

ADVANCES IN MANAGING SPINAL DISORDERS

Selections from the Fifth Annual Symposium on Current Concepts in Spinal Disorders 2006

SELECTION CRITERIA FOR CERVICAL ARTIFICIAL DISC REPLACEMENT—Christopher J. Zarembinski, MD, Chief, Acute Pain Services, Cedars-Sinai Medical Center, Los Angeles, CA

General indications for anterior cervical artificial disc replacement (ADR): similar for anterior cervical decompression; radiculopathy or myelopathy caused by 1 or 2 levels of anterior cervical compression; treat conservatively; *adverse effects of cervical fusion*—adjacent segment degeneration; difficulties in treatment after fusion; plating complications; perioperative immobilization; bone graft site morbidity; pseudoarthrosis; dysphagia; *Hilibrand study*—374 patients having 409 cervical arthrodeses for up to 21 yr; 3% incidence of developing adjacent segment disease; projection that 26% of patients would have new disease at adjacent level (C5-C6 and C6-C7) within 10 yr after surgery; adjacent levels showed increased range of motion and intradiscal pressures; *reoperative challenges*—disc space adjacent to solid fusion challenging environment, biomechanical differential in stiffness between fusion below and open segment above; iliac crest complications; up to 25% incidence of chronic pain, including meralgia paresthetica; pelvic fracture; risk for sacroiliac joint injury; inferior gluteal artery injury

Cervical ADR criteria: from Food and Drug Administration (FDA) trials; *inclusion criteria*—patients requiring surgical treatment at 1 to 2 levels from C3 to T1 with disc herniation and radiculopathy, spondylotic radiculopathy, disc herniation with myelopathy, or spondylotic myelopathy; patients who have failed 6 wk of conservative treatment; focal compression lesion documented radiographically; abnormal neurologic sign indicative of radiculopathy or myelopathy; patients between 18 and 65 yr of age; major role of cervical disc replacement will be adjacent to already established cervical fusion with adjacent segment spinal compression; treatment of patients with primary discogenic axial neck pain with disc replacement controversial and needs further study; *exclusion criteria*—patients with ankylosing spondylitis, rheumatoid arthritis, diffuse idiopathic skeletal hyperostosis (DISH), ossification of posterior longitudinal ligament (OPLL), diabetes mellitus, previous cervical spine infection, long-term steroid use, morbid obesity, pregnancy; axial pain as solitary symptom; narrow cervical canal with anteroposterior (AP) diameter <10 mm; severe arthritis of facet joints; osteoporosis; metallic allergy; tumor; radiographic instability

Diagnostic spinal injections: improve outcome of patients with artificial disc technology; to more fully evaluate patients with axial and radicular components; determine pain generator in multilevel disease; assess patient's validity and compliance when behavioral issues suspected; assess postoperative patient with complex recurrent pain; *facet (z-joint) injection*—important because radiographs, history, and physical examination not specific for cervical, thoracic, or lumbar z-joint-mediated pain; well-defined referral zones based on joint involved; helpful clinically; *selective nerve root block (SNRB)*—93% correlation with surgical lesion; patients with >1 yr of radicular pain who did not have long-term response to SNRB had poor surgical outcome; injection of corticosteroids during SNRB had

good negative predictive value; use test dose of local anesthetic before corticosteroid injection; use microbore extension tubing to minimize needle manipulation; minimize sedation to allow earlier detection of central nervous system dysfunction; needle tip in posterior aspect of neuroforamen; *discography*—history and physical examination unreliable in diagnosing discogenic pain; patient with elevated scores on hypochondriasis, hysteria, and depression scales of Minnesota Multiphasic Personality Inventory (MMPI) overreport pain; discordant pain response should be cautiously interpreted, even with concordant imaging; best discogram negative; referral patterns

Psychologic factors and outcome: Hurme noted that social and psychologic factors influenced outcome more than preoperative physical examination findings or grade of operative findings in patients undergoing initial decompression; Spengler noted that patients with disc herniation and distinctly abnormal score on MMPI had poor surgical outcome; *patient selection red flags*—patients having multiple complications with previous invasive procedures need to be approached cautiously; patients with predominance of non-organic findings on physical examination; patients with active litigation; history of drug abuse or antisocial behavior; elevated hypochondriasis and hysteria scale scores on MMPI

FUTURE PROSPECTS FOR GENETIC DISC REPAIR—Alexander R. Vaccaro, MD, Professor, Neurosurgery and Orthopedic Surgery, Thomas Jefferson University School of Medicine, and Co-Director, Regional Spinal Cord Injury Center of Delaware Valley, Philadelphia, PA

Research goals: develop strategies to emulate and combat disc degeneration through growth factor techniques, genetic repair, and cellular therapy; reverse or stabilize disc degeneration process; increase synthesis and retard catabolism through multiple mechanisms; *models*—bead model or pellet system where cells develop growth factors to stimulate growth; whole disc model grown in culture, looking at disc height regeneration or collapse; cells respond to growth factor in vitro; proteoglycan and collagen synthesis; cell has finite life span; Kang (University of Pittsburgh) replaced cassette of target gene with therapeutic gene; cell continued to produce therapeutic target gene over time; must now identify genes upregulated during degenerative process and develop strategies to attack degenerative cascade

Models used: speaker's laboratory uses induced disc degeneration annular injury; laboratory findings applied to clinical situations (eg, hemostat used to grasp fascia covering disc); studied upregulation of matrix metalloproteinase (MMP)1, MMP9, MMP13, and fibronectin after injury to disc; Kang's laboratory showed correlation of histology, magnetic resonance imaging (MRI), and radiographs over time if disc injured; redelivery of N-terminal fibronectin fragment to animal model induced chemical degeneration; developing models that use enzymes to break down production of proteoglycans, and antisense technology to bind to DNA and prevent replication of disc degeneration products; Kang's laboratory credited with placing therapeutic genes in animal

Estimated time to complete the educational process:

Review Educational Objectives on page 3
Take pretest

5 minutes
10 minutes

Listen to audio program

Review written summary and suggested readings
Take posttest

60 minutes

35 minutes

10 minutes

model; showed that models work and can sustain production of target protein over time; using appropriate target gene, proteoglycan and type 2 collagen production can be induced; can regenerate disc in animal model; multiple target genes have additive effect in producing different proteins

Cellular regeneration: research focuses on developing ways to stimulate one zone disc to regenerate itself; taking mesenchymal stem cells from postterminal adult cells and exposing to hypoxic environment enables them to function as nucleus pulposus cells; laboratories also studying ways to regenerate disc from itself

LUMBAR ARTIFICIAL DISC REPLACEMENT—Hallett H. Mathews, MD, Associate Clinical Professor, Orthopedic Surgery and Surgery, Virginia Commonwealth University, Medical College of Virginia, Richmond

Motion preservation: combination and coordination of muscle relaxation and motion of spine to help in initiating motion; ligament, muscle, and soft tissue disruption must be calculated along with preoperative disease for good surgical result; ligament tension and stiffness important; does device need complete range of motion or does it need acceptable amount of range of motion to reload spine? improvement through reloading and rebalancing of spine; reemphasis of facet joint staging before surgery; important in orientation and prediction of disc herniation based on natural facet orientation; much load on anterior and posterior columns; destabilization naturally or with discectomy important; understand neutral zone; want to restrict bad motion, reload spine, and couple motions to get segments fluid and get soft tissue support in less invasive way to rebalance spine

Mobile stabilization devices: nucleus and disc replacements; dynamic stabilization; historical standard nonmobile static stabilization; contraindications for arthroplasty outweigh indications; different morbidities; 3% to 5% of patients should be considered for mobile restabilization; combination of multilevel pathology at different degrees of degeneration; restabilization process must be considered for individual assessment of specific spinal segment morbidity; must be good diagnostician and understand problem beforehand; use imaging studies along with pain source to understand cascade of events (eg, stenosis, discogenic pain, instability); devices applied to different phases of continuous degenerative cascade

Disc replacement: aim to restore mobility, height, and sagittal balance; remove painful annular pathology, degenerative inflammatory disc disease, and osteophytes; load bearing important to rebalance spine; center of rotation different at each level; posterior center of rotation more important for some prostheses; more important that surgeon place prosthesis in appropriate position (most important indicator); angular motion important; translation motion not important; ball-and-socket prostheses have controlled angular motion; want disc replacement to restabilize and never be more mobile than intact segment; wear debris testing favorable for cobalt chrome; long-term metal-on-metal toxicity not problematic for arthroplasty or disc replacement; nominal amounts of wear debris from Maverick; anterior surgery requires new learning curve; new set of complications; *retroperitoneal approach*—has anatomic restrictions; ascending ilio-lumbar vein system and retraction of vessels important; can control good anatomic dissection and anterior column surgery

Maverick study: cobalt chrome metal-on-metal, ball-and-socket design with hydroxyapatite (HA) coating; keel and combination HA coating provide short- and long-term fixation; *FDA design rationale*—metal-on-metal, long-term durability; one-step insertional technique; surgeon-intuitive device designed by surgeons; *one-piece, simple inser-*

tion—good end plate preparation, midline dissection, controlled anulotomy, keel cut up and down, good mobilization using posterior wall

InFUSE study: first FDA Investigational Device Exceptions (IDE) study to use InFUSE in disc space as biologic fusion stimulator with anterior column only stand-alone device; 21 of 28 patients did not have facet changes at 2 yr; 7 had 0 to 1 change at 2 yr; good range of motion; ensure prosthesis in midline

European balance study: looking at ability to reset sagittal balance; can improve local lordosis that has collapsed from segmental degeneration; spine rebalances at adjacent levels; overall lordosis of entire lumbar spine unchanged; information helpful in understanding rebalancing and facet loading changes after arthroplasty; rebalancing spine major benefit of motion preservation

MINIMALLY INVASIVE SURGERY (MIS) AND DAILY PRACTICE—Kevin T. Foley, MD, Associate Professor, Department of Biomedical Engineering, University of Tennessee School of Medicine, and Director, Complex Spine Program, Semmes-Murphy Clinic, Memphis

Technique: use of very thin-walled tubular retractor using principles of magnification and illumination; effectively removes lumbar disc; expanded to other spinal applications (eg, far lateral discectomy, posterior cervical discectomy, thoracic discectomy, fusion); speaker uses approach similar to lumbar approach; patient in prone position; incision 1.5 cm off midline using 14-mm tubular retractor; performs laminar foraminotomy at cervical root; same neural outcome using open procedure vs minimally invasive surgery (MIS); relief of radiculopathy in equivalent fashion; short hospital stay, quick return to work; *other applications*—posterior cervical laminar foraminotomy through MIS approach as outpatient procedure; lumbar decompressive surgery routinely done in minimally invasive, effective fashion; *MIS in invasive spinal reconstruction*—combining small retractors while placing fixation in more traditional location through MIS approaches; technique used routinely by speaker; MIS used to supplement anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), and onlay and facet fusion, coupled with effective decompression techniques; all approaches evolving

MIS FIXATION IN THORACOLUMBAR TRAUMA—Mark B. Dekutoski, MD, Associate Professor of Orthopedics, Mayo Clinic College of Medicine, Rochester, MN

Trauma management goal: return patient to activity, function, social role, and economic productivity at limited societal cost

CD HORIZON SEXTANT Spinal System: posterior tension band; off-label use of implantation system; not approved for anterior column deficiencies; *selective applications*—in anterior column restoration to prevent graft collapse; increases healing; mobilizes patient without brace; use in bending and rotational injuries; use as posterior tension band or with anterior column restoration over unfused segments (eg, balloon kyphoplasty, supplemented dorsally to avoid collapse); selective fusion with ligamentous injury; bending, ligamentous injury (bony dorsally); holds patient in position; used in lieu of cast or fixator; prevents kyphosis; percutaneous instrumentation will be used more in polytrauma (chest, pelvic, long-bone injury) patients; axial loading injuries with morbid obesity; patients with mechanical pain and metastatic disease; patients with hematogenous disc space infection and comorbidities (eg, obesity, diabetes); *future applications*—multisegment system to span more levels, provide more stable fixation and reduction

Educational Objectives

The goal of this program is to educate the clinician about cervical and lumbar artificial disc replacement and minimally invasive surgery (MIS) in spinal disorders. After hearing and assimilating this program, the clinician will have a better understanding of:

1. Review the selection criteria for anterior cervical artificial disc replacement.
2. Discuss the research goals and applications of genetic disc repair.
3. Summarize the benefits of using mobile stabilization devices.
4. Discuss the findings of the Maverick, InFUSE, and European balance studies.
5. Review the applications of MIS.

Notes

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To locate lectures of related interest, or to see a complete listing of Audio-Digest CME Programs, including written summaries.

Suggested Reading

Acosta FL Jr et al: Cervical disc arthroplasty: general introduction. *Neurosurg Clin N Am* 16:603, 2005; **Acosta FL Jr et al:** Emerging directions in motion preservation spinal surgery. *Neurosurg Clin N Am* 16:665, 2005; **Amini A et al:** Thoracoscopic spine surgery for decompression and stabilization of the anterolateral thoracolumbar spine. *Neurosurg Focus* 19:E4, 2005; **Baron EM et al:** Neuroendoscopy for spinal disorders: a brief review. *Neurosurg Focus* 19:E5, 2005; **Chang BS et al:** Evaluation of the biological response of wear debris. *Spine J* 4:239S, 2004; **Chen Y:** Orthopedic applications of gene therapy. *J Orthop Sci* 6:199, 2001; **Chiu JC et al:** Junctional disc herniation syndrome in post spinal fusion treated with endoscopic spine surgery. *Surg Technol Int* 14:305, 2005; **Denozieri G et al:** Biomechanical comparison between fusion of two vertebrae and implantation of an artificial intervertebral disc. *J Biomech* 39:766, 2006; **Evans CH et al:** The 2003 Nicolas Andry Award. Orthopaedic gene therapy. *Clin Orthop Relat Res* Dec:316, 2004; **Inamasu J et al:** Laparoscopic anterior lumbar interbody fusion: a review of outcome studies. *Minim Invasive Neurosurg* 48:340, 2005; **Isaacs RE et al:** Minimally invasive microendoscopy-assisted transforaminal lumbar interbody fusion with instrumentation. *J Neurosurg Spine* 3:98, 2005; **Kroeber MW et al:** New in vivo animal model to create intervertebral disc degeneration and to investigate the effects of therapeutic strategies to stimulate disc regeneration. *Spine* 27:2684, 2002; **Levin R et al:** Mini-open thoracoscopically assisted thoracotomy versus video-assisted thoracoscopic surgery for anterior release in thoracic scoliosis and kyphosis: a comparison of operative and radiographic results. *Spine J* 5:632, 2005; **Liu J et al:** Effect of the increase in the height of lumbar disc space on facet joint articulation area in sagittal plane. *Spine* 31:E198, 2006; **McAfee PC et al:** A prospective, randomized, multicenter Food and Drug Administration investigational device exemption study of lumbar total disc replacement with the CHARITE artificial disc versus lumbar fusion: part II: evaluation of radiographic outcomes and correlation of surgical technique accuracy with clinical outcomes. *Spine* 30:1576, 2005; **Pickett GE et al:** Complications with cervical arthroplasty. *J Neurosurg Spine* 4:98, 2006; **Powers CJ et al:** Placement of percutaneous pedicle screws without imaging guidance. *Neurosurg Focus* 20:E3, 2006; **Puttlitz CM:** Intervertebral disc replacement maintains cervical spine kinetics. *Spine* 29:2809, 2004; **Roughley PJ et al:** The role of proteoglycans in aging, degeneration and repair of the intervertebral disc. *Biochem Soc Trans* 30:869, 2002; **Roughley PJ:** Biology of intervertebral disc aging and degeneration: involvement of the extracellular matrix. *Spine* 29:2691, 2004; **Sekhon LH et al:** Cervical arthroplasty after previous surgery: results of treating 24 discs in 15 patients. *J Neurosurg Spine* 3:335, 2005; **Sobajima S et al:** Quantitative analysis of gene expression in a rabbit model of intervertebral disc degeneration by real-time polymerase chain reaction. *Spine J* 5:14, 200.

Faculty Disclosure

In adherence to ACCME guidelines, the Audio-Digest Foundation requests all lecturers to disclose any significant financial relationship with the manufacturer or provider of any commercial product or service discussed. For this issue, Dr. Mathews has disclosed that he is a consultant to Medtronic Sofamor Danek and K-2 Medical, and Dr. Dekutoski is a consultant to Medtronic Sofamor Danek.

Drs. Zarembinski, Vaccaro, Mathews, Foley, and Dekutoski addressed the *Fifth Annual Symposium on Current Concepts in Spinal Disorders 2006*, held February 3-4, 2006, in Las Vegas, Nevada and sponsored by Cedars-Sinai Medical Center Institutes for Spinal Disorders. The Audio-Digest Foundation thanks the speakers and the Cedars-Sinai Medical Center for their cooperation in the production of this program.

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On a Test and Evaluation form, complete Pretest section *before* listening and Posttest section *after* listening.

1. Adverse effects of cervical fusion include:
 - (A) Adjacent segment degeneration
 - (B) Plating complications
 - (C) Perioperative immobilization
 - (D) All the above
2. Diagnostic spinal injections are used to assess a patient's validity and compliance when behavioral issues are suspected.
 - (A) True
 - (B) False
3. Selective nerve root block has a _____ correlation with a surgical lesion.
 - (A) 25%
 - (B) 50%
 - (C) 75%
 - (D) >90%
4. The Minnesota Multiphasic Personality Inventory (MMPI) _____ a useful tool in evaluating patients for anterior cervical artificial disc replacement
 - (A) Is
 - (B) Is not
5. Research goals for genetic disc repair include:
 - (A) Developing strategies to emulate and combat disc degeneration through growth factor techniques, genetic repair, and cellular therapy
 - (B) Reversing or stabilizing the degeneration process
 - (C) Increasing synthesis and retarding catabolism through multiple mechanisms
 - (D) All the above
6. Which matrix metalloproteinase (MMP) has not been implicated in disc injury?
 - (A) MMP1
 - (B) MMP9
 - (C) MMP12
 - (D) MMP13
7. The aim of disc replacement is to:
 - (A) Restore mobility, height, and sagittal balance
 - (B) Remove painful anular pathology, degenerative inflammatory disc disease, and osteophytes
 - (C) Rebalance the spine through load bearing
 - (D) All the above
8. Which of the following is associated with the Maverick study?
 - (A) Cobalt chrome metal-on-metal, ball-and-socket design with hydroxyapatite coating
 - (B) Collagen sponge carrier
 - (C) Polymethylmethacrylate (PMMA)
9. The use of minimally invasive surgery has expanded to include all the following, *except*:
 - (A) Far lateral discectomy
 - (B) Posterior cervical discectomy
 - (C) Thoracic discectomy
 - (D) Cervical fusion with adjacent segment spinal compression
10. The Food and Drug Administration has approved the CD HORIZON SEXTANT Spinal System for:
 - (A) Anterior column deficiencies
 - (B) Selective fusion with ligamentous injuries
 - (C) Use in bending and rotational injuries
 - (D) None of the above

Answers to Audio-Digest Orthopaedics Volume 29, Issue 04: 1-B, 2-D, 3-A, 4-C, 5-C, 6-D, 7-A, 8-C, 9-D, 10-D

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