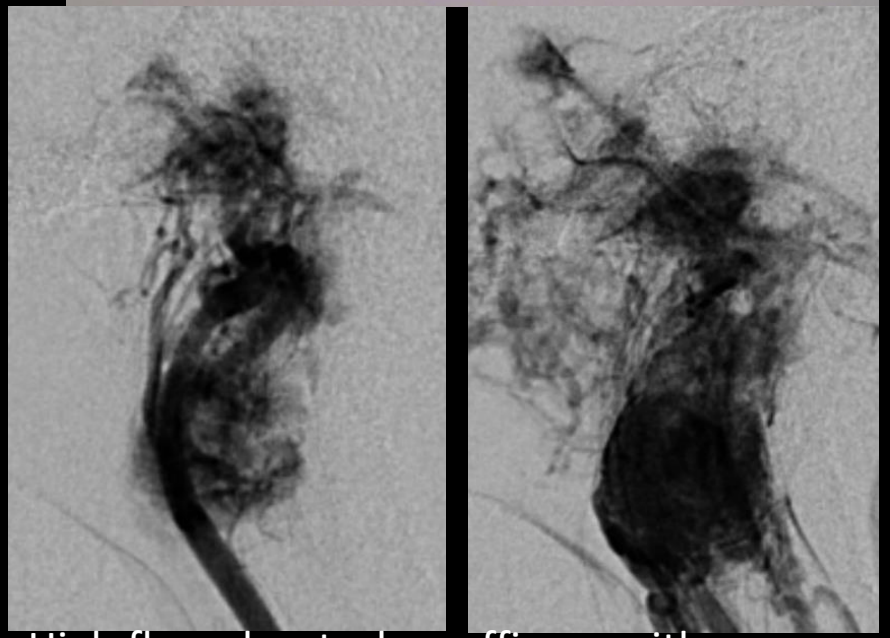
- Access to vascular bed:
  - Transarterial via catheter
  - Transarterial via direct puncture

Choice of technique: morphological features of the tumor's vascular bed





No shunts – good target for particles

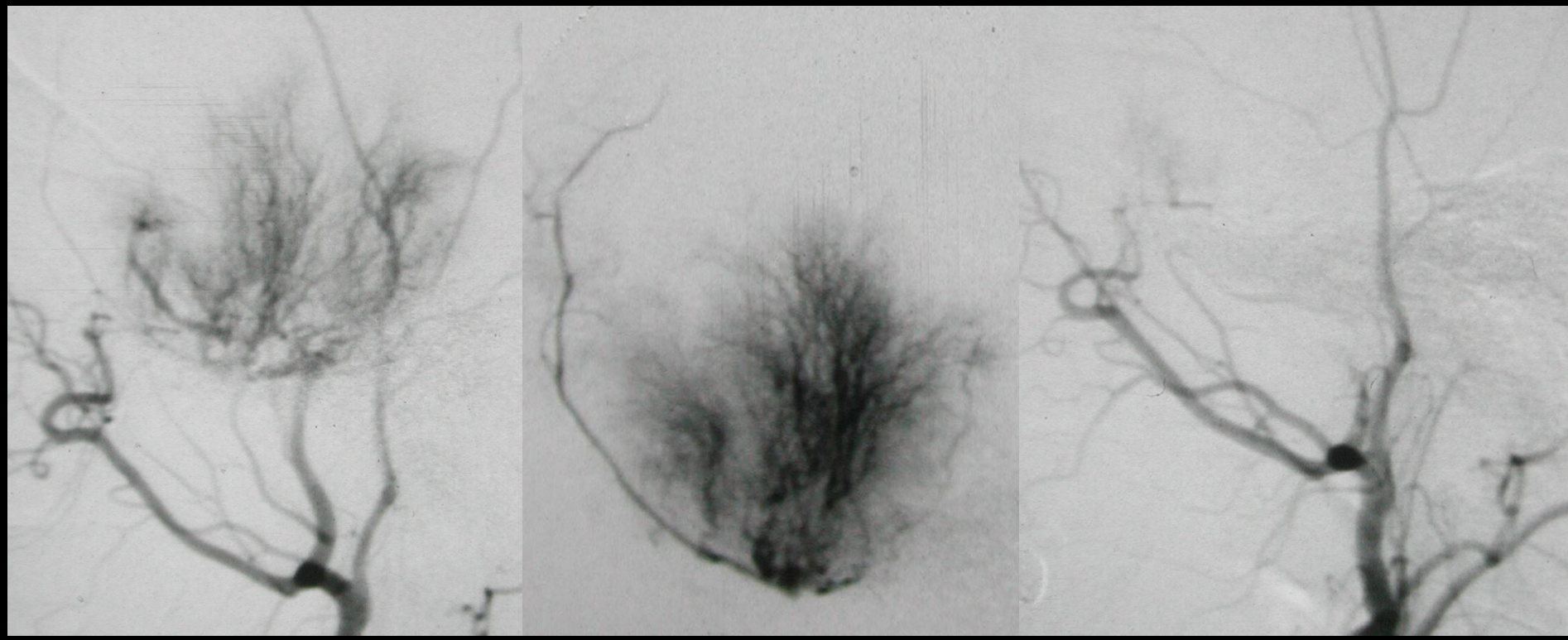


High flow shunts: low efficacy with particles, liquids preferred

Embolization with particles

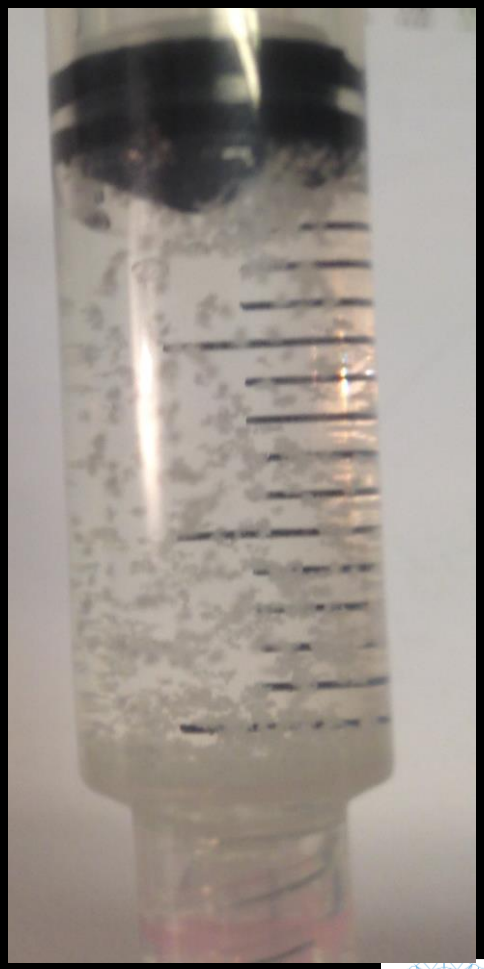
- Catheter choice:
  - Relative large microcatheters needed (0,016-0,018”)
- Distal catheterization
- Particle choice:
  - Small particles to achieve effective embolization (50-150µ)
  - Large particles to avoid passage through dangerous anastomoses

Meningeoma



Technical details

- PVA particles are mixed with 50-70% contrast material
- Any reflux must be carefully watched under subtracted fluoro (“blank road map”)
- Sedimentation
  - May cause clogging of microcatheter
  - Loss of visulization



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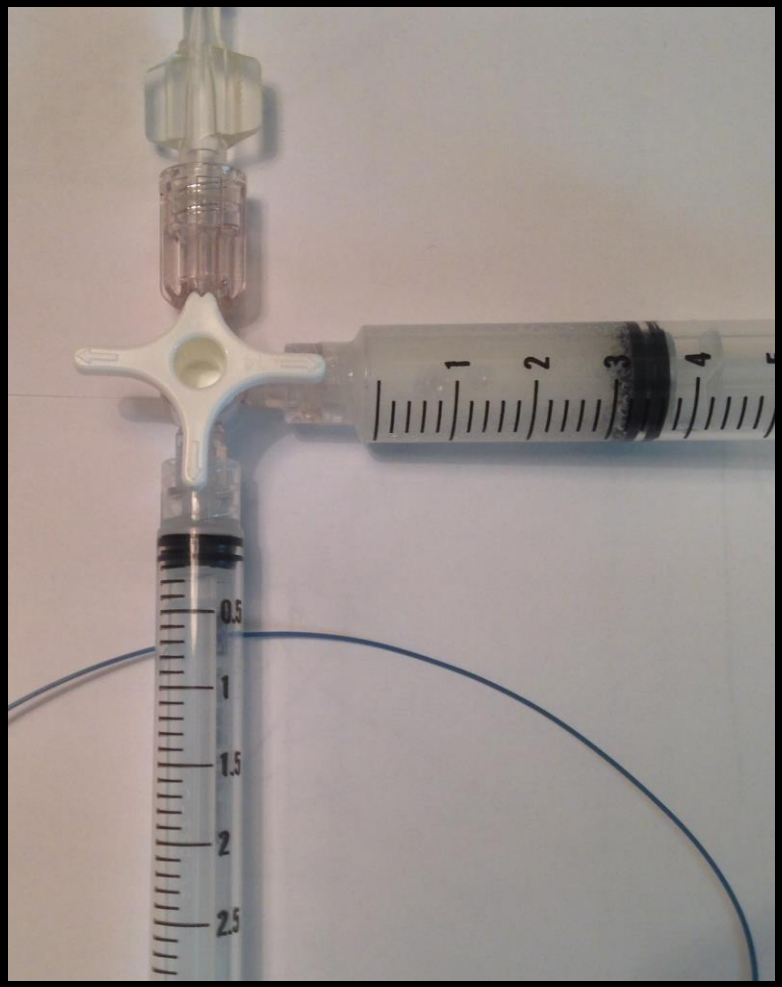
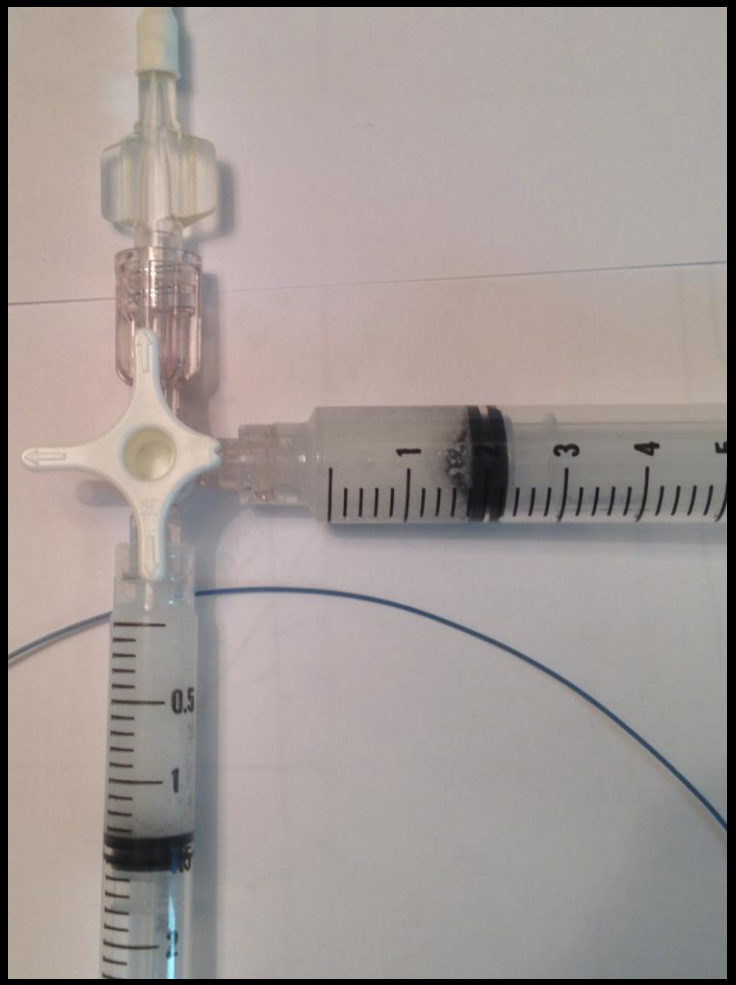
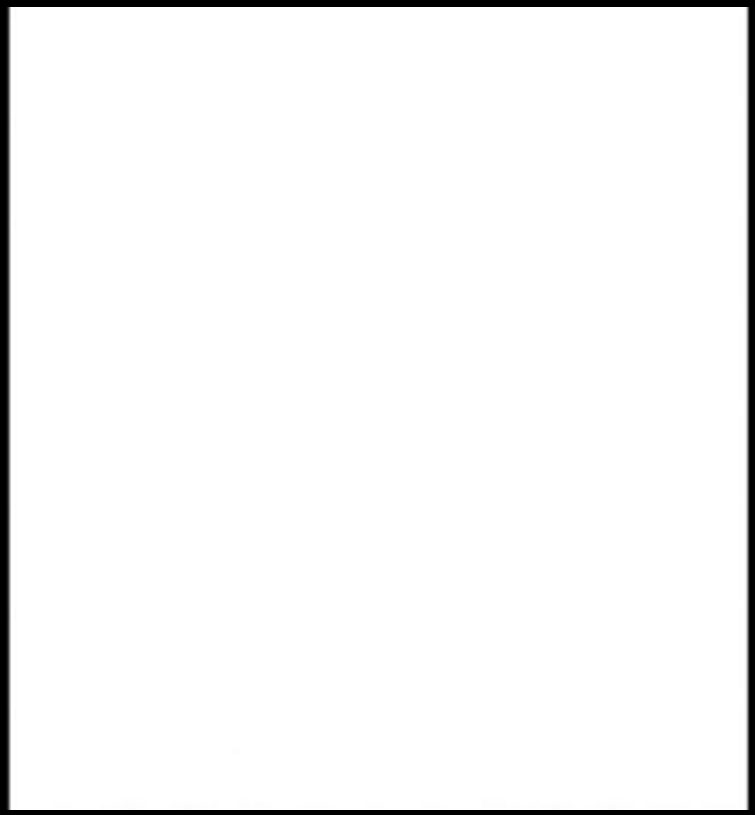




The PVA “mixer”

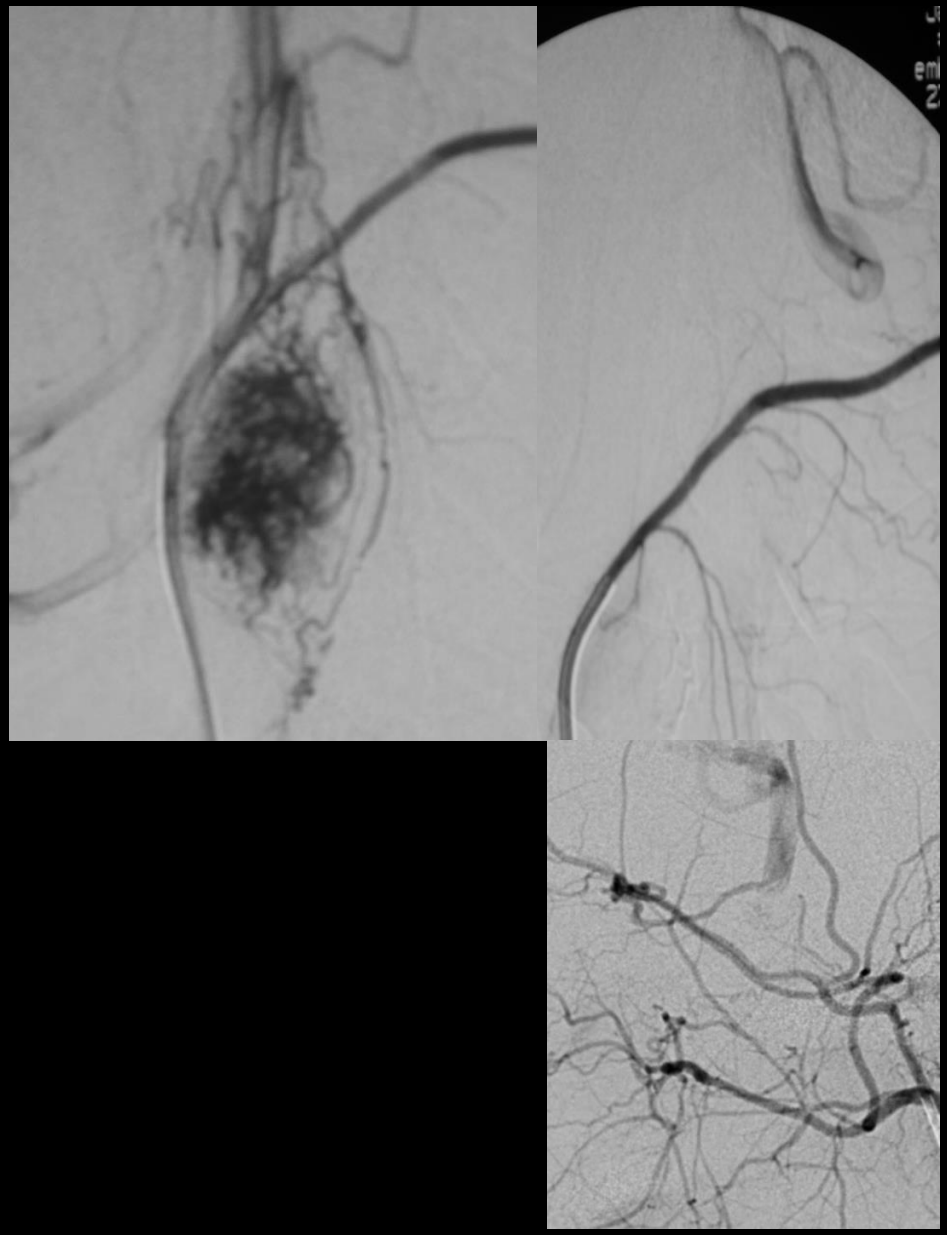
Injection technique

- Avoid vedged position
  - Flow needs to take particles into tumor bed
  - Reflux is dangerous
- Pulsatile injection



Dangerous anastomoses

- Larger particles in neighborhood of dangerous anastomoses
- Prevention of vessels not intended to be embolized:
  - Using resorbable embolics
    - small gel-foam particles (Spongostan)
  - Proximal occlusion with coils



Postembolization care, timing of surgery

- Intracranial tumors:
  - Swelling may occur
    - Meningeoma embo:
      - Significant edema may occur
      - Steroids should be considered
- Surgical timing:
  - Early surgery:
    - No time for tumor necrosis, limited effect of embo
  - delayed surgery:
    - Recanalization starts after 7 days
  - Ideal timing: 2-7 days

Transarterial liquid embolization

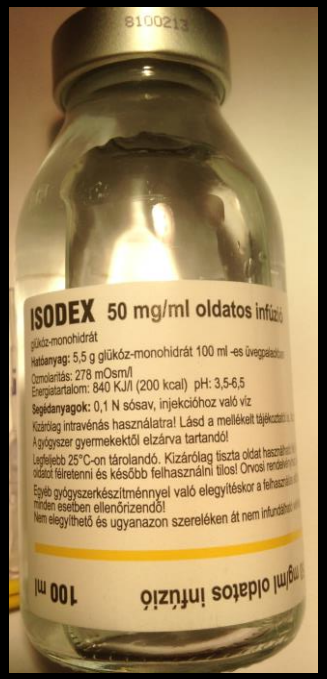
- Advantages:
  - Better penetration
  - Permanent effect
- Disadvantages:
  - Multiple superselective accesses, multiple catheters
  - Risks:
    - Insufficient penetration
    - Inadvertent embo into normal territory

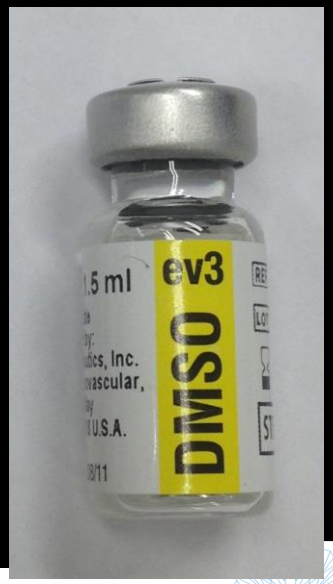
Transarterial liquid embolization

- Embolic material:
  - NBCA glue:
    - High dilution for good penetration
    - Allows for long injection time
    - Vedged position is desirable
      - Detachable tip catheters!
    - Early reflux is a common issue
  - Ethylene-vinyl-copolymer, Hydroxyethyl methacrylate (ONYX, SQID, PHIL)
    - Longer injection time feasible
    - May not penetrate well in small caliber tumor vessels

Liquid embolization: technique

- Microcatheter preparation:
  - All liquid agents solidify in an ionic environment (blood)
  - Microcatheter must be cleaned from blood/saline/contrast
    - For NBCA glue:
      - Rinsing with 5% Glucose
    - Fro precipitating agents:
      - Rinsing with DMSO
        - » DMSO in high volume may cause SAH
        - » Not to exceed the dead volume of microcatheter (0,2-0,3cc)
        - » Slow injection





Injection techniques

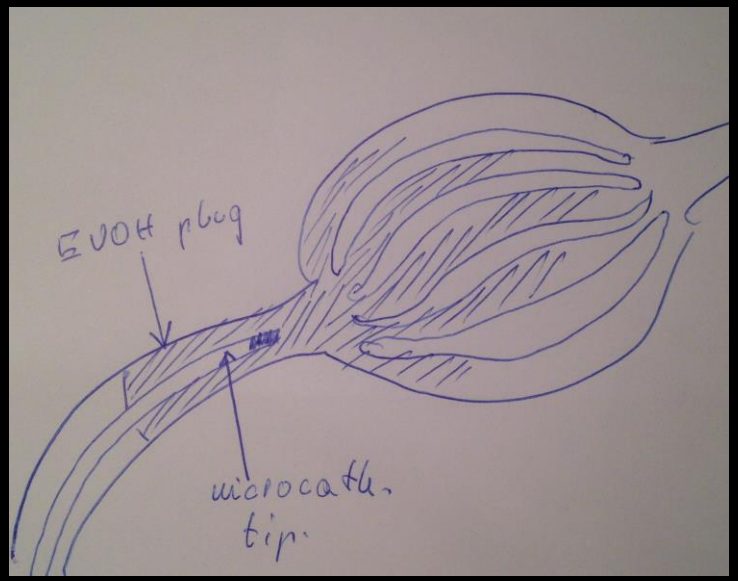
- The single drop technique:
  - Used in high flow shunts
    - Rarely for tumor embo
    - Non-diluted / high concentration (60% max) glue is used
    - Glue is slowly injected
    - Solidifies immediately by exiting the micocatheter
    - Microcatheter needs to be removed very quickly (if non-detachable)

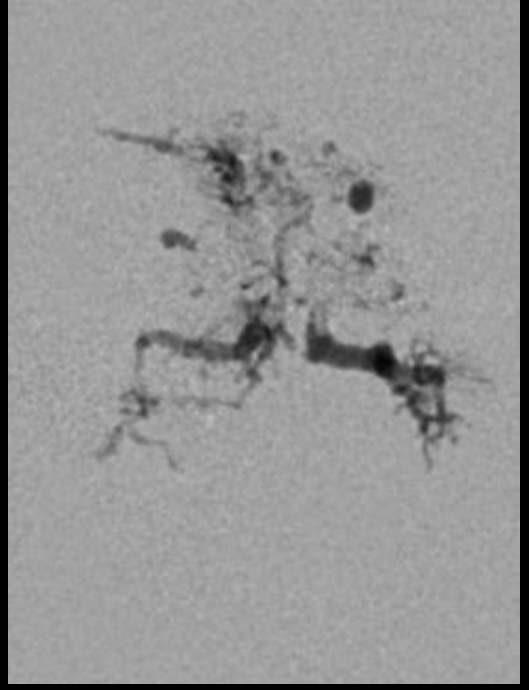
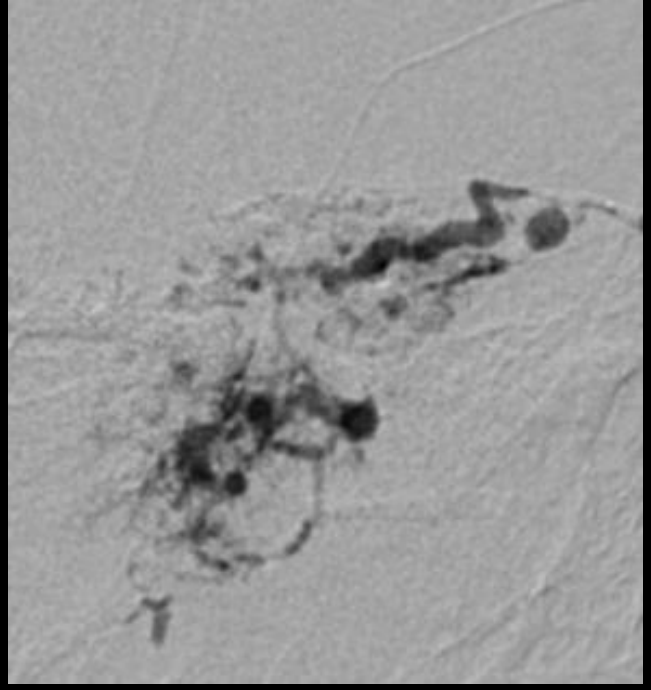
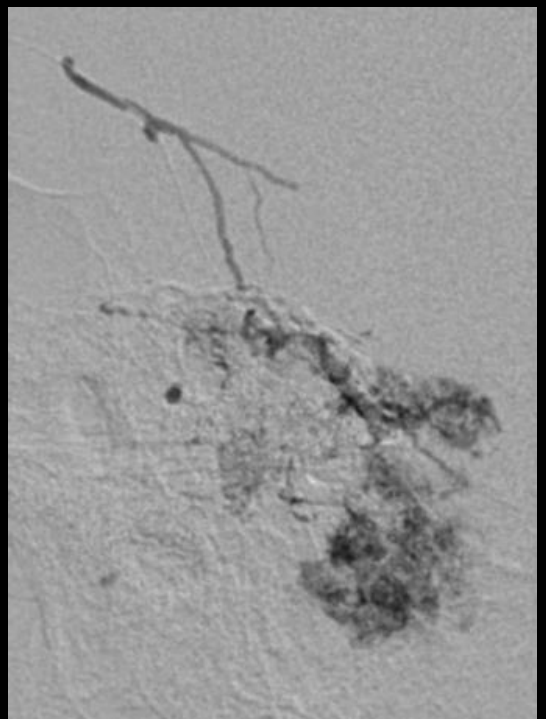
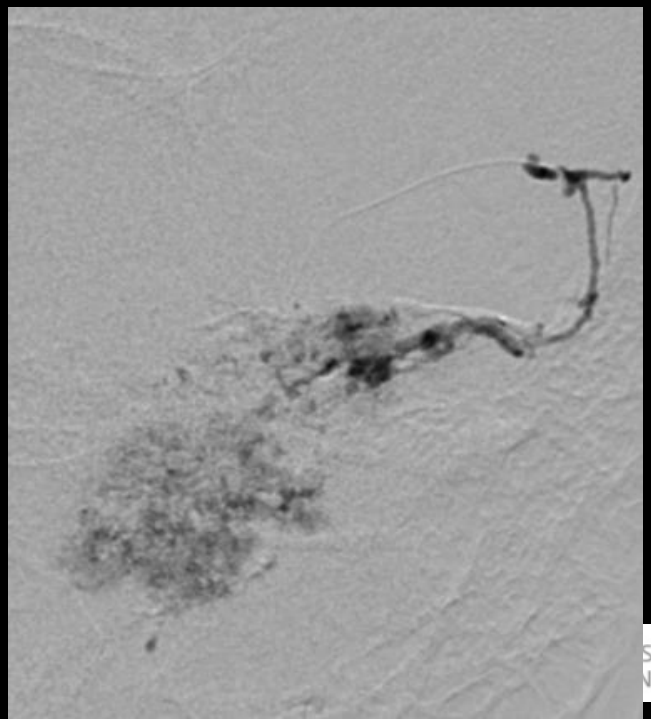
Push and pull technique

- Conventional technique used with NBCA glue
- 25-30% glue is used
  - Depending on the flow velocity
  - Individual judgment based on personal experience
  - Poor penetration in tumors
- Rarely used for tumor
  - Not needed with detachable tip catheters

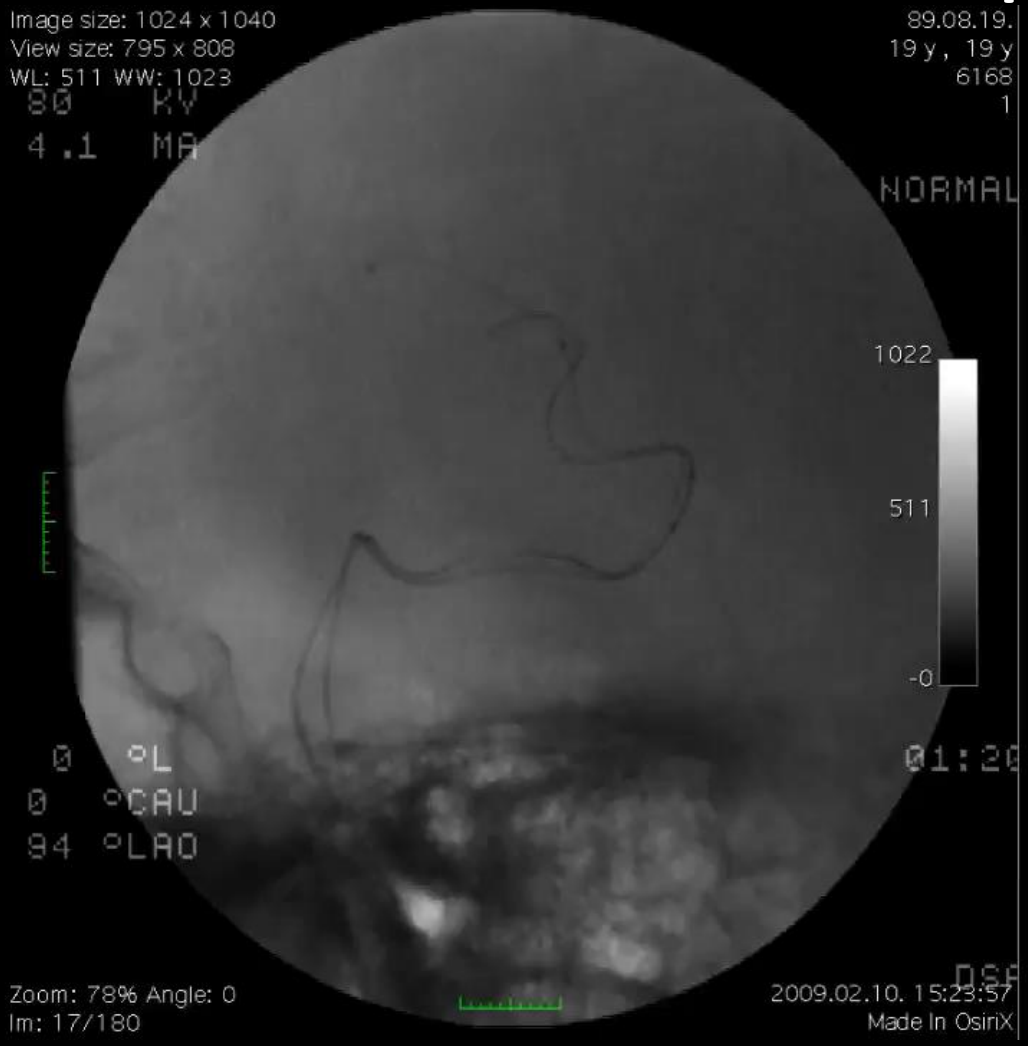
Plug and push technique

- Standard technique for non-adhesive liquid embolics
  - With detachable tip catheters can be used for adhesiev emnbolics, too
- All non-adhesive liquids requires DMSO compatible microcatheters
- Microcatheter needs to be rinsed with DMSO
- Small plug is quickly created at the microcatheter tip by reflux around it
- EVOHis injected slowly with the plug blocking antegrade flow
  - Can be used with high dilution glue, too
  - Detachable tip catheters!



Pressure cooker technique

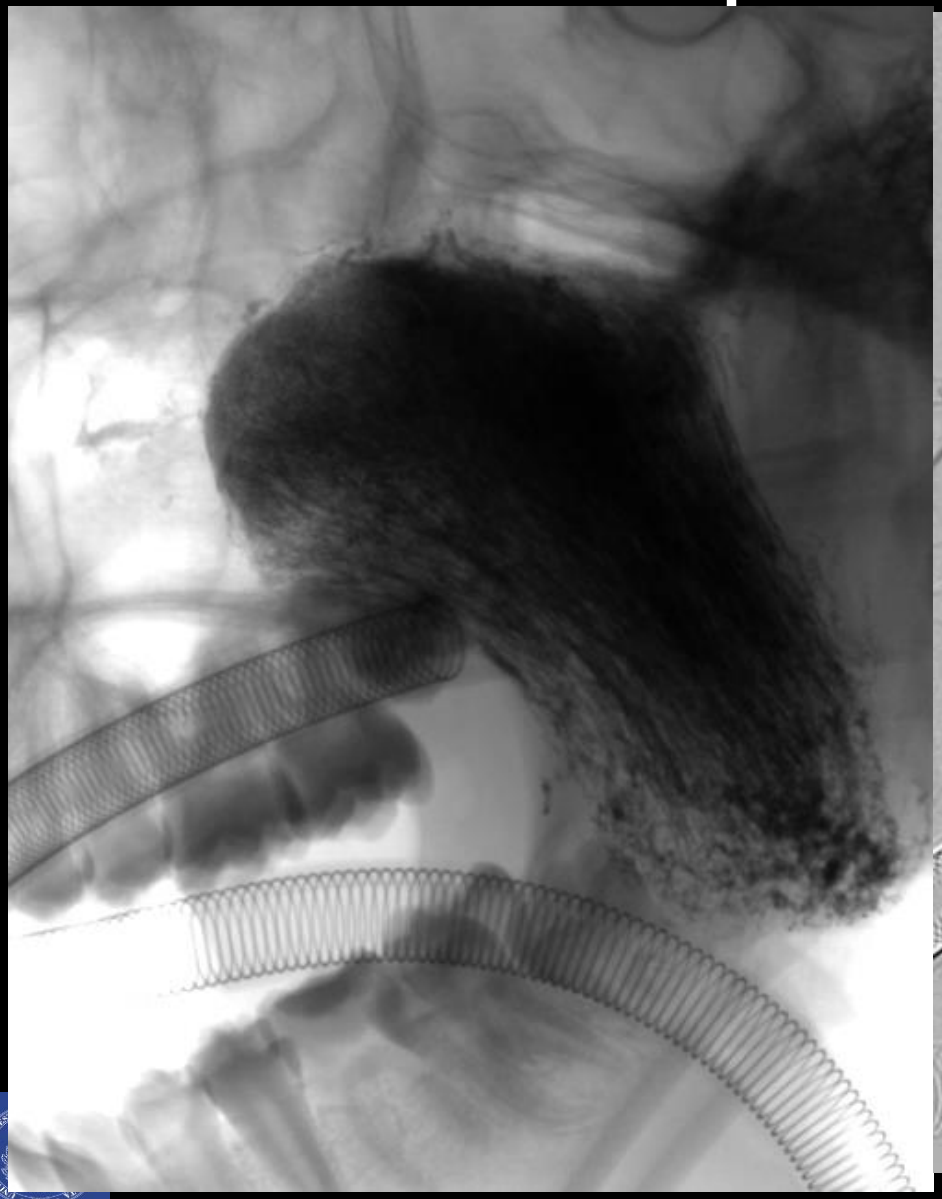


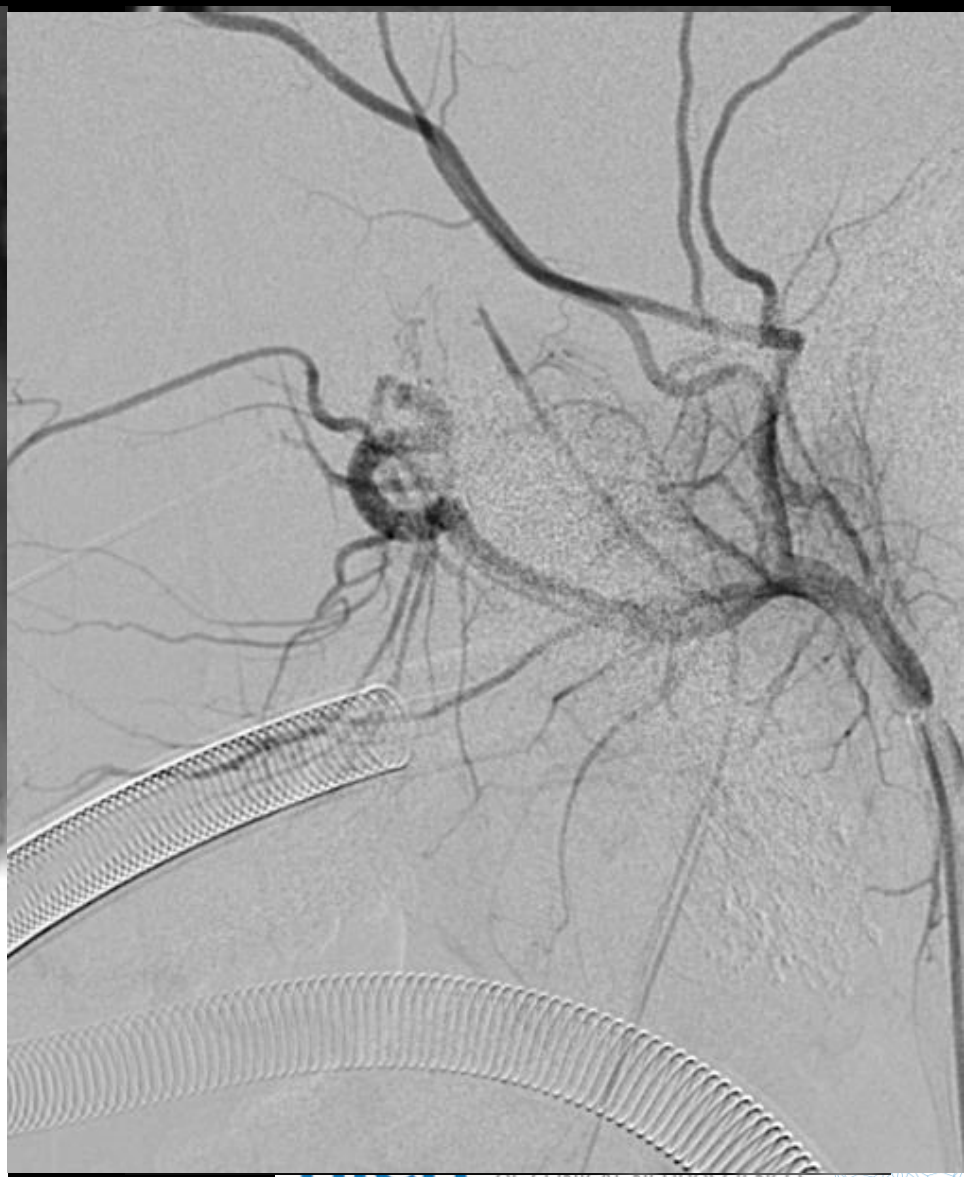
Not needed for tumor embo

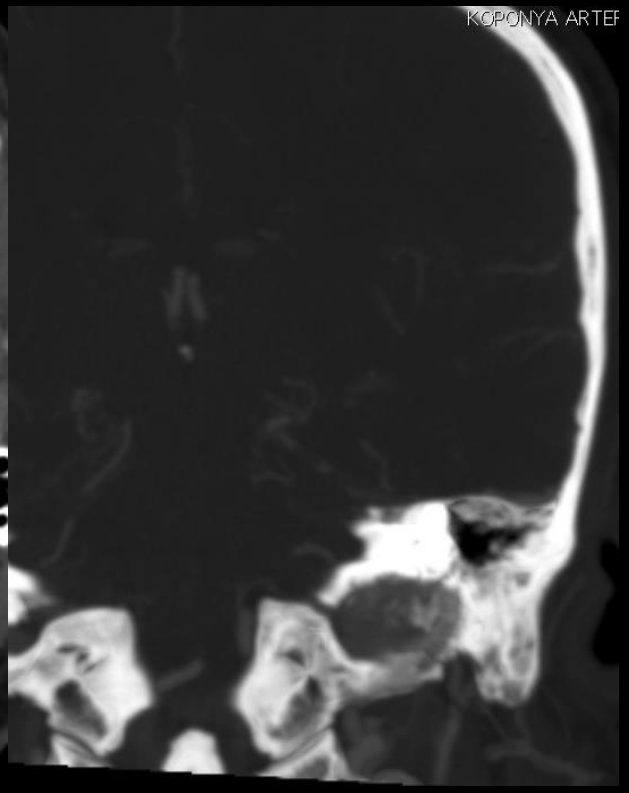
Transarterial embolization by direct puncture

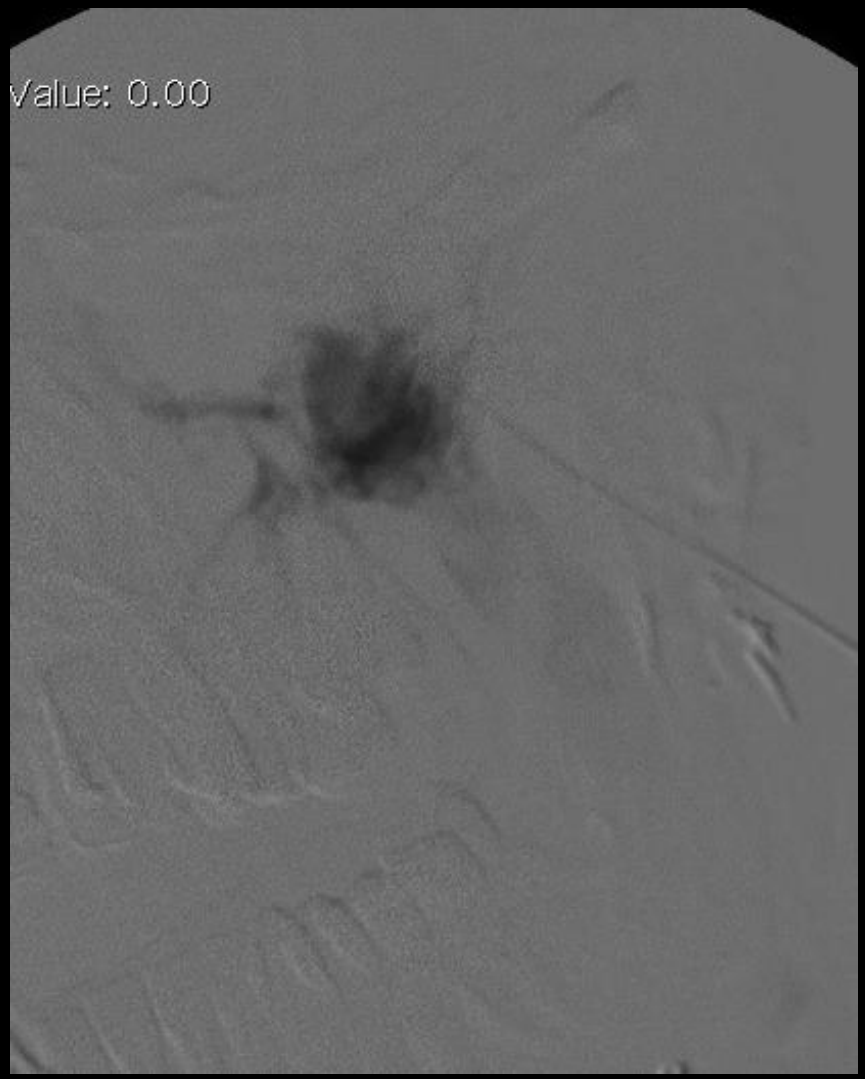
- Can be used for most skull base tumors
- Liquid embolics used
  - Highly diluted glue is optimal
- Advantages:
  - No need for multiple catheterization
  - Deep penetration guaranteed
  - No issues with catheter removal
- Disadvantages:
  - Risk of inadvertent transtumoral embolization into normal territory

Direct puncture embo









Ancillary techniques

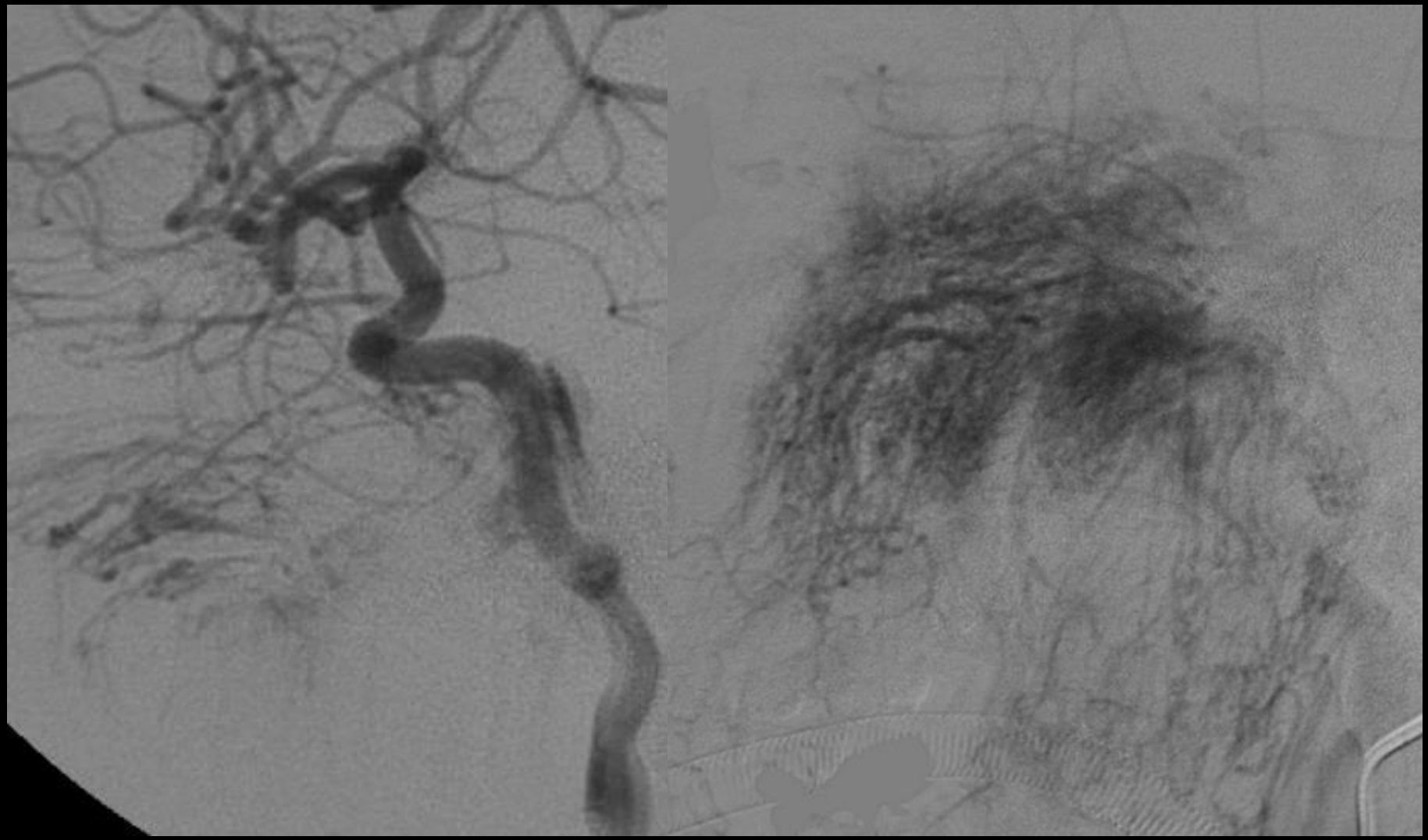
- Occlusion of normal branches to avoid distal embolization into normal territory
  - En passage tumor feeders
  - High risk of reflux and embolization into normal territory
  - Normal territory has sufficient collateral supply
- Occlusion of tumor feeding pedicles following inra-tumoral embolization

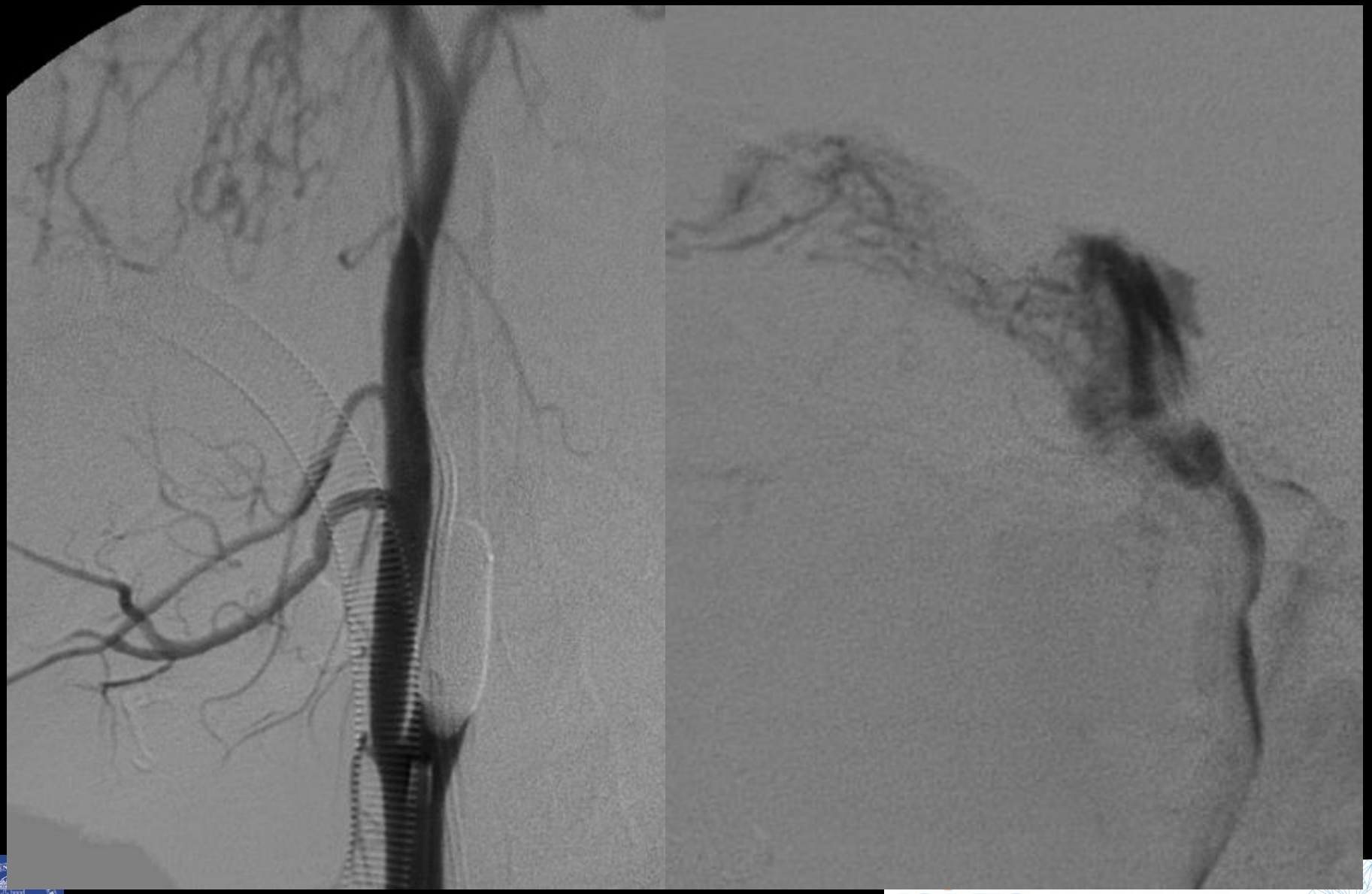
Ancillary techniques

- Temporary balloon protection of normal arteries

Ancillary techniques

- Permanent occlusion of normal arteries





Conclusion

- Head and neck tumor embolization:
  - Effective in reducing surgical blood loss/surgical time / morbidity
    - Based on low level evidence
  - May slow/stop tumor growth
    - Based on anecdotal evidence
  - Indication:
    - Multidisciplinary decision
    - Expected benefits + added risks considered
  - Multiple technical options:
    - No proof of superiority
      - Choice of technique based on individual skills and experience
  - Randomized studies:
    - Desirable – unlikely
      - Rarity of the diseases