This Group of Good Ol’ Boys Just Got Better.

Oregon Neurosurgery Specialists welcomes Andrea Halliday, MD.

Spine and brain injury or disease is serious stuff. When you need it, you need confidence that your neurosurgeon is among the best in his—or her—profession.

The team at Oregon Neurosurgery Specialists—now including Harvard Medical School-trained Dr. Andrea Halliday—brings a depth of experience to every patient case.

From left to right: Stephen McGirr, MD, Angela Halliday, MD, Robert Hacker, MD, Andrew Kojima, MD
Advances in Kyphoplasty

- Percutaneous minimally invasive vertebral augmentation techniques involve the injection of methylmethacrylate into painful vertebral compression fractures.
- The most common application of these techniques is for osteoporotic compression fractures but they are also used in the palliation of back pain secondary to osteolytic metastases and myeloma bone disease.
Advances in Kyphoplasty

- The purpose of this talk is to discuss advances in minimally invasive vertebral augmentation techniques in the treatment of painful compression fractures.
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- Osteoporosis is a disorder characterized by decreased bone density, disruption of trabecular architecture and increased susceptibility to fractures.
- There are approximately 700,000 vertebral compression fractures in the United States each year with approximately 70,000 of these resulting in hospitalization, with an average stay of eight days.
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- Osteolytic lesions of the spine affect as many of 70% of patients with metastatic disease or multiple myeloma.
- Tumor induced osteolysis also weakens the bone leading to pain and vertebral compression fractures.
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- Compression fractures result in height loss, kyphotic deformity, reduced pulmonary function and impairment in mobility and balance.
- Development of a kyphotic deformity increases the risk of additional compression fractures.
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Normal weight bearing

Anterior load transfer
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- Vertebroplasty was the first technique used to treat painful compression fractures.
- Originally developed in France in 1987 to treat painful vertebral hemangiomas.
- Unipedicular injection of bone cement (methylmethacrylate) through a Jamsheedi needle.
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- **Class I data** – Prospective randomized controlled trials
- **Class II data** – Clinical studies in which the data were collected prospectively and retrospective analyses which were based on clearly reliable data
- **Class III data** – Most studies based on retrospectively collected data.
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- As of 2008 there have been 74 studies reported for the treatment of osteoporotic vertebral compression fractures (VCF)
  - 1 level I, 2 level II, 70 level III
- There is good (level 1) evidence that vertebroplasty results in superior pain control within the first two weeks of intervention compared with optimal medical management.
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- There is fair evidence (level II) that vertebroplasty results in decreased use of pain medication, less disability and greater improvement in function as compared with optimal medical management within the first three months after vertebroplasty.
- There is fair evidence that this improvement diminishes at two years.
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- The major complication of vertebroplasty is cement extravasation outside of the vertebral body. The range of reported cement extravasation in the literature range from vertebroplasty is 3% to 65%.
- Although rare, serious complications of cement extravasation such as pulmonary emboli and neurologic complications have been reported.
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- Another complication of vertebroplasty is a possible increased incidence of adjacent segment fractures.
  - One clinical study suggests that extravasation of cement into the disc space is a possible cause.
  - Biomechanical data indicates that an acute change in stiffness of the augmented vertebral body transfers load to the adjacent vertebral body increasing the risk of fracture.
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- Balloon kyphoplasty is a minimally invasive vertebral augmentation technique utilizing inflatable balloon tamps placed inside the vertebral body.
- Balloon inflation compacts the cancellous bone and pushes the compressed endplates apart to partly restore height and correct kyphotic deformity.
- Once the balloons have been removed, the resulting void is filled with bone cement.
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Advances in Kyphoplasty

- Advantages of balloon kyphoplasty as compared to vertebroplasty
  - Increased deformity reduction
    - controversial as some deformity reduction is lost when the balloons are removed
  - Decreased cement extravasation
    - true
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- Purported advantages of kyphoplasty include deformity reduction and decreased cement leakage.
- There are no randomized clinical trials comparing kyphoplasty and vertebroplasty.
- There are few studies which directly compare vertebroplasty and kyphoplasty.
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- A recent study in the American Journal of Neuroradiology (AJNR, 2009 Apr;30(4):669-73) demonstrated that both vertebroplasty and kyphoplasty improved vertebral body height and the wedge angles of the fractured vertebral body but the differences between the two techniques were not statistically different.

- 18% of the kyphoplasty group and 49% of the vertebroplasty group showed cement leakage into the paravertebral soft tissues or veins on postoperative CT scans.
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- Disadvantages of kyphoplasty
  - Expense $500 per level versus $3,500 per level
  - Possible increased risk of adjacent segment fracture
    - Vertebroplasty
      - Subsequent fracture
        - 17%-52%
      - Adjacent to treated level
        - 62%-75%
    - Kyphoplasty
      - 19%-29%
      - 77%-90%
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- The results of a prospective randomized controlled trial comparing 149 patients treated with kyphoplasty and a 151 patients treated with medical management was recently published in Lancet (Lancet 2009; 373: 1016-24)
- This study showed that balloon kyphoplasty improved quality of life, function, mobility, and pain more rapidly than medical management, with significant differences between the two groups at one month.
- For most outcome measures, the differences between the two groups diminished at one year.
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- In the Lancet randomized control trial the rate of subsequent fracture was numerically higher in the kyphoplasty group but not significantly different (33% versus 25%).
- The study was not powered to detect differences in fracture between the two groups.
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- The high subsequent fracture rate in all patients with osteoporosis regardless of treatment (vertebroplasty, kyphoplasty or medical management) underscores the need to develop a treatment that reduces the risk of new fractures.
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- What is the cause of new fractures in the osteoporotic patient?
  - Natural history of the disease
    - Prior vertebral compression fracture (VCF) is a strong risk fracture for additional vertebral fractures.
    - The risk increases 5 fold after one fracture, 12 fold with two or more fractures.
    - 11.5% of patients will develop a new VCF within one year after a previous VCF.
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- Kyphotic deformity causes a forward shift of the center of gravity increasing the forward bending moment which increases the load within the kyphotic segment leading to adjacent VCFs.
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- Does correction of the kyphosis protect the osteoporotic spine from developing additional vertebral compression fractures?
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- Reduction by balloon inflation as in a balloon kyphoplasty
Some reduction is lost after the balloon is removed.

Residual deformity remained larger than intact.
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Average failure load is 1003 N

Average failure load is 2084 N
When a vertebral compression fracture occurs, the superior endplate of the vertebral body often fractures.

Altered disc mechanics adjacent to the endplate fracture is another possible cause of an adjacent segment fracture.
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- 80% of the body’s weight is transferred through the vertebral bodies and discs.
- During flexion the nucleus increases pressure to resist the increased load.
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- After an endplate fracture the volume of space the nucleus occupies increases.
- During flexion the nucleus is unable to increase pressure and the load is transferred to the anterior aspect of the vertebral boy increasing the risk of adjacent segment fracture.
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Disc Pressure at Level with Fractured Endplates

-0.2
-0.1
0
0.1
0.2
0.3
0
1
2
3
4
5
6
7
Pressure (MPa)
Moment (Nm)

Anterior Strain on VB Adjacent to Fractured Endplates

-0.0015
-0.001
-0.0005
0
0.0005
0.001
0 50 100 150
Average Anterior Strain
Time

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- Does reduction of the endplate deformity protect the osteoporotic spine from adjacent segment fractures?
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- The nucleus pressure in flexion of a disc adjacent to an endplate fracture is 32% of normal.
- The nucleus pressure in flexion of disc adjacent to an endplate fracture that has been reduced by a structural kyphoplasty procedure is 73% of normal.
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- Structural kyphoplasty is a new form of kyphoplasty designed to decrease the kyphotic deformity and restore more physiologic loading through the disc as compared to kyphoplasty and vertebroplasty.

- By correcting two probable causes of adjacent segment fractures the promise of this new technology is not only to alleviate the pain of VCF but to decrease the risk of additional fractures.
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- **Design Objectives**
  - Consistent vertebral fracture reduction
  - Restore normal loading
  - Maximize physician control
  - Minimize intra-operative height loss
    - Vertical lifting force
    - Controlled incremental implant expansion
  - Reduce risk of posterior and intradiscal cement extravasation
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Biconcave fracture

Re-aligned endplates
Pre – 38 degrees of kyphosis  

Post-21 degrees of kyphosis
Will treatment of vertebral compression fractures by structural kyphoplasty result in improved outcomes as compared to medical treatment, vertebroplasty and kyphoplasty?

The answer will require clinical trials including the multicenter trial that is just beginning with Riverbend as one of the sites.
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- THANK YOU