Interventional Management of Spinal Cancer: Vertebral Augmentation & Interventional Techniques for Analgesia in Spinal Metastases

Dr. Roger Smith MB ChB, FRCSE
Medical Imaging
Toronto Western Hospital
UHN Toronto
Disclosures

- Medtronic (Kyphon), Medical Technology Company – Consultant

- Benvenue Medical, Medical Technology Company – Investigator, research funding
Objectives

- Nomenclature
- Referral
- Aids to decision making
- SINS
- Technical considerations
- Literature evidence
- Examples
- Future directions
Nomenclature

Vertebral Augmentation:
- Refers to any procedure in which there is the creation of a cavity using a mechanical device before PMMA ‘bone cement’ injection

Kyphoplasty
- Creation of cavity using a balloon before PMMA injection

Vertebroplasty
- Direct injection of PMMA ‘bone cement’ into vertebral body
How Effective Is a Virtual Consultation Process in Facilitating Multidisciplinary Decision-Making for Malignant Epidural Spinal Cord Compression?

David Fitzpatrick, MBChB, FRCP, Daniel Grabarz, MD, FRCP, Lisa Wang, MSc, Andrea Bezjak, MD, MSc, FRCP, Michael G. Fehlings, MD, PhD, FRCS, Christopher Fosker, MD, Raja Rampersaud, MD, FRCS, Rebecca K.S. Wong, MBChB, MSc, FRCP

Int J Radiation Oncol Biol Phys, Vol. 84, No. 2, pp. e167ee172, 2012 0360-3016

Results:

- 125 patients eligible for VC
- 46 patients had a VC
- Surgery recommended in 28, performed in 23.
- Retrospective review - only 5/79 patients who did not have a VC would have been considered surgical candidates.
- The overall accuracy of the virtual consultation process was estimated at 92%.
Virtual Consultation:

Conclusion:

The VC process for MESCC patients provides a reliable means of arriving at a multidisciplinary opinion while minimizing patient transfer.

This can potentially shorten treatment decision time and enhance clinical outcomes.
Davison, Kelly
Great! Thank you all—

Tuchschner, Paul
It's been arranged for tomorrow—

Smith, Roger
It is scheduled for 11am tomorrow December 21, 2012 here at TWH—

Davison, Kelly
Hi all, Can you please let me know at your earliest convenience when this patient's kyphoplasty might be done? If it's not possible to do it in the short-term future, I will make plans to discharge her (if possible) with optimization of her analgesics—

Sahgal, Arjun – UHN – Radiation Medicine Program
Kelly have you liaised with Dr Smith—

Smith, Roger
Paul, Is there any chance of doing this in patient from PMH this week?

Sahgal, Arjun – UHN – Radiation Medicine Program
Roger can do kypho. So Roger let us know what you want to do as she is an impatient, I'll treat after you're done—

Smith, Roger
I think kypho to both bodies T10, T11 will be good for stabilization and pain relief. CT confirms enough bone at both levels to be supported—

Sahgal, Arjun – UHN – Radiation Medicine Program
I can treat I just want pain to settle. Asked Roger Smith to look at images as maybe kyphoplasty first. Is CT spine done? If Roger agrees then kypho and start meds. If not we will plan her the 28th for rats and hopefully pain of fracture settles down—

Sahgal, Arjun – UHN – Radiation Medicine Program
Hey Roger, this impatient right now, mycemia, take a look re kyphoplasty as Eric (Neurosurgery) may not want to operate—
Imaging

- Plain films - “insufficient data”
- CT – complimentary to MRI
- MRI – T₁W, T₂W, STIR
- Bone Scan

STIR
- sequence demonstrates bone edema
- differentiates acute from healed fracture
Mechanical pain

Case #1
65 Male
Amyloid
Pain 10/10
Previous VCFs
Previous Rx

MRI scan
CT compliments MRI in presence of fracture
Indications

- Disabling pain due to fracture
- Diminished ambulatory capacity
- Prevention of collapse
- Poor surgical candidate
  - Multilevel spinal disease
  - Co-morbid illness

Cancer specific goals
- Shorter term optics
- Prevention of collapse
Contraindications

- Instability due to posterior element or facet involvement
- Epidural compression
  - Retro pulsed tissue or bone fragments
- Unable to localize painful level
- Radicular pain

- Significant medical contraindications
  - Uncorrected coagulopathy
  - Local or systemic infection
  - Unable to position prone

These are not absolute and may be relative depending on management or prognostic expectations
Decision Making:

- SINS
- NOMS
- TUMOUR
- ESCC Scale

Decision involves Surgery, Radiation Oncology, Interventional (Neuro)Radiology and Palliative Care.
NOMS Assessment: Fundamental considerations

- **Neurologic (N):**
  - degree of myelopathy and functional radiculopathy (clinical)
  - degree of radiographic spinal cord compression (imaging)

- **Oncologic (O):**
  - known radiosensitivity of the tumor

- **Mechanical instability (M):**
  - broadly defined as movement-related pain
  - level dependent

- **Systemic disease (S):**
  - extent of disease
  - medical comorbidities.
Epidural spinal cord compression (ESCC): Grade 0-3


- Grade 0 –
  - vertebral body or posterior element disease
  - no epidural impingement

- Grade 1 –
  - subarachnoid space impingement
  - no spinal cord deformation

- Grade 2 –
  - spinal cord deformation
  - partially obliterated subarachnoid space

- Grade 3 –
  - spinal cord deformation
  - no cerebrospinal seen

Fig. 1. Epidural compression. (A) No subarachnoid space compression. (B) Subarachnoid space partially obliterated, no cord compression. (C) Subarachnoid space partially obliterated with cord compression. (D) Subarachnoid space completely blocked, with cord compression.
Local disease control after decompressive surgery and adjuvant high-dose single fraction radiosurgery for spine metastases:

Hugh D. Moulding, M.D., Ph.D., James B. Elder, M.D., Eric Lis, M.D., Dale M. Lovelock, Ph.D., Zhigang Zhang, Ph.D., Yoshiya Yamada, M.D., and Mark H. Bilsky, M.D.


Fig. 1. Illustration of the ESCC scale currently used in our practice. **Left:** Grade 0 is disease confined to bone, Grade 1a disease involves the epidural space but does not compress the dura, Grade 1b disease compresses the dura but does not abut the spinal cord, and Grade 1c disease abuts but does not compress or adjust the course of the spinal cord. **Center:** Grade 2 disease compresses the spinal cord, but CSF is still visible. **Right:** Grade 3 disease compresses the spinal cord, obliterating all visible CSF at that level.
Local disease control after decompressive surgery and adjuvant high-dose single fraction radiosurgery for spine metastases:

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Conclusions:

- The majority of patients with spine tumors can be treated successfully with radiation, either conventional EBRT for radiosensitive tumors or SRS for radioresistant tumors.

- The study suggests that high-dose single-fraction radiation (24 Gy) provides durable tumor control that is histology independent.

- The ability to achieve local tumor control that is histology independent suggests the possibility of a more limited surgery to resect epidural tumor with the placement of segmental fixation and the treatment of significant gross residual disease, such as large paraspinal masses, with SRS.

- Limiting tumor resection may reduce surgical morbidity and provide more effective palliation.
Prospectively randomized to surgery and RT vs RT alone:

Result: for selected patients, combination of radical Sx and RT is superior to RT only.

Early diagnosis and appropriate treatment will prevent paraplegia in most patients with MESCC
Stereotactic Body Radiation (SBRT)

- Highly focused radiation therapy can treat the lesion with low risk to the spinal cord however the risk of collapse may be high.
- Stereotactic body radiation therapy (SBRT)
- Can be considered even if previous radiation to spine
Conventional Radiotherapy

(Courtesy: Arjun Sahgal, MD, University of Toronto)
SBRT Dose Distribution

Courtesy: Arjun Sahgal, MD, University of Toronto

Marcelo V.R. Cunha, MD, Ameen Al-Omair, MD, Eshetu G. Atenafu, MSc, Giuseppina Laura Masucci, MD, Daniel Letourneau, PhD, Renee Korol, PhD, Eugene Yu, MD, Peter Howard, MD, Fiona Lochray, MRTT, Leodante B. da Costa, MD, Michael G. Fehlings, MD, PhD, Arjun Sahgal, MD


Conclusions: The presence of kyphotic/scoliotic deformity and the presence of lytic tumor were the only predictive factors of VCF based on the original 6 SINS criteria. We also report that patients with lung and hepatocellular tumors and treatment with SBRT of 20 Gy or greater in a single fraction are at a higher risk of VCF.
# Spinal Instability Neoplastic Score (SINS)

Table 1: The Spinal Instability Neoplastic Score (SINS)

<table>
<thead>
<tr>
<th>SINS Component</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Junctional (occiput-C2, C7-T2, T11-L1, L5-S1)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Mobile spine (C3-C6, L2-L4)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Semi-rigid (T3-T10)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Rigid (S2-S5)</td>
<td>0</td>
</tr>
<tr>
<td>Pain*</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Occasional pain but not mechanical</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Pain-free lesion</td>
<td>0</td>
</tr>
<tr>
<td>Bone lesion</td>
<td>Lytic</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Mixed (lytic/blastic)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Blastic</td>
<td>0</td>
</tr>
<tr>
<td>Radiographic spinal alignment</td>
<td>Subluxation/translation present</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>De novo deformity (kyphosis/scoliosis)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Normal alignment</td>
<td>0</td>
</tr>
<tr>
<td>Vertebral body collapse</td>
<td>&gt;50% collapse</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>&lt;50% collapse</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No collapse with &gt;50% body involved</td>
<td>1</td>
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<tr>
<td></td>
<td>None of the above</td>
<td>0</td>
</tr>
<tr>
<td>Posterolateral involvement of spinal elements**</td>
<td>Bilateral</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Unilateral</td>
<td>1</td>
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*Pain relief with recumbency and/or pain with movement/loading of the spine.

**Facet, pedicle or costovertebral joint fracture or replacement with tumor.
SINS

- Score: 0 - 18
  - 0-6: “stable”
  - 7-12: “indeterminate (impending) instability”
  - 13-18: “instability”

SINS score >7:
Surgical consultation recommended
SINS (Baseline)

- Location 3
- Pain 3
- Bone Lesion (Lytic) 2
- De novo kyphosis 2
- <50% Collapse 2
- Posterior element involvement 0

- TOTAL 12

INDETERMINATE “IMPENDING” COLLAPSE
SINS (after 1 month)

- Location 3
- Pain 3
- Bone Lesion (Lytic) 2
- De novo kyphosis 2
- >50% Collapse 3
- Posterior element involvement 3

- Total 16

INSTABILITY
SINS (at 2 months)

- Surgical consultation

- Elective percutaneous PMMA augmented pedicle screw and rod posterior fusion

- SBRT

- Elective interval kyphoplasty planned if return of symptoms

At 2 years:

Pain free @ T2
Stable imaging of fusion
Preserved mobility and QOL
Common to all:
- Transpedicular access to vertebral body
- Bipedicular or unipedicular
- Local anesthetic and conscious sedation
- Day surgery or outpatient

Cavity Creation:
- Balloon
- Other

Bone Cement / PMMA Injection:
- Viscosity
- Properties
Why do we need to create a cavity?

- Tumor (compared to cancellous bone)
- Densely packed cells
- High pressure injection
- Tumor planes determine direction of cement fill
- Cavity creation contains or directs cement
- Decreased cement leakage
- Controllable by surgeon
Balloon dilatation anterior, cement fill anteriorly avoids posterior body and ‘defective cortex’
Complications

- Cement extravasation causing nerve / cord compression or thermal injury
- Pulmonary embolism
- Infection
- Hemorrhage
- Further Collapse
- Adjacent level fracture
Vertebroplasty and Kyphoplasty: a systematic review of 69 clinical studies.

Hulme PA, Krebs J, Ferguson SJ, Berlemann U.

BKP has a lower rate of overall complications and total cement leakages than VPY

<table>
<thead>
<tr>
<th></th>
<th>BKP</th>
<th>VPY</th>
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<tbody>
<tr>
<td></td>
<td>Total Cement Leakage (per vertebra)</td>
<td>Clinical Complications (per vertebra)</td>
<td>Clinical Complications (per patient)</td>
<td>Pulmonary Embolism (per vertebra)</td>
<td>Neurologic (per vertebra)</td>
</tr>
<tr>
<td>Balloon Kyphoplasty</td>
<td>9%</td>
<td>1.3%</td>
<td>2.2%</td>
<td>0.01%</td>
<td>0.03%</td>
</tr>
<tr>
<td>Vertebroplasty</td>
<td>41%</td>
<td>2.6%</td>
<td>3.9%</td>
<td>0.6%</td>
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(Data from Figure 4, Hulme – Spine 2006)
Evidence

- CAFE
- Other
CAFE
(Cancer Patient Fracture Evaluation Study) Summary

- 134 patients randomized to kyphoplasty (n=70) or non-surgical management (n=64)

- Compared balloon kyphoplasty with non-surgical management for cancer patients with painful VCFs.

- Measured – Pain, Roland-Morris disability questionnaire (RDQ) score at 1 month.

- Patients in the control group were allowed to crossover to receive kyphoplasty after 1 month.

- Kyphoplasty is an effective and safe treatment that rapidly reduces pain and improves function in patients with painful VCF cancer
Multicenter Study to assess the efficacy and safety of sacroplasty in patients with osteoporotic sacral insufficiency fractures or pathological sacral lesions

Keith Kortman, Orlando Ortiz, Todd Miller, Allan Brook, Sean Tutton, John Mathis, Bassem Georgy

- 243 Patients: 204 Sacral Insufficiency #s, 39 symptomatic sacral lesions
- Average pre-treatment VAS score of 9.2 +/- 1.1 in sacral insufficiency fractures significantly improved after sacroplasty to 1.96 +/- 1.7 (p<0.001).

- VAS score of 9.0 +/- 0.9 in sacral lesions improved to 2.6 +/- 2.4 (p<0.001).

- Safe and effective, delivers prompt and durable pain relief

- Should be considered as an effective treatment option in this patient population.
SINS

SCORE: ?
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**Facet, pedicle or costovertebral joint fracture or replacement with tumor.
Open Augmentation during decompression without fusion
Future Directions

- Extension of procedure under Minimally Invasive Surgery (MIS) team approach
- High quality imaging coupled with emerging technologies for prevention of collapse and cord compression
- Move from reactive to “elective” prevention approach with impending vertebral body collapse and cord compression where possible
Extension of procedure (SINS 16)

Percutaneous PMMA augmented fusion – day surgery

Pre 2 years post
Percutaneous PMMA augmented fusion

Kyphoplasty reserved for recurrence of symptoms or collapse
Percutaneous PMMA augmented fusion (3rd Stage)

Following SBRT, recurrence of load bearing mechanical pain: decision - elective kyphoplasty
3rd Stage Kyphoplasty
Review

- Nomenclature
- Referral
- Aids to decision making
- SINS
- Technical considerations
- Literature evidence
- Examples
- Future directions
• Vertebral augmentation does not treat cancer

• Radiation & Chemotherapy do not treat fractures

• Virtual Consultation
Thank you

Dr. Roger Smith MB ChB, FRCSE
Medical Imaging
Toronto Western Hospital
University Health Network Toronto

Interventional Management of Spinal Cancer: Vertebral Augmentation & Interventional Techniques for Analgesia in Spinal Metastases