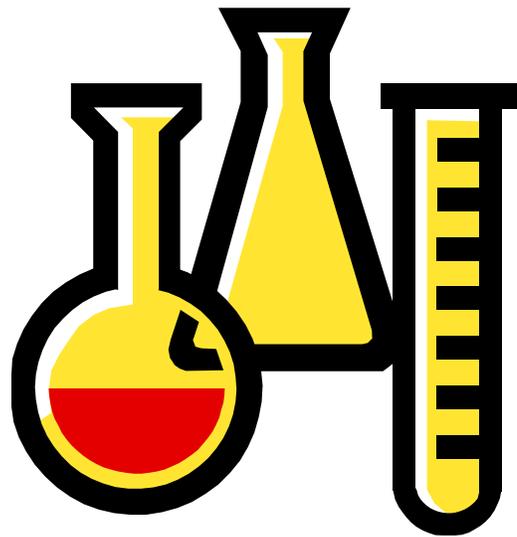


THE OHIO STATE UNIVERSITY

Department of Orthopaedics

31st Annual
Mallory-Coleman
Resident Research Day



Friday, April 11, 2003
7:00 am

JL Camera Center
2050 Kenny Rd

PROGRAM

- 7:30 am Refreshments
- 7:45 am Welcome and Introduction
- 8:00 am ***JOEL McCLURG, M.D., PH.D.***
"Growth, Recombinant Adeno-Associated Virus Transfection and Rescue of Equine Chondrocytes in a New 3-Dimensional Matrix"
- 8:15 am ***KEITH BEREND, M.D.***
"Hard-on-Hard Alternative Bearings in Total Hip Arthroplasty: Metal-on-Metal and Ceramic-on-Ceramic, an Update from the Field"
- 8:30 am ***KEITH BEREND, M.D.***
"Total Femoral Arthroplasty for the Salvage of End-Stage Prosthetic Disease: the Compromised Femur "
- 8:45 am ***JASPER PETRUCCI, M.D.***
"Radiographic Evaluation of Screw Position in Revision Total Hip Arthroplasty"
- 9:00 am ***KEITH HILL, M.D.***
"The Role of Cyclooxygenase-2 Inhibitors in Fusion Rates of Hindfoot Arthrodeses"
- 9:15-9:30 *Break*
- 9:30 am ***ALICIA BERTONE, D.V.M, PH.D.***
"Radiofrequency Coupled With Conductive Fluid for Hemostasis of Cancellous and Cortical Bone In An Ovine Model: Assessment of Bone Healing"
- 9:45 am ***JAMES KERPSACK, M.D.***
"The Use of Oxycontin Versus Scheduled Percocet in the Immediate Postoperative Period Following Total Joint Arthroplasty"
- 10:00 am ***TIMOTHY WILLIAMS, M.D.***
"The Risk of Infection Associated with Intra-Articular Bupivacaine Infiltration via Pain Control Infusion Pumps in Total Knee Arthroplasty Pain Management"
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PROGRAM, CONTD

- 10:15 am ***TERRI ZACHOS, D.V.M***
 "Adenovirus-Mediated Bone Morphogenetic Protein 2 Gene Delivery
 Promotes Osteogenesis in Equine Stem Cells"
- 10:30 –10:45 Break
- 10:45 am ***JOSEPH BUCKWALTER, M.D., VISITING PROFESSOR AND MODERATOR***
 "Chondrocyte Senescences, Osteoarthritis, and Chondrosarcomas"
- 11:45-12:45 *Lunch*
- 12:45 pm ***CHRISTOPHER HYER, D.P.M***
 "Anatomic Evaluation of the Anterior and Middle Talocalcaneal Articular
 Facets and the Evans Osteotomy"
- 1:00 pm ***SCOTT ZIMMER, M.D.***
 "Arthrodesis of the Thumb Metacarpophalangeal Joint Using a 3.0 mm
 Cannulated Screw and Threaded Washer"
- 1:15 PM ***TARIQ NAYFEH, M.D., PH.D.***
 "Painful Neuromata Following Total Knee Arthroplasty"
- 1:30 pm ***SCOTT GOIN, M.D.***
 "Small Intestine Submucosal Implants in Collateral Ligament Repair"
- 1:45 pm ***Irwin Mandel, M.D.***
 "The Chondrocyte Program"
- 2:00 pm *End of Day*
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MALLORY-COLEMAN DAY

Mallory-Coleman resident research day was established in 1972 in memory of Katherine Virginia Mallory and Sally Jo Coleman.

This research day was established in order to encourage the development of ideas related to research in orthopaedic surgery and basic science. In accordance with the curriculum for both the OSU Orthopaedic and Podiatric residency programs, each chief resident is required to present his or her research project during this forum.

Each year, a distinguished visiting professor from an outside institution is invited to moderate and analyze the resident presentations and abstracts as well as provide constructive criticism and commentary for each resident presentation.

Past Visiting Professors Include:

2002 Victor Goldberg, M.D.
2001 James Urbaniak, M.D.
2000 Douglas Jackson, M.D.
1999 Douglas Dennis, MD
1998 Thomas Einhorn, MD
1997 Larry S. Matthews, MD
1996 Gary Friedlander, MD
1995 James Herndon, MD
1994 Clement B. Sledge, MD
1993 Eric L. Radin, MD

2003 MALLORY-COLEMAN VISITING PROFESSOR AND MODERATOR:

JOSEPH BUCKWALTER, M.D.



Dr. Buckwalter is currently the Chair of Orthopaedic Surgery at the University of Iowa where he has been on the faculty since 1979. He received a B.A. in Psychology with high distinction in 1969 and a M.S. in Pathology in 1971, both from the University of Iowa. He also earned an M.D. from the University of Iowa in 1974. He went on to do an internship in Internal Medicine and a residency in orthopaedics, both at the University of Iowa. He is certified by the American Board of Orthopaedic Surgeons.

Along with his Professor of Orthopaedic Surgery title at the University of Iowa, Dr. Buckwalter has also held International Visiting Professor titles at both the Nuffield Orthopaedic Center in Oxford, England and the Muller-Institut fur Biomechanik, in Berne, Switzerland. He is also currently a team physician for the University of Iowa and Chief of Orthopaedic Surgery at the Iowa City VA Medical Center.

He has held several positions in scientific and professional organizations which include serving as an oral examiner as well as the Director and President for the American Board of Orthopaedic Surgeons. He has also served as the President of the American Orthopaedic Association.

Dr. Buckwalter is active in scientific research and publication. He has served on the scientific advisory boards of over twenty companies and organizations. He is also currently a consulting editor for research for the Journal of Bone and Joint Surgery and a co-editor in chief of the Journal of Orthopaedic Research.

He has been the invited visiting professor for over forty national and international institutions, including a visiting professorship to Ohio State in 1994. In addition, he has given over 400 local, regional, and international presentations in his area of expertise.

Dr. Buckwalter is also the author of over 190 articles and over 100 book chapters.



*Joel McClurg, M.D.,
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Ohio State University*

GROWTH, RECOMBINANT ADENO-ASSOCIATED VIRUS TRANSFECTION AND RESCUE OF EQUINE CHONDROCYTES IN A NEW 3-DIMENSIONAL MATRIX

Authors: Joel McClurg, M.D., Ph.D., Alicia Bertone, D.V.M, Ph.D.,
Jeffrey Bartlett, Ph.D.

Presenter: Joel C. McClurg, M.D., Ph.D.

The current studies developed and validated a 3-Dimensional (3-D) chondrocyte culture model, which permits chondrocytes to express a differentiated phenotype including production of a hyaline cartilage specific extracellular matrix. Monolayer cell cultures, although commonly used, are disadvantaged by marked cellular dedifferentiation. Chondrocytes cultured in 3-D matrices are more physiological and may more appropriately respond to exogenous growth factors. Only very recently, and in very few laboratories, have 3-D matrices been successfully attempted in materials that may allow rescue of viable chondrocytes. Adeno-Associated virus (AAV) vectors may have lower transfection efficiencies and gene expression than other vectors, such as retrovirus or adenovirus, due to surface receptor mediated cell entry and second strand DNA synthesis requirements, but offer many advantages that make it an appealing vector system for human gene delivery. With the successful development of this 3-D cartilage model we hope to extend our efforts to systematically study chondrocyte response to cytokines, and recombinant Adeno-Associated virus (rAAV) mediated therapeutic gene expression. The goal of this study was to evaluate cell health and phenotype in this 3-D matrix, determine the feasibility of vector-mediated gene delivery in 3-D suspension, and confirm successful rescue of chondrocytes from the 3-D matrix.

Gene transfer has routinely been performed in monolayer cultures due to the relative ease of vector-cell contact during cell growth. Native chondrocytes, however, are suspended in a complex 3-D matrix. Culture systems that mimic this architecture include collagen gels, biodegradable discs, agarose, and recently alginate/cell suspensions. Gene delivery by vector application to cells in 3-D culture systems may be difficult if not impossible due to the physical exclusion of the vector-cell interaction and may be different in normal as compared to diseased chondrocytes. **Preliminary Study:** Chondrocytes from normal and osteoarthrotic (diseased) equine articular cartilage were cultured as monolayer in 24 well plates at various MOIs (multiplicities of infection) [100:1, 1000:1] for 4 days, with and without Adenovirus augmentation, to evaluate gene transfection efficiency of rAAV [AAV wildtype-2-LacZ reporter gene] using an assay for β -galactosidase expression. Monolayer transfection efficiencies were low (2.9% to 5.7%) and required Adenovirus co-transfection. Equine chondrocytes can be rescued from the alginate beads using a benign process and maintained viability of >92% at 3 days and >94% at 14 days in culture. **Main Experiment:** Alginate bead/chondrocyte/rAAV 3-D suspensions were cultured in 24 well plates at an MOI of 1000:1, and 10,000:1 for rAAV and an MOI of 5 or 50 for Adenovirus. After 4 days of incubation the cells were evaluated for transfection efficiency (0.67% to 5.67%), and maintenance of cellular morphology (phenotype). **Results:** Recombinant AAV delivered to chondrocytes in monolayer or suspended in alginate beads induced a low, but consistent, gene transfer and expression, and when cultured in a 3-D matrix, maintenance of chondrocyte phenotype. Transfection of equine chondrocytes with AAV-2 wildtype virus appears to be dependent on Adenovirus co-transfection. Equine chondrocytes can be grown in a 3-D matrix and maintain their viability following rescue from the alginate matrix. Future *in vitro* work will examine rAAV mediated gene transfer to examine novel protein expression and chondrocyte phenotype response in normal and diseased articular chondrocytes using this model.



*Keith Berend, M.D. is
an associate with Joint
Implant Surgeons*

HARD-ON-HARD ALTERNATIVE BEARINGS IN TOTAL HIP ARTHROPLASTY: METAL-ON-METAL AND CERAMIC-ON-CERAMIC, AN UPDATE FROM THE FIELD

Authors: Keith Berend, M.D., Adolph Lombardi, M.D., Thomas Mallory, M.D.,
Kathie Dodds, RN, Joanne Adams, BFA.

Presenter: Keith Berend, M.D.

Introduction:

The rate-limiting step in the long-term survival of total hip arthroplasty (THA) has now become wear of the bearing surface. Femoral fixation, using both cemented and uncemented designs has proven successful. Wear of the bearing surface itself is now the most common reason for aseptic failure. In a search to discover longer lasting bearing surfaces, new technology has evolved and older concepts have been revisited. The first is highly-crosslinked polyethylene and other alternatives are "hard-on-hard" articulations. These include metal on metal (MOM) and ceramic on ceramic (COC) surfaces.

We present a review of our current experience with MOM and COC bearings in THA. First is a prospective, randomized, IRB approved study of a polyethylene-free MOM THA versus traditional metal-on polyethylene (MOP), with minimum 5-year follow-up. The second is a prospective, IRB approved, randomized study of COC versus ceramic on traditional polyethylene (COP). The third is the use of an enlarged femoral head size (38mm) in the polyethylene-free MOM THA.

Methods:

268 patients underwent 271 THA using a plasma-sprayed femoral component inserted in a cementless fashion. In the MOM Study, 40 patients (42 THA) received a MOP control acetabular component, and 35 patients (36 hips) received a 28mm MOM component. In the COC study, 38 patients (42 hips) received a 28mm COP control liner, and 58 patients (62 hips) received a COC liner. In the 38-MOM study, 97 patients (106 hips) received a 38mm MOM acetabular component.

Results:

Average follow-up for the three groups was: 5.2 years for the MOM, 14 months for the COC, and 2.5 months for the 38-MOM. There have been no revisions or device related complications in any of the MOM hips. The average HHS was 95 for both the MOM and the MOP control groups. In the COC study, there have been 2 reoperations, 1 in each group. In the COC group, one stem and acetabular liner was revised for aseptic loosening,. In the COP control group, one component was revised for recurrent dislocation associated with trochanteric fracture. One patient, with a COC on one side --

HARD-ON-HARD ALTERNATIVE BEARINGS IN TOTAL HIP ARTHROPLASTY: METAL-ON-METAL AND CERAMIC-ON-CERAMIC, AN UPDATE FROM THE FIELD, CONTINUED....

and a COP on the other, dislocated each hip, once. No ceramic fractures were seen in the current study. No difference on HSS was seen between the COC and COP. In the 38-MOM group, there have been no revisions, and most importantly, no dislocations despite having been used in revisions and at risk cases.

Discussion:

At variable follow-up times, hard-on-hard alternative bearings appear to be effective in providing pain relief and increased function in the THA patient. In the MOM group, with minimum 5-year follow-up, no measurable wear has been seen in any MOM hip. In previous reports from our institution, primary THA should have a dislocation rate below 1%. However, there are reports in the literature that hard-on-hard bearings may have an increased risk of dislocation. The three dislocations that occurred in these patients were all in the ceramic study. However, 2 of these were in the COP control group and the third was a contralateral COC hip in the same patient. Technical errors could be identified for each, and the components do not appear to place the patient at increased risk. We are, however, cautiously optimistic about the use of enlarged femoral heads, and have seen no dislocations, even in the highest risk patients (revisions, developmental dysplasia, post-traumatic), with the use of the 38mm MOM THA.

Hard-on-hard bearings, including ceramic-on-ceramic and metal-on-metal are effective and appear to be safe. But each bearing couple has its potential benefits and possible drawbacks. Traditional MOP fails by wear and osteolysis, but remains the gold standard with time-honored characteristics. Ceramics represent the couple with the lowest possible wear rates in simulator studies, but they are more brittle and have been reported to have a higher fracture risk, and as seen here may be associated with an increased dislocation rate. MOM has a very low wear rate, considerably lower than MOP. Furthermore, enlarged femoral heads have an even lower wear rate, with possible added stability. However, there is concern over the high levels of metal ions in the serum and urine. No causal relationship between metal-on-metal bearings and the development of cancer have been proven, despite continued caution and skepticism. Hexavalent chromium ions, which are mutagenic, have not been associated with metal implants. Any unsubstantiated risk associated with MOM bearings should be assessed against the probable benefits associated with improved wear characteristics and lower dislocation rates. Hard-on-hard alternatives are just those, viable alternatives for the young, high-demand, active patient or the patient who is at risk for dislocation.



Keith Berend, M.D. is an associate with Joint Implant Surgeons

TOTAL FEMORAL ARTHROPLASTY FOR THE SALVAGE OF END-STAGE PROSTHETIC DISEASE: THE COMPROMISED FEMUR

Authors: Keith Berend, M.D., Adolph Lombardi, M.D., Thomas Mallory, M.D., Kathie Dodds, RN, Joanne Adams, BFA
Presenter: Keith Berend, M.D.

The arthritic patient trades degenerative joint disease for prosthetic disease, which encompasses the life span of the implant and the patient. Increased life expectancy and implant service life results in increasing revision surgeries and severity of prosthetic disease. Salvage of the severely compromised femur following multiple revision total hip arthroplasty (THA) or knee arthroplasty (TKA), failed periprosthetic fractures, and infections presents a challenge to the hip surgeon. The authors review the results of total femoral arthroplasty (TFA) performed for severe bone destruction following THA and TKA failures. In a retrospective review 59 cases were identified where TFA was performed using a constrained acetabulum, a proximal femoral replacement, a diaphyseal segment, and a distal femoral replacement of hinged or constrained design. Adequate pain relief with an average 33.6 of 44 in Harris hip pain scores, and an average 40 of 50 in Knee pain scores was seen. Good function was achieved at follow-up in most patients with 93% able to ambulate and 42% using no assistive device or a cane alone. There were 15 complications or subsequent surgeries. Infection, the most common complication, occurred in 7. Total femoral arthroplasty for salvage of the severely compromised femur provides good results even in the most difficult of cases.



Jaspere Petrucci, M.D. is a PGY5 Resident in Orthopaedics at The Ohio State University

RADIOGRAPHIC EVALUATION OF SCREW POSITION IN REVISION TOTAL HIP ARTHROPLASTY

Authors: Daniel Galat, M.D., Jasper Petrucci, M.D., Ray Wasielewski, M.D.
Presenter: Jaspere Petrucci, M.D.

Injury to intrapelvic structures during removal of screws in revision acetabular arthroplasty is an uncommon, yet potentially serious complication. Bicortical screws are at greatest risk for causing injury during removal, especially if directed toward intrapelvic vessels and nerves. Complications can be minimized with thorough evaluation of screw position before revision surgery. A study of seven cadaveric pelvises was done to determine if plain radiographic views provide useful information regarding screw position. In each pelvis, bicortical transacetabular screws were fixed in all acetabular quadrants 15mm longer than the measured depth. Afterwards, anteroposterior, inlet, Judet and crossfire lateral radiographic views were obtained and intrapelvic dissections were done. Radiographs and intrapelvic dissections were compared to determine screw position. We found that the obturator and iliac oblique (Judet) views were most useful in defining screw position. The iliac oblique view clearly revealed screws that violated the quadrilateral surface and thus were directed toward the obturator vessels and nerve. The obturator oblique view revealed screws that violated the anterior column and thus were directed toward the external iliac vessels. The lateral view further clarified such screws by determining general anterior or posterior direction.



*Keith Hill, M.D. is a
Foot and Ankle Fellow
with Drs. Lee and
Berlet*

THE ROLE OF CYCLOOXYGENASE-2 INHIBITORS IN FUSION RATES OF HINDFOOT ARTHRODESIS

Authors: Keith Hill, M.D., Greg Berlet, M.D., Thomas Lee, M.D.
Presenter: Keith Hill, M.D.

Hypotheses/Purpose:

Recent research demonstrates the effectiveness of cyclooxygenase-2 (COX-2) inhibitors in controlling postoperative pain. These reports have shown that COX-2 inhibitors delay bone fracture healing in animal models. Our hypothesis states that short-term use of COX-2 inhibitors can be utilized for postoperative pain management without impact on fusion rates in patients undergoing subtalar and ankle arthrodesis.

Conclusions/Significance:

The use of COX-2 inhibitors for postoperative pain control has no effect on the rate of fusion for patients undergoing subtalar and ankle arthrodesis. The overall nonunion rate does not appear to be affected by use of COX-2 inhibitor drugs. In addition, the time to union for patients who received COX-2 inhibitors was less than those who did not receive COX-2 inhibitors, but this was not statistically significant. This study suggests that despite evidence that COX-2 inhibitors may inhibit bone healing at the cellular level, their use in the short-term postoperative setting does not affect overall ankle arthrodesis rates. Short-term use of these medications appears to not cause significant clinical difficulties and is therefore not contraindicated in orthopedic procedures.

Summary of Methods/Results:

200 consecutive patients undergoing subtalar and ankle arthrodesis were reviewed. Patients underwent the procedure by either of the senior two authors between 1999 and 2002. The surgical techniques were performed in similar manner minimizing variability. One group of patients received COX-2 inhibitor medications postoperatively. This group received the recommended dose for post-operative pain control for five days after surgery. The other group did not receive this medication. Records were reviewed to evaluate for time immobilized, time to full weight bearing, time to radiographic fusion and clinical union. Radiographs were reviewed to evaluate for radiographic union. Reviewers were blinded as to which group did and did not receive COX-2 inhibitor medications. Time to union and nonunion rates were established for each group to determine if there was a significant difference between groups receiving COX-2 inhibitor medications for acute pain indications. A nonunion was determined if patients were clinically symptomatic with pain or motion at the attempted arthrodesis site. A nonunion was also determined if bridging trabeculae were not apparent across the arthrodesis site on plain radiographs. The group that received the COX-2 inhibitor medication had an overall nonunion rate of 11.2%. For all patients that achieved arthrodesis, average time to union was 89.8 days for this group. When separated by arthrodesis site, the majority of nonunions were failed ankle arthrodeses (96%). In the group that did not receive a COX-2 inhibitor postoperatively, the overall nonunion rate was 12.4%, again with failed ankle arthrodeses accounting for the majority of the nonunions (97%). Time to union in this group averaged 93.4 days. The time to union was shorter in the group that received COX-2 inhibitors, but this was not statistically significant. The overall nonunion rate was lower in the group that received COX-2 inhibitors, but this, too, was not statistically significant.



*Alicia Bertone, D.V.M.,
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and Professor of
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Surgery at The Ohio
State University*

RADIOFREQUENCY COUPLED WITH CONDUCTIVE FLUID FOR HEMOSTASIS OF CANCELLOUS AND CORTICAL BONE IN AN OVINE MODEL: ASSESSMENT OF BONE HEALING

Authors: Alicia Bertone, D.V.M., D. Lipson, Jang Kamei, Alan Litsky, M.D., Sc.D., Victor Krebs, Steven Weisbrode, D.V.M., Ph.D.
Presenter: Alicia Bertone, DVM, Ph.D.

Introduction:

In orthopaedic surgical procedures, blood loss occurs during the surgical procedure and for a significant time during the post operative period. Flordal and Neander reported a mean total blood loss of 1089 mL with 56% of hip reconstruction patients and 39% of knee reconstruction patients receiving 1.7 to 2.2 units of blood. Blood transfusions, both allogeneic and autologous, carry significant risks and negative outcomes. Application of radio frequency [RF] energy for tissue ablation and collagenous tissue shrinkage is well studied^{2,3}, but the use of thermal modification of connective tissues to induce coagulation of tissue that simultaneously seals blood vessels is novel and only recently reported as clinically successful in the liver.⁴ A bipolar floating ball wand [TissueLink™FB3.0™] couples the saline conductive fluid flow and RF energy such that arcing is eliminated and the tissue is cooled to < 100°C. The result is hemostasis via collagen shrinkage without tissue desiccation, smoking, arcing, and char. In contrast, conventional electrocautery (EC) reaches temperatures of 300°C. The purposes of this study were to evaluate the effectiveness of RF coupled with conductive fluid to induce hemostasis in cancellous and cortical bone and to follow the postoperative clinical and bone healing response to this procedure as compared to standard electrosurgical coagulation.

Methods:

Based on pilot studies, a bipolar ball wand [BPS5.0™] designed to accept a saline drip and Force FX generator were used to seal the bone at 200J fluence/sq cm [50W, 4cc/min flow rate for 11 sec/2.9sq cm]. After I.A.C.U.C. approval, bilateral iliac crest osteotomy (3 x 1cm) and tibial unicortical defects (5.5mm diameter) were performed in 10 adult sheep. The iliac crest was removed by an osteotome to expose underlying cancellous bone. The distal medial tibial cortex was drilled with a high-speed air drill to expose bleeding cortical bone and periosteum. 10 iliac osteotomies and 10 tibia defects were treated with RF/saline (Fig 1) and 10 were treated with conventional electrocautery at similar power/density and time of exposure [duration of application 13-22 sec for ilia and 2-5 sec for tibiae].



Fig 1. Bipolar ball wand conducting saline and a treated tibial defect

Hemostasis was scored as a percent reduction of bleeding surface and intensity of bleeding rate. Animals were serially evaluated clinically for swelling, lameness, limb pain, and radiographic evidence of bone formation or reaction. Animals were sacrificed at 6 and 12 weeks. At sacrifice, iliac crests were harvested for decalcified (6 wks) and undecalcified (12 wk) histology and scored to assess inflammation, bone necrosis, surface tissue morphology and bone formation rate (12 wks). Tibiae were harvested for quantitative computer tomography (qCT), biomechanical testing and histology. The central slice of the CT images were quantified for % bone filling the defect and defect bone density. Halved tibiae were subject to 3-pt bending in a servohydraulic testing machine and loaded on the cut surface opposite the hole at 0.5N/sec to failure. Additional halves were used as intact and drilled [empty hole] control tibiae. Mode of failure was scored as through the defect (1),

RADIOFREQUENCY COUPLED WITH CONDUCTIVE FLUID FOR HEMOSTASIS OF CANCELLOUS AND CORTICAL BONE IN AN OVINE MODEL: ASSESSMENT OF BONE HEALING, CONTD.....

around the defect (2) or away from the defect (3). After failure, defects were decalcified (6 wk) and processed undecalcified (12wk) for histology. Tibiae histology was scored for inflammation in the defect and at the periosteal and endosteal surfaces, morphology and type of the tissue within the defect, and bone necrosis (empty lacunae) within the new bone and in the adjacent bone to the defect.

Quantitative data was compared with a paired t-test or ANOVA (biomechanical data). Scored data was compared with a Mann-Whitney Rank test. Significance was set at $P < 0.05$.

Essential Results: Hemostasis was significantly greater ($P < 0.015$) and nearly complete with the RF/saline treatment (mean 92%) as compared to EC (mean 58%) in cancellous and cortical bone. After RF/saline treatment the surface was dry and a tan color (ie a bloodless field). Electrocautery induced surface char (black color) and incomplete hemostasis. No incisional complications or swelling developed with either treatment and animals were not lame throughout the study. Radiographs demonstrated bone filling the defect and bone remodeling (ilia) as anticipated with no difference between treatments. Good bone healing occurred with no significant bone reaction and no bone resorption at the osteotomy sites with a mean of 63% bone filling the tibia defect at 6 weeks and 84% bone filling the defect at 12 weeks. Density of the new bone within the defect (expressed as a % of adjacent bone density) was greater at 12 weeks (74%) than 6 weeks (44%). There was no difference in bone healing between treatments. Bone healing progressed well as anticipated without image evidence of necrosis, bone resorption or delayed bone formation. (Fig 2)



Fig 2a. 6wk tibial defect CT



Fig 2b. 12 wk tibial defect CT

Intact tibiae had significantly greater strength (mean 219N/mm; $P < 0.066$) than any 6 wk defect and all 6 wk defects failed through the hole. RF/saline, EC, and control empty defects were not significantly different at 6 wks. At 12 wks, RF/saline (205 N/mm) and EC (219 N/mm) were similar and as strong as intact tibiae. The median mode of failure (2) at 12 wks was around the defect. Histology confirmed the qCT results and demonstrated that a mature, dense fibrous tissue with no evidence of inflammation was attached to the surface of the treated osteotomy sites by 6 wks. The surface bone had minimal evidence of necrosis (regional empty lacunae with normal morphology) in 1 ilia treated with RF/saline and 2 treated with EC.



Fig 3. Fibrous tissue and healthy bone at RF/saline-treated ilium surface (6wks)

A 50 um surface layer of intermittent hemosiderin laden giant cells was present in the RF/saline treated group and was interpreted as a normal scavenging of coagulated heme products related to the effective hemostasis. Carbon shreds and clumps were still evident in most EC treated surfaces both grossly (black color) and histologically.

Discussion: Radio frequency coupled with a conductive fluid provided bone sealing and near complete hemostasis in both cancellous and cortical bone. Cancellous and cortical bone necrosis was minimal, similar to conventional techniques, and did not interfere with return of bone integrity, biomechanical strength, and healed bone. Tissue inflammation and proliferative bone reaction was minimal to nonexistent in all applications. This technology [TissueLinkBPS5.0™] may be an effective method to produce hemostasis in orthopedic surgery.



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THE USE OF OXYCONTIN VERUS SCHEDULED PERCOCET IN THE IMMEDIATE POSTOPERATIVE PERIOD FOLLOWING TOTAL JOINT ARTHROPLASTY

Authors: James Kerpsack, M.D., Richard Fankhauser, M.D.
Presenter: James Kerpsack, M.D.

INTRODUCTION: Postoperative pain control is an important part of joint replacement surgery, and many methods are available. The use of Oxycontin has become very common as a means of maintaining steady levels of drug in the body and decreasing the need for intravenous analgesics. The goal of this study was to determine the effectiveness of Oxycontin in the immediate postoperative period following total joint arthroplasty

METHODS: Patients undergoing total joint arthroplasty were enrolled for study. Oxycontin was begun on the day of surgery and continued during the hospital stay. During the first 48 hours, the patients were administered the McGill Short Form pain questionnaire during the four regularly scheduled physical therapy sessions. Patients also had Percocet and Dilaudid available for breakthrough pain. The study group was compared to a previous group in which superior pain control was obtained with around the clock Percocet.

RESULTS: There were no significant differences in the pain control scores as determined by the questionnaire. There was

DISCUSSION AND CONCLUSION: Oxycontin in the immediate postoperative period offered no benefit over scheduled Percocet and as needed intravenous Dilaudid. With the increasing social awareness of the dangers of improperly used Oxycontin and with no benefit over other commonly used agents, we recommend not using Oxycontin for postoperative pain control in total joint arthroplasty.

THE RISK OF INFECTION ASSOCIATED WITH INTRA-ARTICULAR BUPIVACAINE INFILTRATION VIA PAIN CONTROL INFUSION PUMPS IN TOTAL KNEE ARTHROPLASTY PAIN MANAGEMENT

Authors: Michael McShane, M.D., Timothy Williams, M.D., Jodi Hartman, M.S.
Presenter: Timothy Williams, M.D.

Complications associated with intra-articular pain control infusion pump use in 195 primary total knee arthroplasties were compared to complications reported in a historic control group of 103 primary total knee arthroplasties in which no pain pumps were used to determine if pump use was associated with an increased risk of infection. Perioperative blistering occurred in 4 (2.0%) pain pump patients and infection (1 superficial; 1 deep) occurred in 2 (1.0%) pain pump patients. The late deep infection occurred after dental abscess drainage and resulted in revision. No other complications occurred. No significant differences in infection and blistering incidences were calculated between groups. The absence of major perioperative complications and low infection incidence suggest that pain pump use is a safe addition to a multi-modal TKA pain management regimen consisting of scheduled oral opioids with breakthrough intravenous pain support



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ADENOVIRUS-MEDIATED BONE MORPHOGENETIC PROTEIN 2 GENE DELIVERY PROMOTES OSTEOGENESIS IN EQUINE STEM CELLS

Authors: Terri Zachos, D.V.M, Alicia Bertone, D.V.M, Ph.D.
Presenter: Terri Zachos, D.V.M

The healing of fractures under compromised conditions, leading to delayed union and non-union, poses a formidable clinical challenge. Limitations associated with the methods traditionally employed in these cases have led to the exploration of alternative techniques to address this problem. Among these is the delivery of genes encoding naturally occurring growth factors to augment fracture healing. Bone morphogenetic protein 2 (BMP2) has been shown to induce osteogenesis in pluripotential cells.¹⁻⁴ Human bone marrow-derived mesenchymal stem cells have been used as targets for delivery of the gene encoding BMP2 using an adenoviral vector (AdBMP2), resulting in a three-fold increase in BMP2 expression over that induced by used of recombinant human BMP2.⁴ Adenoviral vectors have been shown to be efficient, safe mediators of gene delivery, and can be used for the delivery of reporter genes to monitor transfection efficiency.⁵ The purpose of our study was to use an adenoviral vector to transfect equine bone marrow-derived mesenchymal stem cells with the gene encoding BMP2 *in vitro*, and to evaluate subsequent osteogenic cell differentiation. Our hypothesis is that AdBMP2 will promote osteogenic differentiation.

Mesenchymal stem cells were obtained from equine bone marrow and expanded in monolayer culture. Prior to initiating our main experiment, we confirmed the pluripotentiality of our equine bone marrow-derived stem cells by culture in controlled osteogenic, chondrogenic, and adipogenic medium cocktails containing dexamethasone with ascorbate, rhTGF β 1, and dexamethasone with insulin and indomethacin, respectively. Subsequently, suspended mesenchymal stem cells were assigned to three groups: 1) No Vector Control, 2) Adenoviral Vector Control (AdLacZ construct encoding the bacterial β -galactosidase gene) and 3) AdBMP2 Vector. Adenoviral vectors were applied to cells at a multiplicity of infection (MOI) of 100:1. The transgene construct encoding bacterial β -galactosidase (AdLacZ) was utilized as a reporter gene to calculate gene transfection efficiency. Transfection efficiency in Group 2 (AdLacZ wells) (%) and cell scoring (Groups 1-3) were evaluated at days 2 and 12 post-transfection as a method of assessing cell health and viability. A normal-appearing, attached mesenchymal stem cell was scored a 2. Cell scores ranged from 0 (detached and round) to 4 (fibroblastic and spindle). On days 2, 5, and 12, duplicate wells were fixed and stained for alkaline phosphatase (Sigma Alkaline Phosphatase No. 85) and mineral (von Kossa method). Quantification of BMP2 production was determined in cell culture medium harvested at days 2, 5, 10, and 12 post-transfection using an enzyme-linked immunosorbent assay (ELISA) for recombinant human BMP2.

Gene transduction efficiency was maximal (100%) by day 2. BMP2 gene transfection in the AdBMP2-treated group 3 as compared to the control group 1 was confirmed by an 8-fold (day 2; 678 pg/ml *versus* 83 pg/ml) and 14-fold (day 12; 1236 pg/ml *versus* 88 pg/ml) increase in BMP2 medium concentration. AdBMP2-treated cells sustained more normal cell morphology scores than AdLacZ or Control cells. The addition of AdLacZ reduced cell numbers and cell morphology scores as compared to AdBMP2 or the Control. Greater alkaline phosphatase staining and mineral production were noted as early as day 5 in AdBMP2-transduced cells, as compared with controls. Significant differences in cell numbers were not found between AdBMP2-treated cells and controls at either time period for days 2 and 12, respectively.

Efficient BMP2 gene transfer to equine mesenchymal stem cells was achieved using an adenoviral vector. While adenovirus results in some degree of cytotoxicity, BMP2 appears to have a supportive trophic effect, preventing cell attrition. In addition, greater positive staining with alkaline phosphatase stain and the von Kossa method, relative to controls, suggests promotion of osteogenic differentiation. Studies to evaluate the production of BMP2 at longer periods post-transduction and use in other models are needed to confirm the findings of this study.



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ANATOMIC EVALUATION OF THE ANTERIOR AND MIDDLE TALOCALCANEAL ARTICULAR FACETS AND THE EVANS OSTEOTOMY

Author and Presenter: Christopher Hyer, D.P.M

The purpose of this study was to determine the occurrence of discrete anterior and middle talocalcaneal facets and what distance from the calcaneocuboid joint an Evans osteotomy should begin to avoid those facets. 768 calcanei were examined from the human osteology archive at the Cleveland Museum of Natural History. Measurements taken included: (1) distance from the proximal border of the anterior facet to the calcaneocuboid joint (DTAF); (2) distance from the distal border of the middle facet to the calcaneocuboid joint (DTMF); and (3) width of facet separation (WFS).

The results revealed that 310 of 755 (41.06%) had discrete anterior and middle facets and 423 of 755 (56.03%) had a conjoined facet. In those with discrete facets, the mean DTAF, DTMF and WFS were 11.04 mm, 15.47 mm and 3.85 mm respectively. Since 56 % of the specimens had a conjoined anterior-middle facet, it should be expected that in this percentage of patients, an Evans osteotomy will always disrupt this articular surface. These patients are at risk for pseudoarthrosis, arthritis or malalignment and an alternative procedure should be chosen for this patient population.

In those with discrete facets, an osteotomy begun between 11.5 mm and 15 mm from the calcaneocuboid joint should pass between the anterior and middle facets and avoid damaging these articular surfaces.

The authors feel this information will aid the foot and ankle surgeon in patient selection and attaining optimal surgical outcome for the Evans lateral column lengthening procedure.

ARTHRODESIS OF THE THUMB METACARPOPHALANGEAL JOINT USING A 3.0 MM CANNULATED SCREW AND THREADED WASHER

Authors: Christopher Schmidt, M.D., Scott Zimmer, M.D., David Boles, M.D.

Presenter: Scott Zimmer, M.D.

Twenty-six patients underwent arthrodesis of the first metacarpophalangeal joint using a new technique. Indications for surgery were instability (six patients), chronic instability with secondary degenerative joint disease (six), osteoarthritis (six), inflammatory arthritis (seven), and paralytic boutonniere (one). The new technique uses the cup and cone method of decontamination and positioning with the internal fixation using a 3.0 mm partially-threaded cannulated screw and threaded washer (Synthes, Paoli, PA). Twenty-five of 26 patients (96%) had clinical and radiographic fusion. Average time to radiographic fusion for 24 patients (one nonunion and one patient without x-rays until 4 months) was 9.7 weeks. Long-term follow-up was available for 20 patients and averaged 31.5 months (range, 22-44 months). All 20 patients had stable radiographic fusion with maintenance of the fusion angle. There were no infections and no need for any painful hardware removal. Our results indicate that this new technique for arthrodesis of the thumb metacarpophalangeal joint is effective and reliable, is accomplished easily, and has a low incidence of complications.



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PAINFUL NEUROMATA FOLLOWING TOTAL KNEE ARTHROPLASTY

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Presenter: Tariq Nayfeh, M.D., Ph.D.

Treatment of knee joint pain is a basic component of most orthopaedic practices. Depending on the etiology of the pain, it may be managed with a variety of nonoperative and operative techniques. Neuroma formation after trauma or surgery is a common but under reported and missed cause of pain. It can occur after any surgical procedure around the knee, especially when a medial incision or dissection has occurred. Neuroma formation has been reported following minor falls or dashboard impacts. The pain and swelling following the formation of neuromata can be quite debilitating and may result in the loss of flexion, chronic swelling, and loss of function.

The diagnosis of knee pain secondary to neuroma formation is done on a clinical basis. The typical patient presents with a history of previous trauma or surgery to the knee. Many complain of a region of hyperesthesia around the joint. They may complain of pain from clothing or bedclothes when it touches the skin around the knee, indicating cutaneous nerve irritation. On physical exam painful trigger points around the knee are identified by deep palpation. Selective subcutaneous nerve blocks confirm the diagnosis.

In this study we perform a retrospective chart review of the 684 patients treated by the senior author (RW) with primary or revision total knee arthroplasty during the period from January 1995 to July 2001. During this time, 4.7% (32) patients developed symptomatic neuromas around their knees. Of these 32 patients, 56% (18) had no predisposing history, 3% (1) had a previous traumatic injury, 12.5% (4) had a prior arthroscopy, 6.2% (2) had a failed total knee, 3% (1) had an infected total knee, 6.2% (2) had a prior surgery (not including arthroscopy), 3% (1) had a prior arthroscopy and a failed total knee, and finally 3% (1) had a history of inflammatory arthritis. Based on our findings, the only predictive aspect of the patient's history for neuroma formation is a prior history of a neuroma at the knee joint.

All patients were initially treated with subcutaneous injections of lidocaine and 40 mg of triamcinolone. 6.2% (2) had complete resolution of symptoms after the first injection. 22% (7) improved with iontophoreses using dexamethasone as the topical agent. 12.5% (4) improved with ablation of the neuromas by pain specialists, an additional 12.5% (4) did not improve after having attempted ablation of the neuromas. 6.2% (2) had attempted arthroscopic excision that failed to provide relief of symptoms. 3% (1) patient had relief of symptoms following arthroscopic excision. 9.3% (3) obtained relief of symptoms after open excision of the neuroma. 3% (1) had no relief after open excision. 22% (8) had relief of symptoms after three injections. One patient went to another surgeon and had her knee revised, she subsequently returned with continued pain and is undergoing treatment at this time.

In conclusion, neuroma formation following total knee arthroplasty occurs in less than 5% of patients. With the small number of patients in this study we cannot derive any predisposing factors to predict who will form a neuroma. The treatment regimen should begin with a diagnostic injection with a corticosteroid, followed by noninvasive measures such as iontophoreses. If the iontophoreses fails, serial injections should be attempted. If these fail, then ablation via a pain specialist or open excision should be performed.



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SMALL INTESTINE SUBMUCOSAL IMPLANTS IN COLLATERAL LIGAMENT REPAIR

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Presenter: Scott Goin, M.D.

OBJECTIVE: To assess the biocompatibility and clinical efficacy of small intestine submucosa (SIS®) augmentation in repair of collateral ligament injury. The goal was to assess tissue reaction, joint pain and function, joint stability and integration of the SIS into the bone and surrounding periarticular tissue during the healing process and at long term outcome after application of the SIS to repair a collateral ligament transection. The investigators hypothesized that the SIS would restore and maintain mechanical stability to the joint, resulting in improved lameness and joint stability, and be biocompatible with the surrounding periarticular tissue.

ANIMALS: 10 adult horses with normal MCP joints were divided into 2 groups; 6 received collateral ligament repair with SIS and 4 received sham surgery.

PROCEDURE: The lateral collateral metacarpalphalangeal ligament was percutaneously transected in all animals. Two centimeter incisions were made proximal and distal to the joint line. An 8.0 mm hole was drilled unicortically from lateral to medial in the condylar fossa of the third metacarpal bone and transcortically in the proximal first phalanx in the treatment group parallel to the joint. The SIS implant was passed into the proximal drill hole and secured with a partially threaded 6.5 mm cancellous bone screw in interference fashion. The implant was then pulled with Ticon suture into a snug position through the transcortical drill holes in the proximal phalanx and secured with a similar screw. The control group underwent transection of the ligament and placement of sham screws into the metacarpal and proximal phalanx. Clinical parameters were assessed immediately after surgery, at 4 weeks and at 8 weeks. Parameters included pain free joint range of motion, lameness evaluation, and joint circumference. Quality of healing was assessed by stress radiographs and ultrasound immediately after surgery, at 4 weeks and at 8 weeks. After euthanasia at 8 weeks, the MCP joint was dissected removing all soft tissue except the lateral collateral ligament tissue area. Biomechanical testing was performed with the joints secured into a jig for cantilever lateral to medial bending to assess peak load to failure and strength in tension. Sections of the screw-bone-implant interface, proximal and distal repaired ligament were obtained, decalcified, stained and scored histologically for inflammation and collagen fiber alignment. Quantitative data was analyzed by 2-factor analysis of variance and scored data by Mann-Whitney Rank Test. Significance was considered at $P < 0.05$.

RESULTS: Clinical parameters were not significantly different between treatment groups. SIS-treated ligaments were less thick in longitudinal cross-section and had a greater linear pattern by 8 weeks ($P < 0.01$) indicating a smaller and better quality repair. On stress radiographic analysis, immediate laxity was confirmed at surgery after ligament transection which was fully reduced with SIS repair. The SIS treatment group retained less joint laxity than sham repair for at least 8 weeks. ($P < 0.0000$) All transected ligaments failed at lower loads than the contralateral intact limb, mean 1124.3N versus mean 2972.2N respectively, indicating incomplete ligament healing in both groups at 8 weeks. SIS and sham treated limbs did not differ in peak failure load (N), however SIS treated limbs tended ($0.05 < P < 0.1$) to be stronger (N/mm) due to their lesser thickness.

CONCLUSION: Collateral ligament repair with SIS is biocompatible, improves joint stability, and heals with more anatomic tissue than the controls without SIS repair.

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The Department wishes good luck to all of the residents and fellows who are completing their respective programs.

Please Read Regarding Category I CME Credit for This Presentation:

The Department of Orthopaedics has been authorized by The Ohio State University Center for Continuing Medical Education to provide a total of **five credit hours** in Category I for this research day. In order to receive the full five credits, each attendee must complete two evaluation/attendance forms. One is for the Visiting Professor Grand Rounds and the other is for the research presentations. We will be collecting these forms throughout the day.

Mark your calendars now!

MALLORY-COLEMAN DAY 2004

Friday, April 9, 2004

Visiting Professor and Moderator

To be Announced....

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