Treatment of vertebral compression fractures: current options of useful tools and products

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Disclosure

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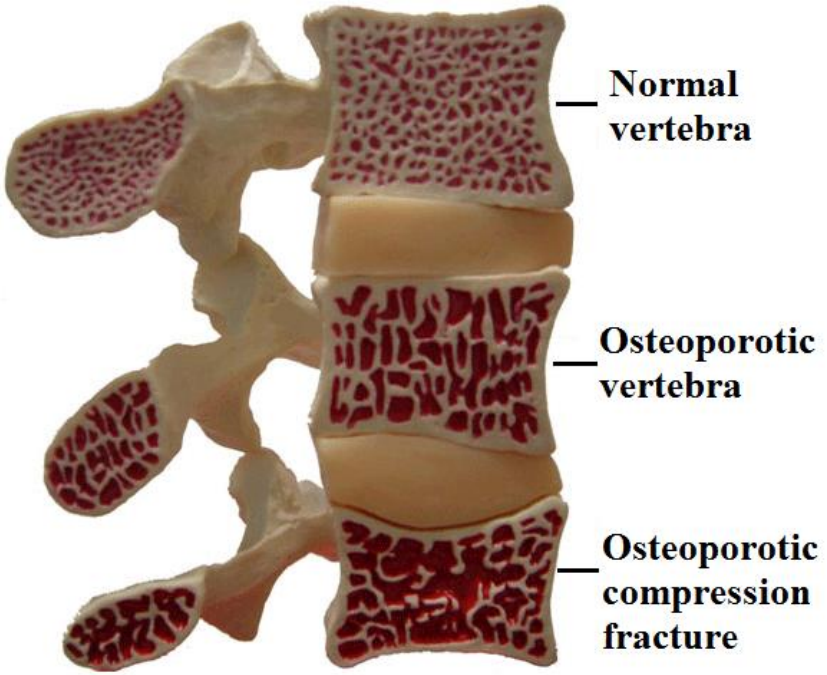
- Scientific consultant-Medtronic, Boston Scientific

Learning objectives

- Identify specific indications for vertebral augmentation procedures in clinical practice
- Describe available techniques and technologies for vertebral augmentation
- Understand complications and adverse events that can arise from performing vertebral augmentation procedures

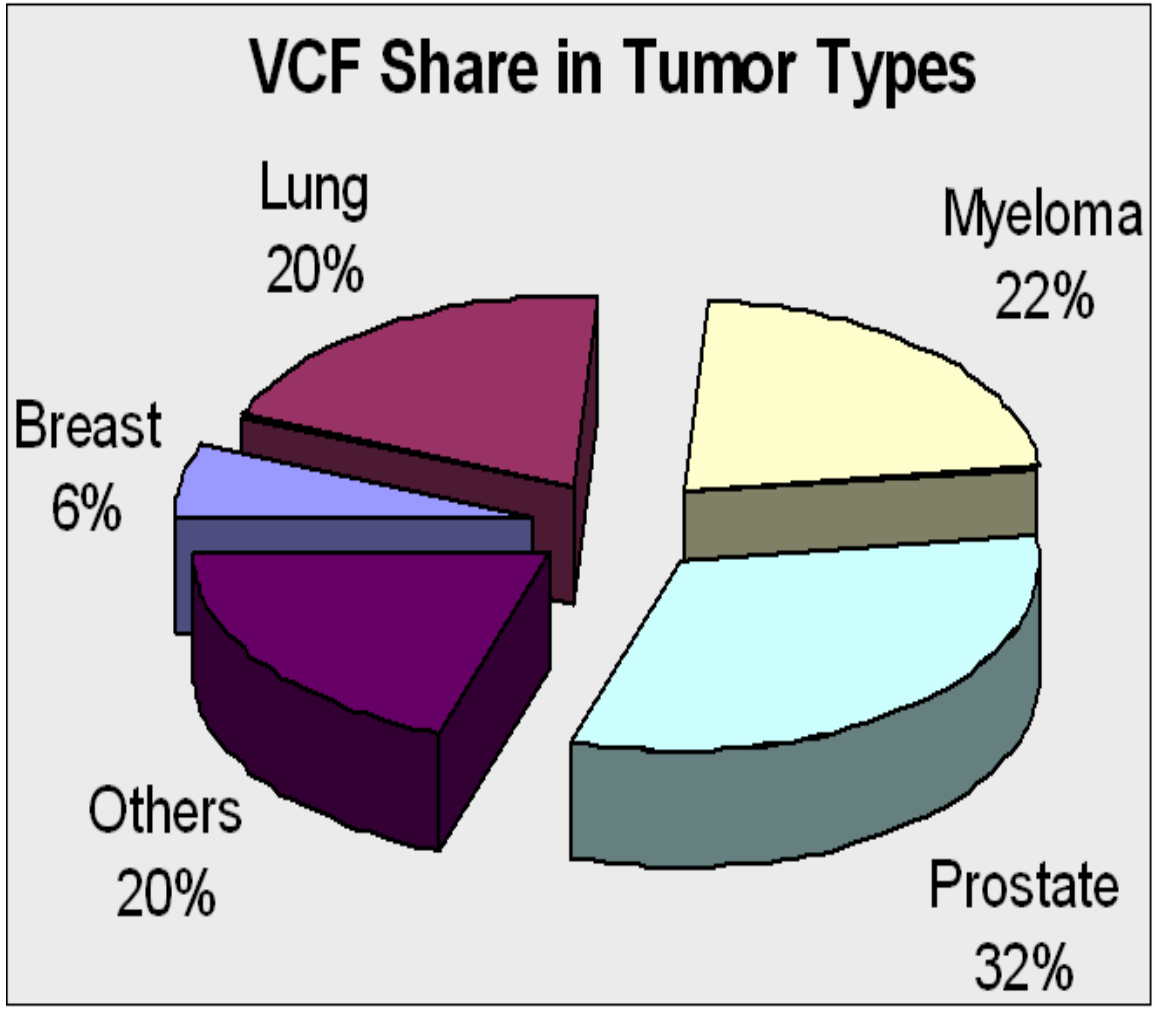
Vertebral compression fracture

- Pathologic
  - Malignant
  - Osteoporotic
- Diagnosis
  - X-ray
  - MRI
    - Gold standard
    - Identify acuity of compression



Compression Fractures in Cancer Patients

- An estimated 75-100K cancer-induced VCFs occur annually in the U.S.
  - Stage IV breast and lung cancers
  - All stages of Multiple Myeloma
  - Stages III and IV of prostate cancer



Hortobagy et al. *NEJM.* 1996;335:1785-1791. Berenson et al. *NEJM.* 1996;334:488-493. Brincker et al. *Brit J Haematol.* 1998;101:280-286. McCloskey et al. *Brit J Haematol.* 1998;100:317-325. Melton et al. *J Bone Miner Res*. 2005 ;20:487-493.Djulbegovic et al. *Cochrane Database Syst Rev*. 2002; 4, CD003188:1-32. Berruti et al. *J Urol.* 2000; 164:1248-1253. Diamond et al. *J Urol,* 2004;172:529-532.

Multiple Myeloma Fractures

- Over 70% of patients have bone pain at diagnosis and half have back pain
- 55%-70% have VCFs or history of vertebral body abnormalities
- 15%-30% develop new VCFs annually
- About half of patients with at least 1 osteolytic lesion develop pathologic fractures within 9 months

McClosekey et al. *Br J Hematol*. 1998;100:317-325. Ray et al. *J Bone Min Res*. 1997;12:24-35.
McCloskey et al. *Drugs.* 2001;61:1253-1274. Berenson et al. *NEJM.* 1996;334:488-493.

VCFs why do they happen?

- Metastatic bone cancer with lytic lesions
  - Breast, prostate, multiple myeloma
- Chemotherapy
  - Steroids: secondary osteoporosis and increase the risk for VCFs
- Radiation Therapy
  - Conflicting evidence- radiation-VCFs associated risk: 0 to 41%
  - Does not prevent fracture progression
  - Does not correct the anatomic abnormality from fracture

Van Staa TP. J Bone Miner Res. 2000;15:993–1000. Stricker . *Sem Oncol Nurs.* 2007;23(1):55-70. Tong et al. *Cancer.* 1982;50:893-899. Janjan. *Sem Oncol*. 2001;28:28-34.

Spine Instability Neoplastic Index

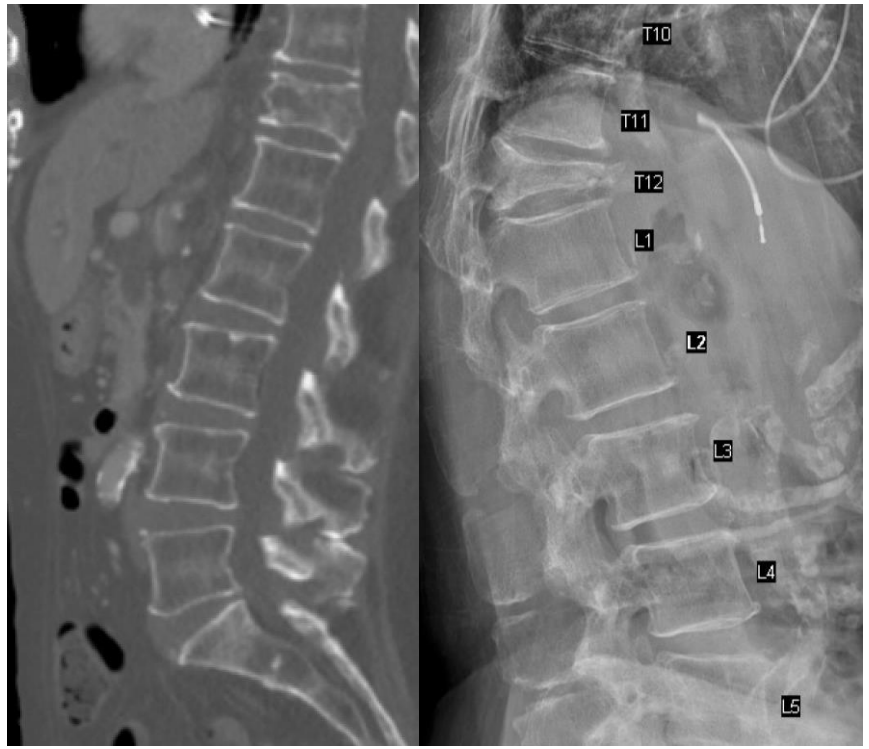
Element of SINS	Score
Location	
Junctional (occiput-C2, C7–T2, T11–L1, L5–S1)	3
Mobile spine (C3–C6, L2–L4)	2
Semi-rigid (T3–T10)	1
Rigid (S2–S5)	0
Pain relief with recumbency and/or pain with movement/loading of the spine	
Yes	3
No (occasional pain but not mechanical)	1
Pain free lesion	0
Bone lesion	
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 the spinal elements (facet, pedicle or CV joint fracture or replacement with tumor)	
Bilateral	3
Unilateral	1
None of the above	0

Predicts which patient with spine mets may be in need of stabilization

- 0-6-stable
- 7-12 potentially unstable
- >12 unstable

Osteoporotic compression fracture

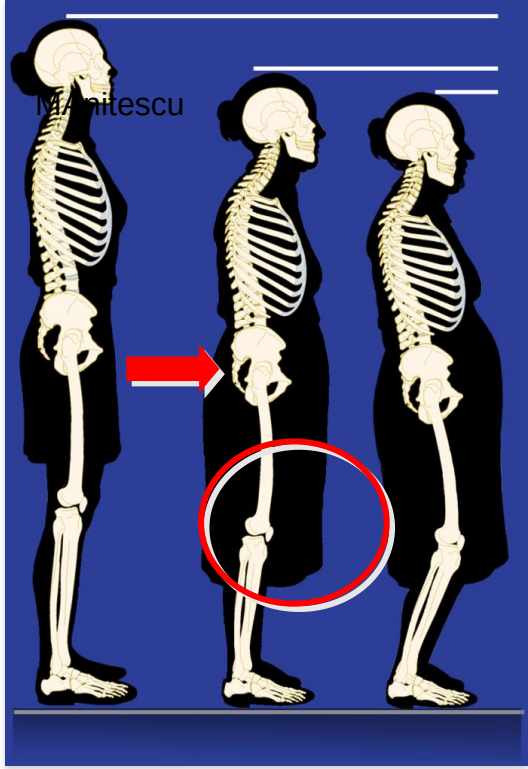
- Controversial data still.
- 1.4 million cases worldwide
- Conservative regimen works, heals in 3 months
- Selection process identifies ideal candidates essential for long term positive outcome
- Vertebroplasty vs kyphoplasty.



Signs of Vertebral Compression Fractures

- Acute Event
  - Sudden onset of back pain
  - Point tenderness
  - Girdle/belt/band-like pain
  - Muscle spasms
- Chronic Manifestation(s)
  - Loss of height
  - Spinal deformity – kyphosis
  - Protuberant abdomen

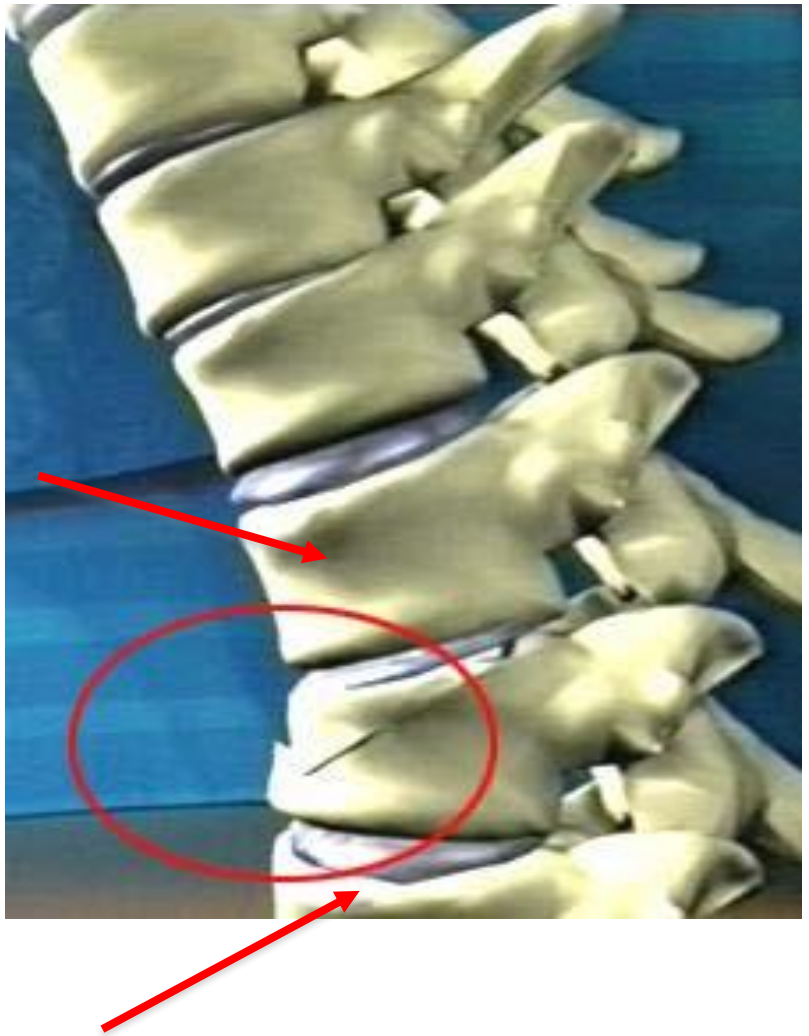
- Subsequently
  - Knees bend, pelvis tilts forward
  - Change in balance
  - Decrease in gait velocity
  - **Increased risk of falls/additional fractures**



Coleman. *Cancer*. 1997;80:1588-1594. Lavelle et al. *Med Clin N Am.* 2007;91:299-314.

Future Fracture Risk

- After first VCF, risk of subsequent VCF is increased:
  - 5-fold after first VCF
  - 12-fold after 2 or more VCFs
  - 75-fold after 2 or more VCFs and low bone mass (below the 33rd percentile)



Ross et al. *Annals Int Med.* 1991; 114(11):919-23

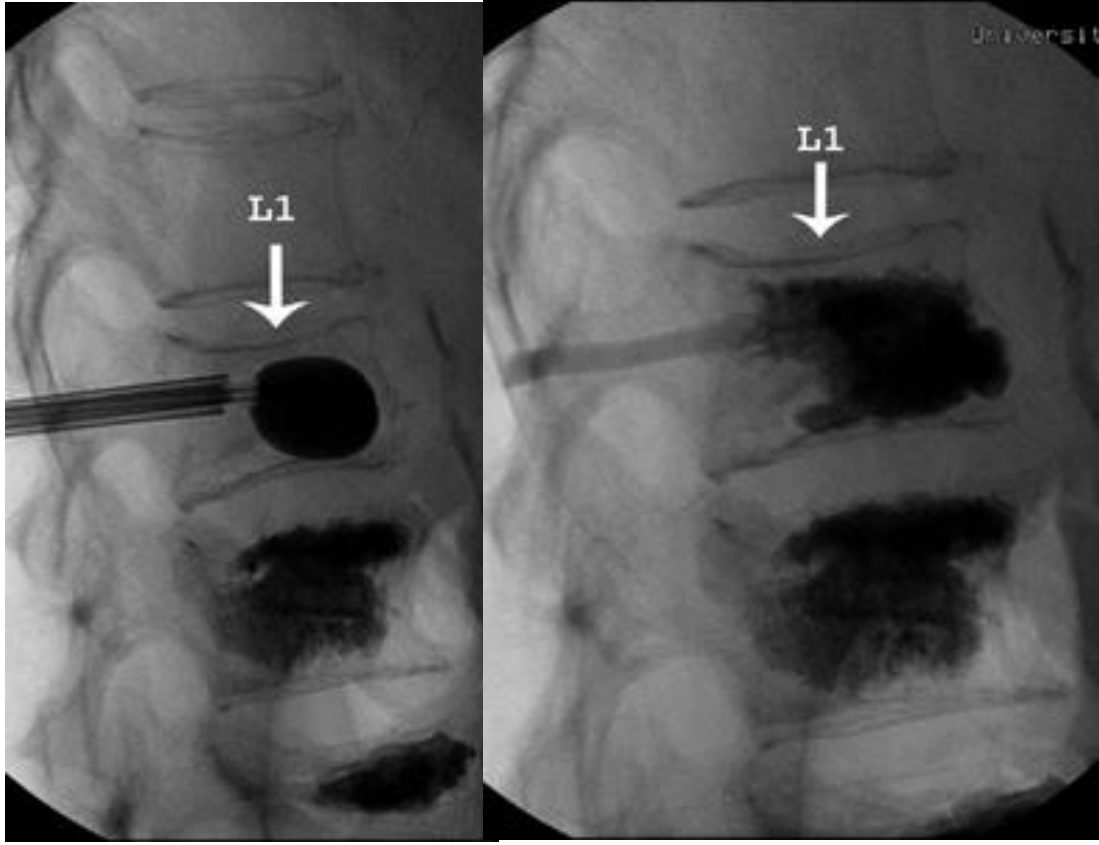
Vertebral augmentation techniques

Bone metastases/osteoporosis-

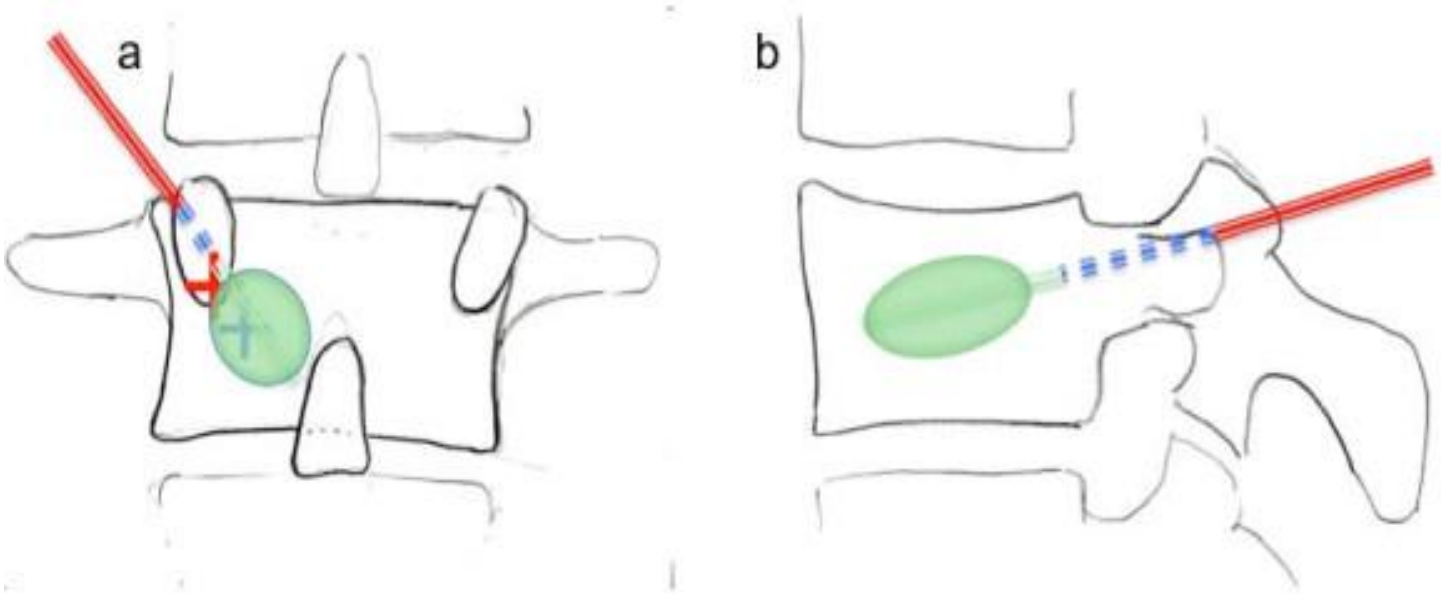
- Percutaneous cementing of collapsed vertebral body
- Only when symptomatic

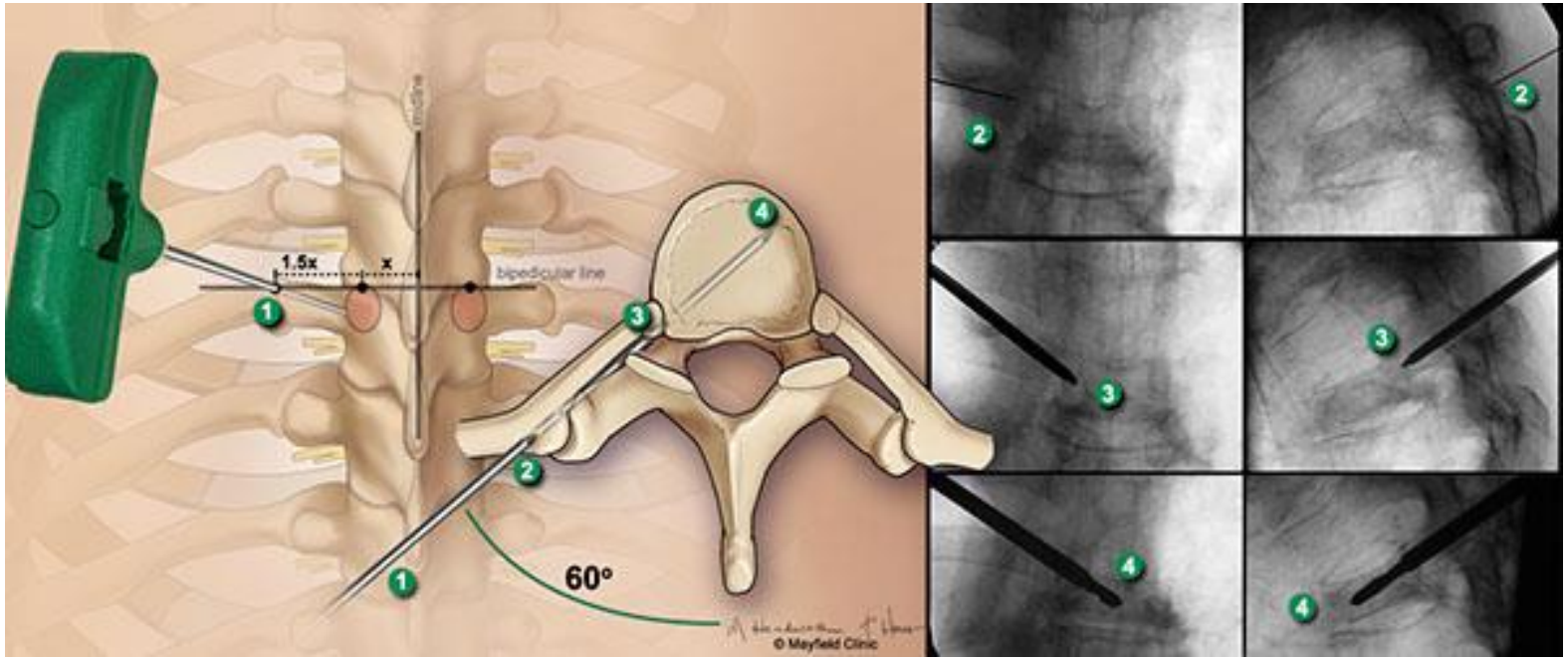
Technique

- Transpedicular-contact with bone at all times-somewhat safer
- Extrapedicular-acute angle, no bone until the vertebral body-somewhat less safe

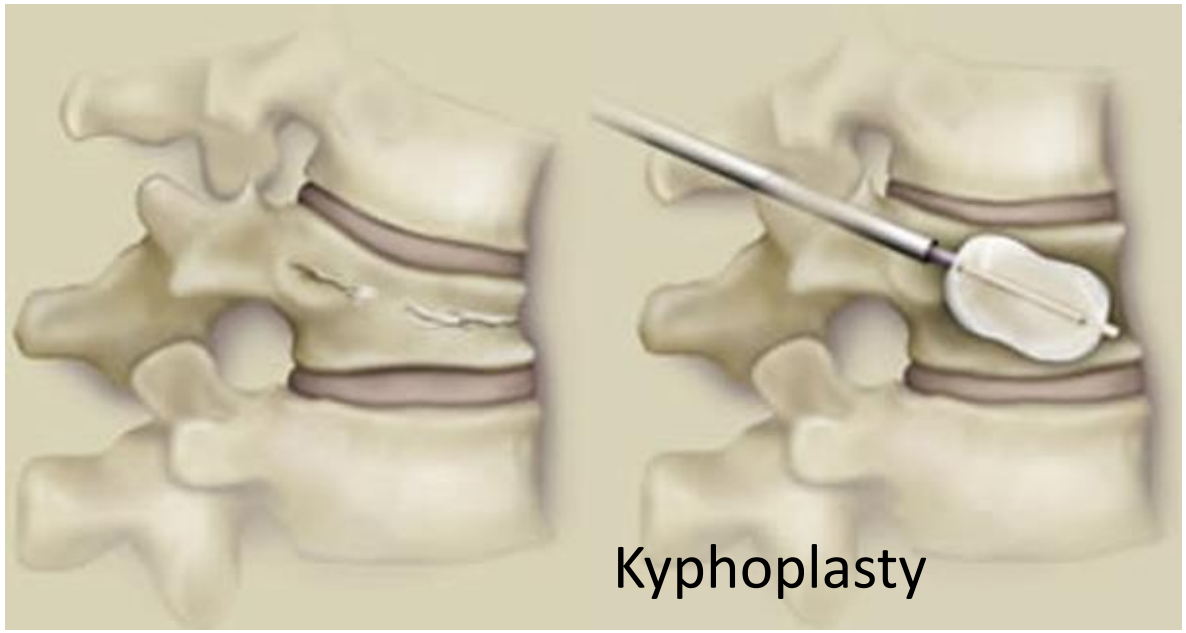


Approaches: extrapedicular vs transpedicular

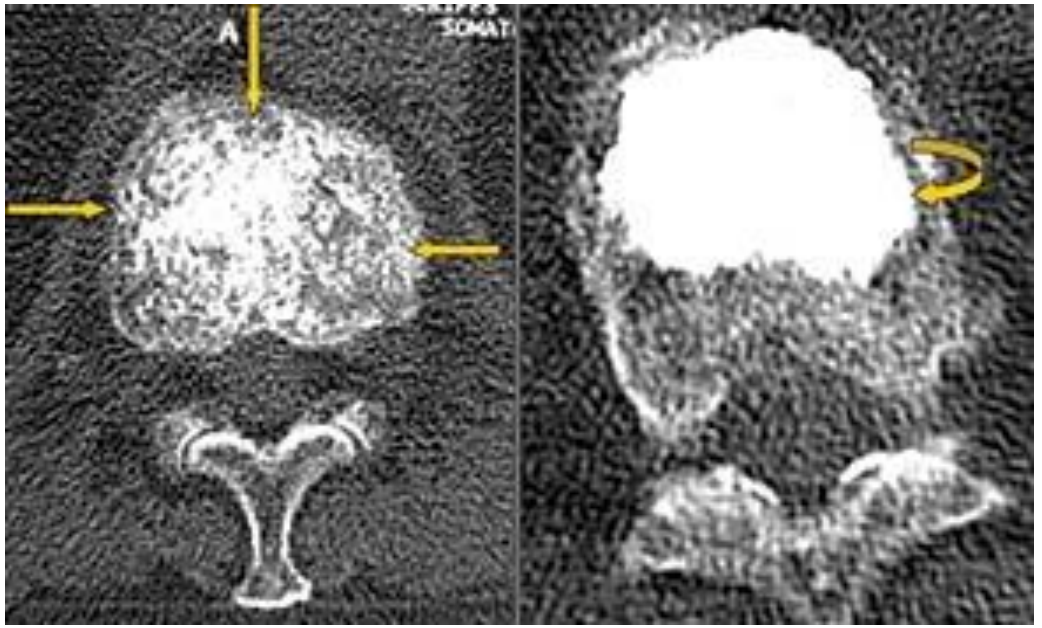




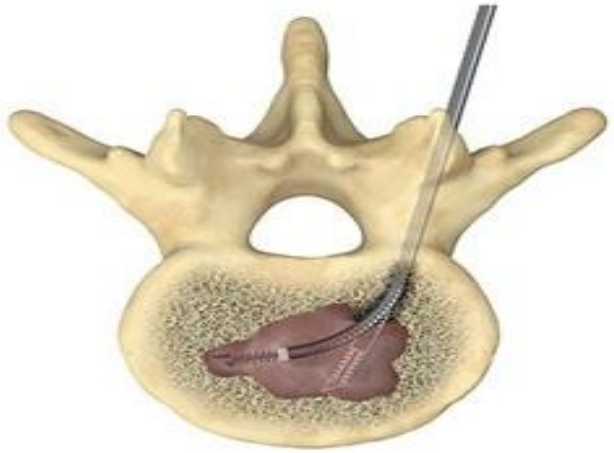
Vertebral augmentation techniques



Kyphoplasty



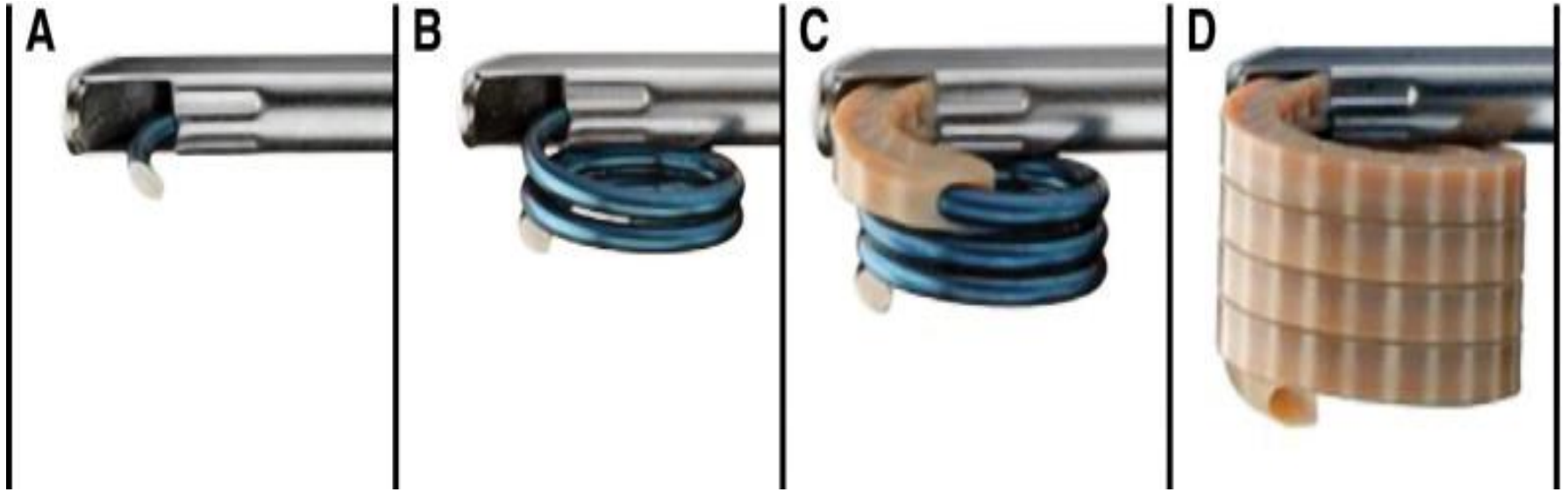
Synthetic Bone vs. PMMA

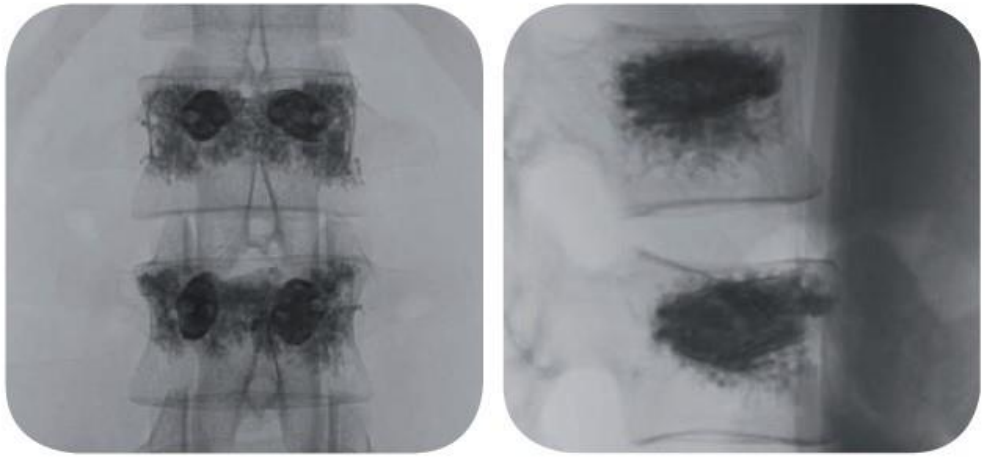


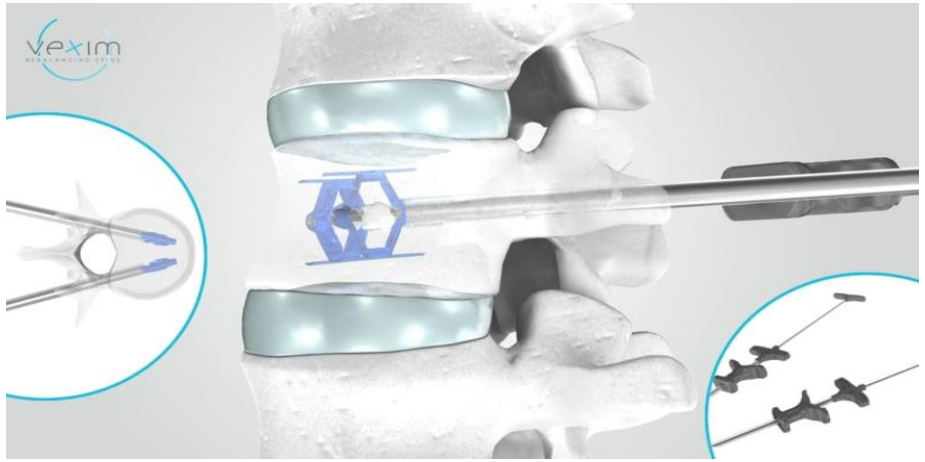
Vertebroplasty

Newer methods

- PEEK Implant/PMMA



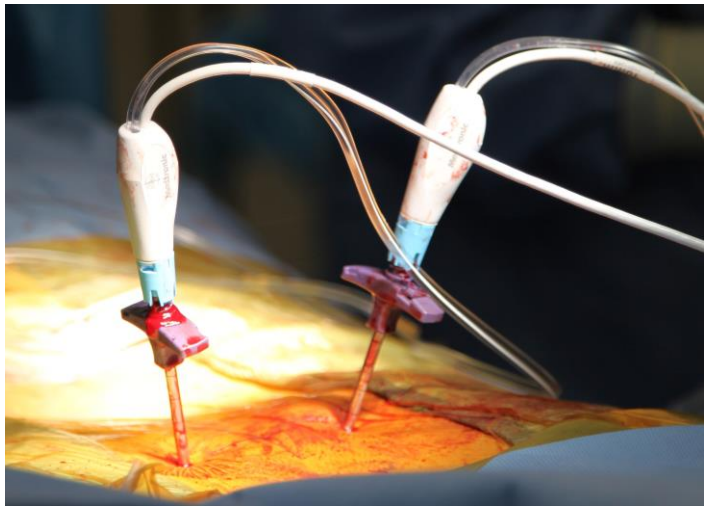




Spine Jack

Thermal bone ablation

- Heat lesion to 90 centigrade
- Traditional: create char
- Water-cooled: expanded lesion



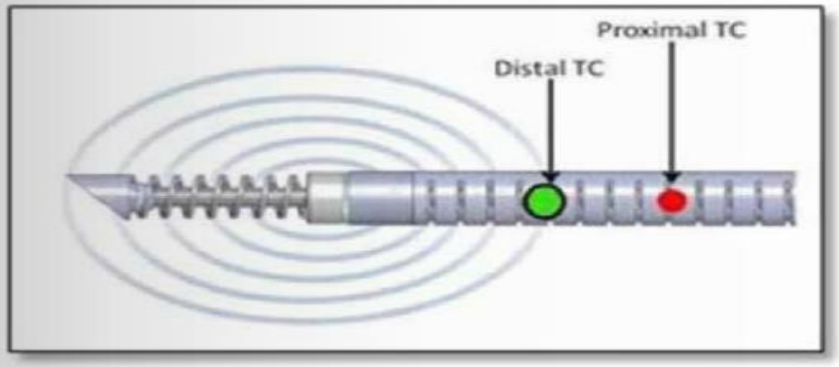
Water-cooled

Traditional

Conventional Vertebral body RF

Figures 1 and 2: *Cannula and radiofrequency probe; curved probe allows unipedicular approach to treat vertebral metastases. (Reprinted with permission of DFINE, Inc.)*

Figure 3: *Radiofrequency ablation zone in DFINE STAR system (Reprinted with permission from DFINE, Inc.)*



- Conventional RF
- Multiple lesioning
- Unipedicular
- High temperature
- Disadvantages: possible char, longer

Water Cool RF

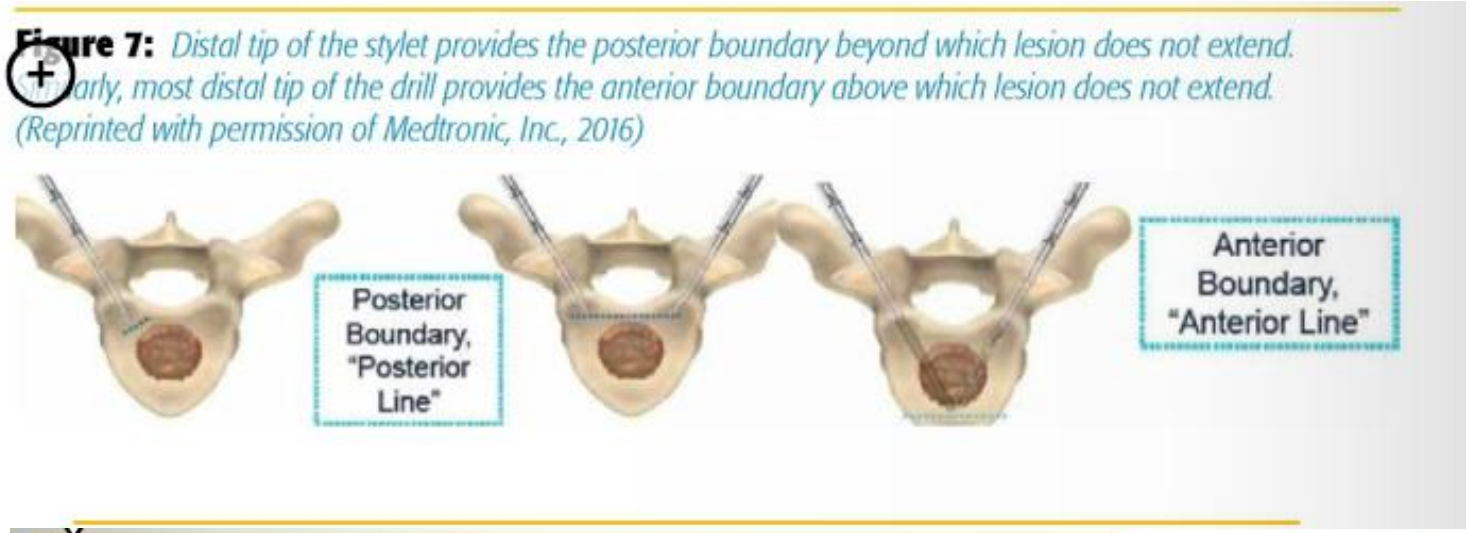


Figure 7: *Distal tip of the stylet provides the posterior boundary beyond which lesion does not extend. Similarly, most distal tip of the drill provides the anterior boundary above which lesion does not extend. (Reprinted with permission of Medtronic, Inc., 2016)*

- Water cooled lesion
- Significantly bigger, combined lesioning
- Easy to use
- No charing
- One lesioning

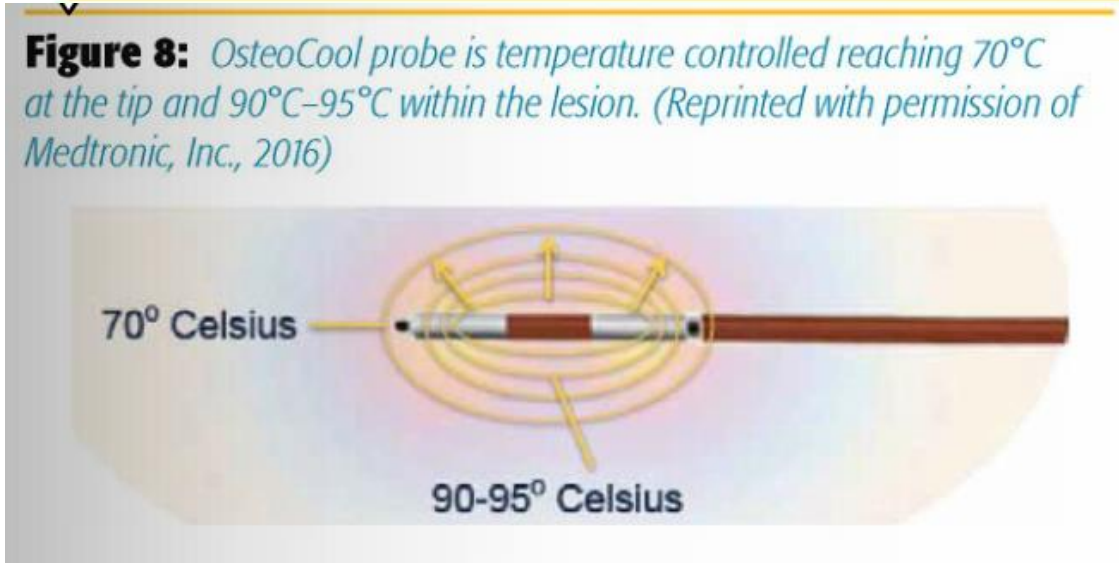


Figure 8: *OsteoCool probe is temperature controlled reaching 70°C at the tip and 90°C–95°C within the lesion. (Reprinted with permission of Medtronic, Inc., 2016)*

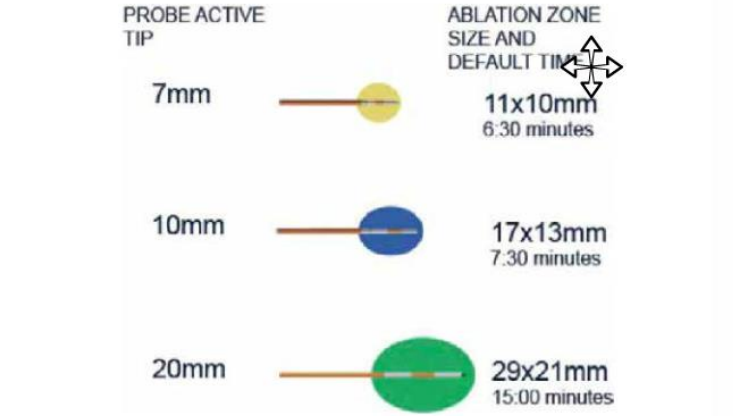


Figure 5: *Disposable Osteocool RF Ablation probes. (Reprinted with permission of Medtronic, Inc., 2016)*

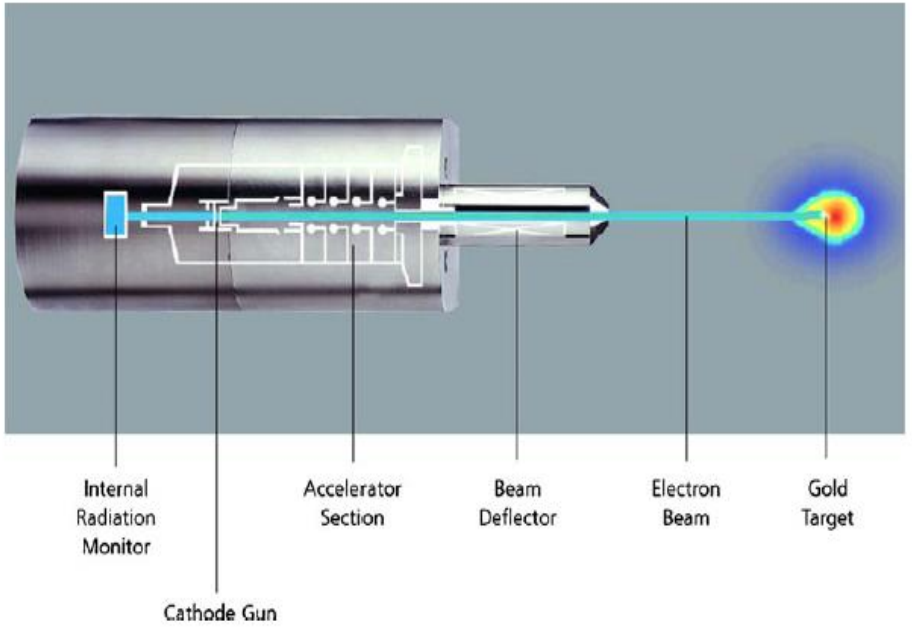
Ablative techniques characteristics and differences

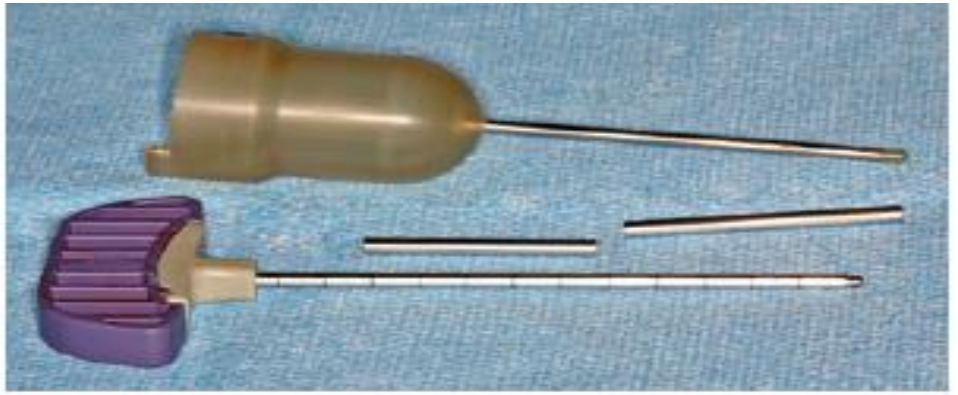
Characteristics	Conventional RF	Water-cooled RF
Access	Unipedicular, possible bipedicular	Bipedicular, possible unipedicular
Instrument	Flexible, articulated instrument	Straight instrument
Temperature	Temperature measured at the tip, stopped when 50°	Temperature measured at the tip is 70°
Form of the lesion	Oval lesion, advantage in small lesion	Round spherical, advantage in significant tumor presence
Design of the instrument	Simple design, multiple steps	Complex design, one step (built-in features)
Number of lesions needed	Multiple burns, advantage in small multiple lesions	One burn, advantage in small and big lesions

Vertebral augmentation and bone radiofrequency ablation

	Kyphoplasty	Vertebroplasty	PEEK implant	Spine Jack
Fracture reduction	yes	Not always	yes	Yes
Cavity creation	yes	no	yes	No
Cement consistency	Pasty	liquid	pasty	Pasty
Preserved bone elasticity	PMMA	PMMA, Synthetic cortical bone	PMMA, Synthetic cortical bone	PMMA
Radiofrequency ablation	Yes, water cooled RF	Yes, traditional RF	Yes, traditional/ water cooled	Combined with the partner system

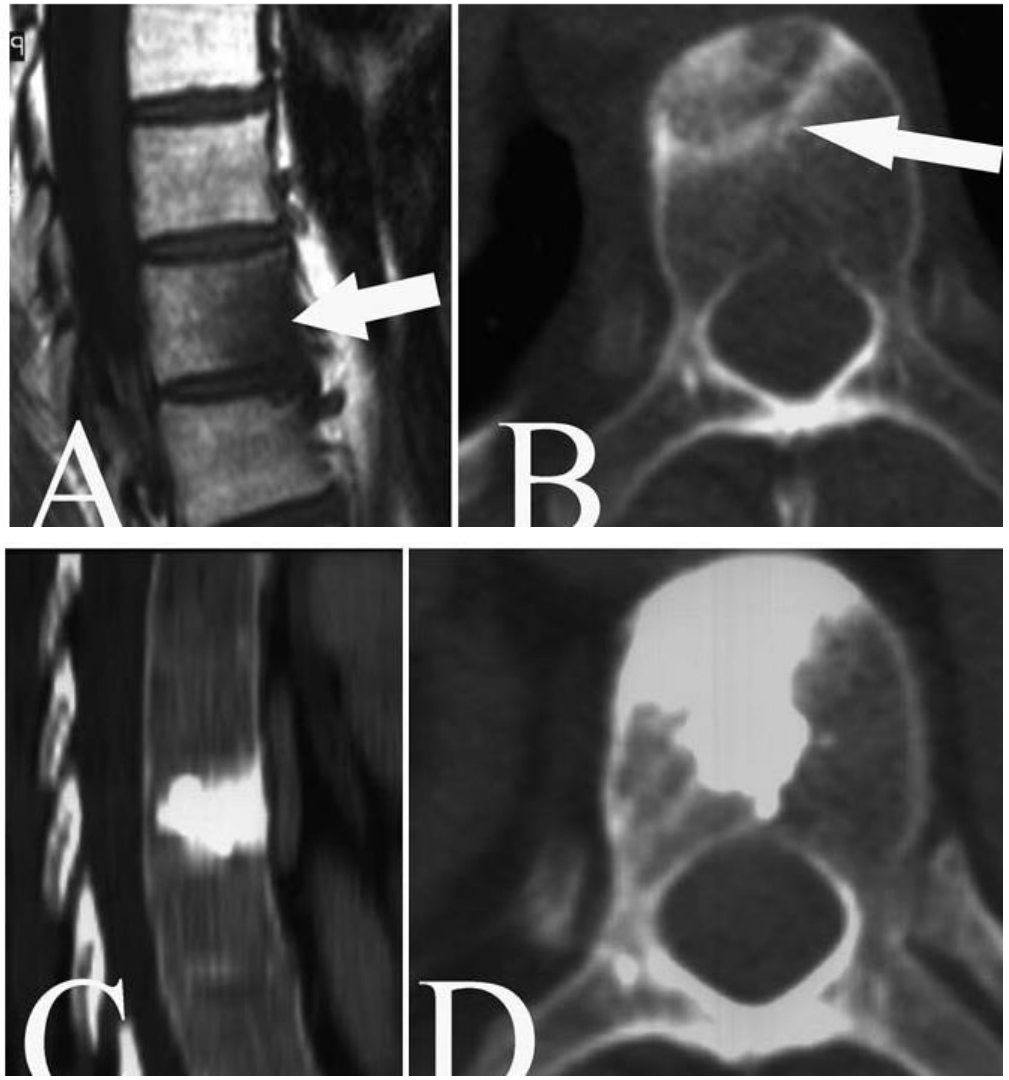
Other techniques for vertebral metastatic disease: Intrabeam Radiation Source

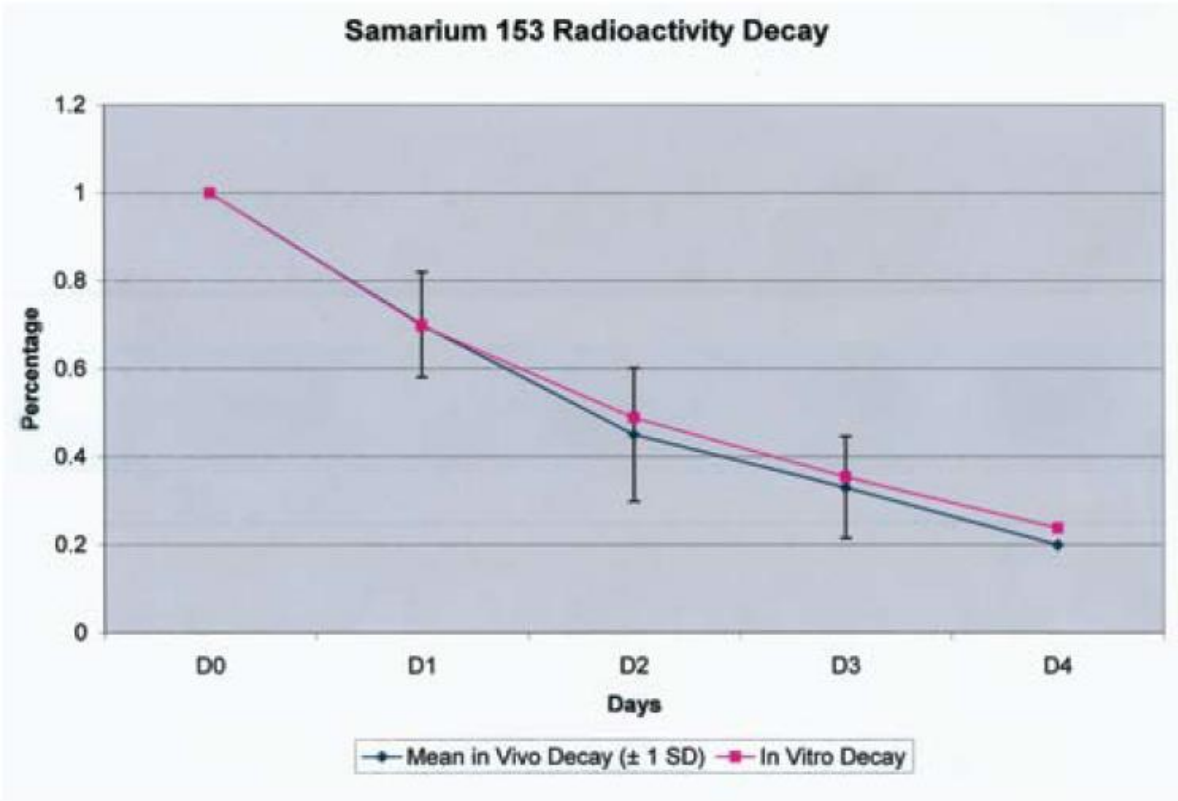




Schmit R, et al, International Orthopedics 2012, 36:1225-1260Kyphoplasty and intraoperative radiation |

Radioactive Cement





3mCi in 0.3cc added to PMMA;
1.5 cc per vertebral body

Cardoso RR et al, J Neurosurg Spine 10:336-342, 2009Percutaneous tumor curettage Samarium 153 |

Other Bone Treatments

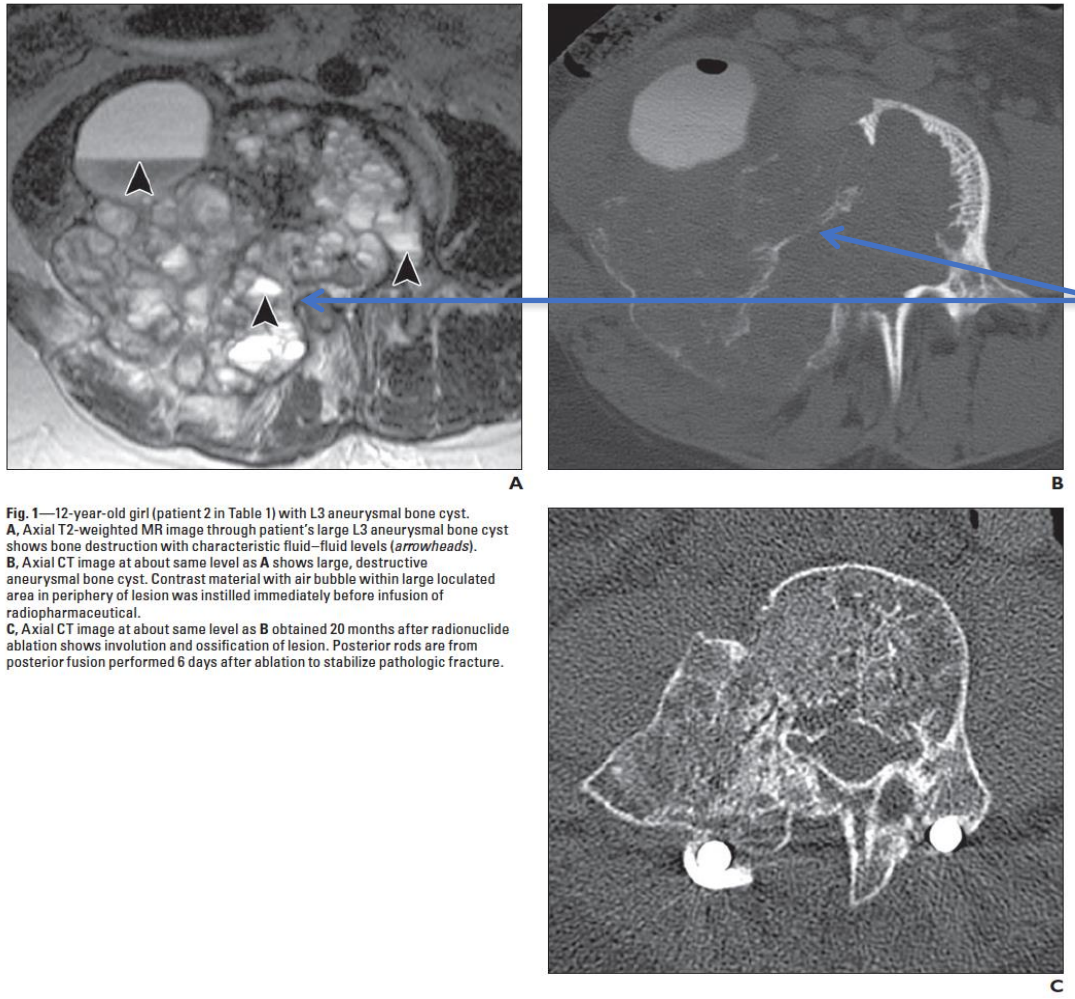


Fig. 1—12-year-old girl (patient 2 in Table 1) with L3 aneurysmal bone cyst.
A, Axial T2-weighted MR image through patient's large L3 aneurysmal bone cyst shows bone destruction with characteristic fluid–fluid levels (*arrowheads*).
B, Axial CT image at about same level as **A** shows large, destructive aneurysmal bone cyst. Contrast material with air bubble within large loculated area in periphery of lesion was instilled immediately before infusion of radiopharmaceutical.
C, Axial CT image at about same level as **B** obtained 20 months after radionuclide ablation shows involution and ossification of lesion. Posterior rods are from posterior fusion performed 6 days after ablation to stabilize pathologic fracture.

- 95% Alcohol in hemangioma
- P32 sclerose bone aneurysms
- ? Brachytherapy
- ? Intravertebral Chemotherapy
- ? Intravertebral Steroids

Complications

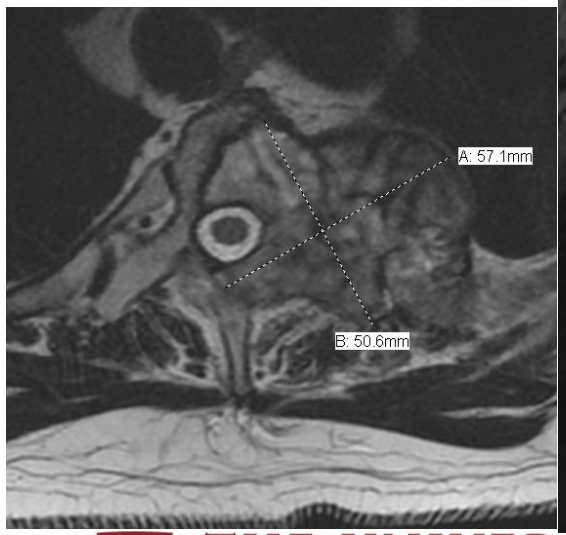
- Complications reduced when tailored to patient, type of tumor, comorbidities

Complications of vertebral augmentation

Complication	Effect	Management
Cement extrusion into spinal canal	Transient or permanent paralysis, radiculopathy, or paresthesias	Emergent surgical decompression
Cement extrusion into neural foramen	Transient or permanent radiculopathy	Conservative management, rarely surgical intervention
Cement extrusion into intervertebral disk	Usually asymptomatic, rarely may result in scans diskitis	Conservative management, rarely surgical intervention
Cement embolus	Usually asymptomatic, rarely may result in symptomatic pulmonary embolus	Supportive management as indicated
Fat embolus	Varies; can be asymptomatic or cause transient hypotension, respiratory failure, or life-threatening cardiac collapse	Conservative management if minimally symptomatic, may require ACLS with serious emboli
Epidural hematoma	Transient or permanent paralysis	Emergent surgical decompression
Infection	Superficial skin infection, rarely epidural abscess, osteomyelitis, or diskitis	Oral or IV antibiotics as indicated, rarely surgical debridement
Allergic reaction	Anaphylaxis: associated with contrast dye and polymethyl methacrylate	Epinephrine, ACLS as needed
Rib fractures	Chest wall pain	Conservative management

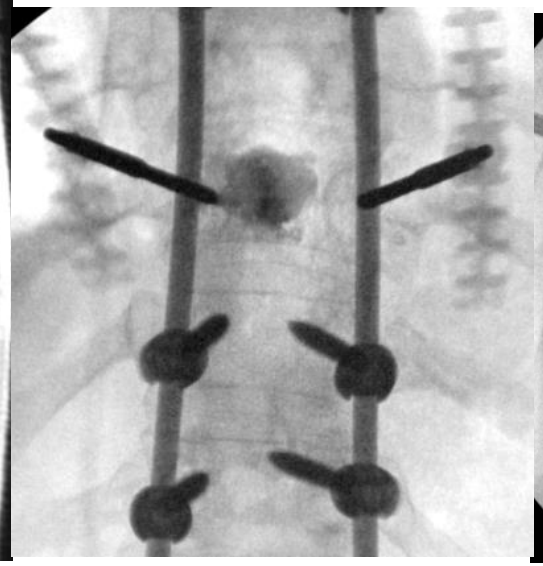
Case studies-renal cell Ca

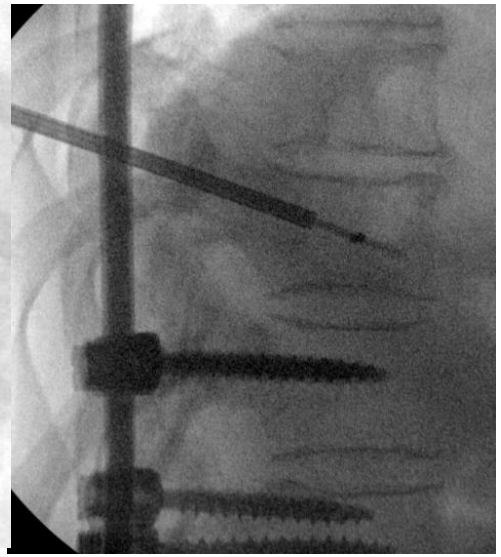
- Multiple mets, T3, sacrum, thoracic
- Thoracic and caudal ESI



T10 treatment

- Technical difficult
- Transpedicular
- Hardware contact
- Possible overheat
- Measure distance



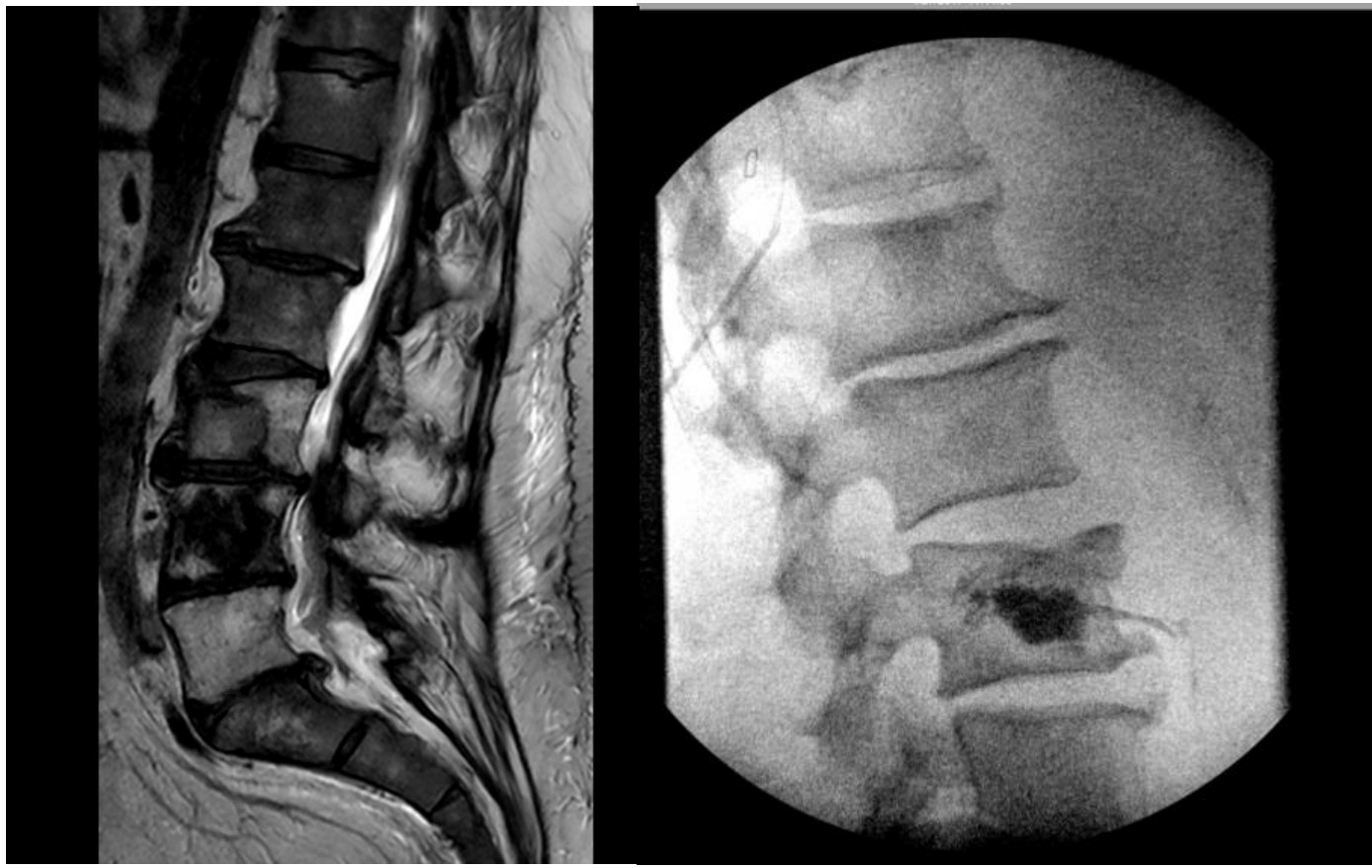


Results

- Downgraded lesion to the small balloon, 0.7 mm
- Close to posterior vertebral wall
- Complete pain relief
- Softer tumor
- More interdigitation

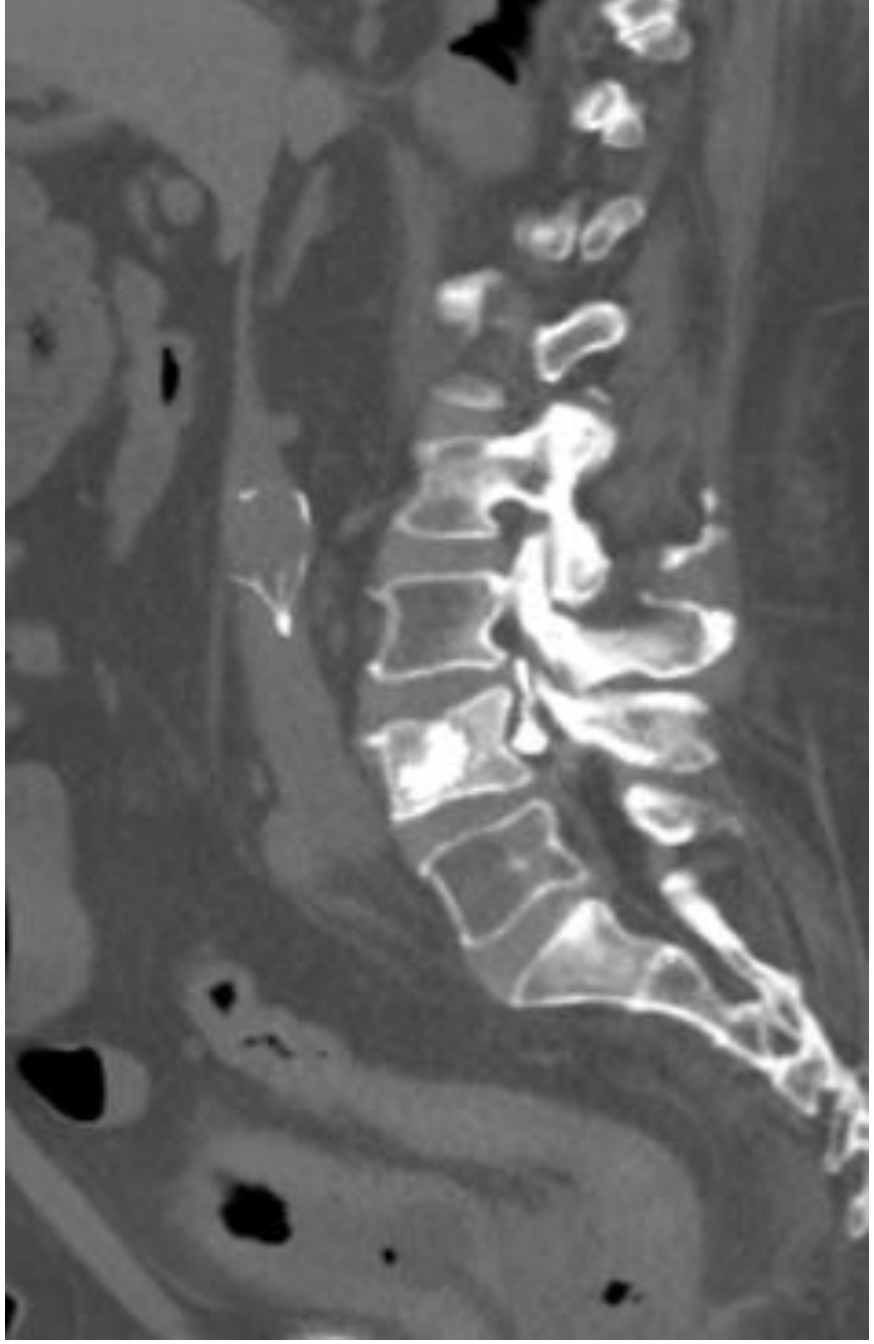
Metastatic prostate Ca, Highly vascular

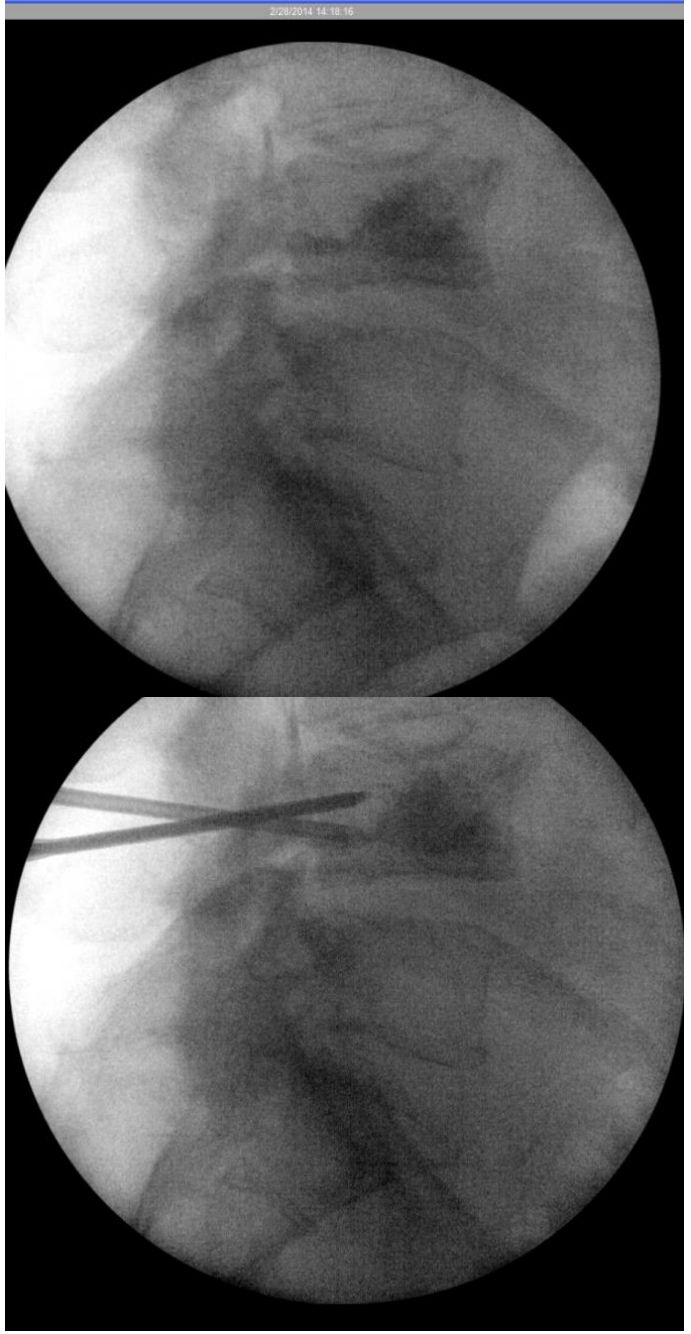
- L3 kyphoplasty/watercooled
- Clefts within bone
- Significant sterilization of tumor
- Perivertebral venous plexi-common leak



Renal cell Ca, lytic lesion

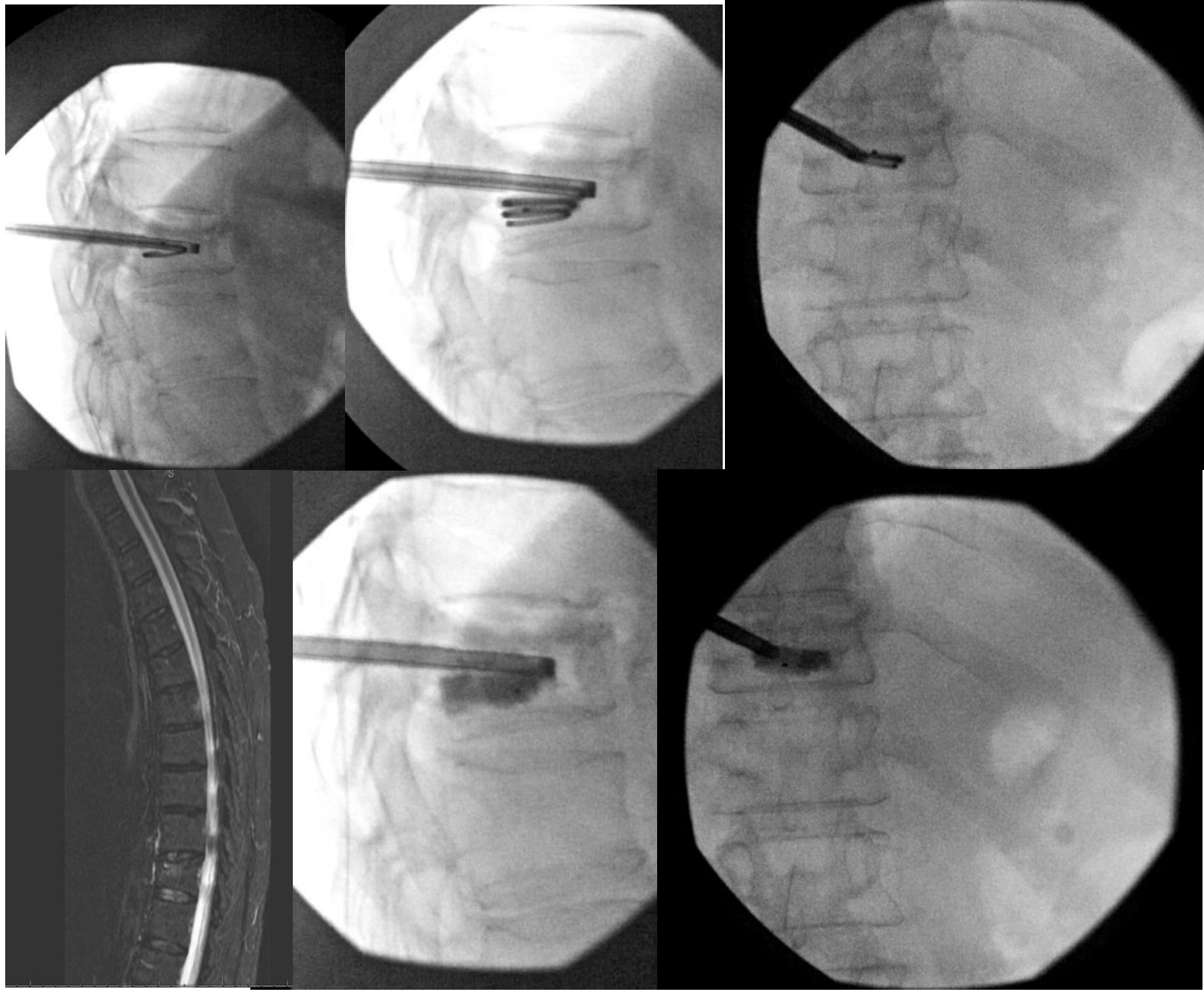
- L4 single lesion,
- Kyphoplasty alone,
- Radicular pain postop





Peek Implant

- T12 compression, not healed after 3 months, pain with every movement
- Osteoporosis, Anticoagulated,
- Significant cardiac and pulmonary history, Recent closure of PFO, A fib
- Need contained cement with no extravasation



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Conclusions

- Vertebral augmentation techniques are utilized in pathologic or osteoporotic procedures
- Indication and timing of procedures is essential for optimal outcomes.
- In metastatic vertebral compression fractures, several devices do sterilize tumor by radiofrequency ablation
- Complications do exist in vertebral augmentation procedures and are primarily present when patients are also debilitated with various co-morbidities

Thank You