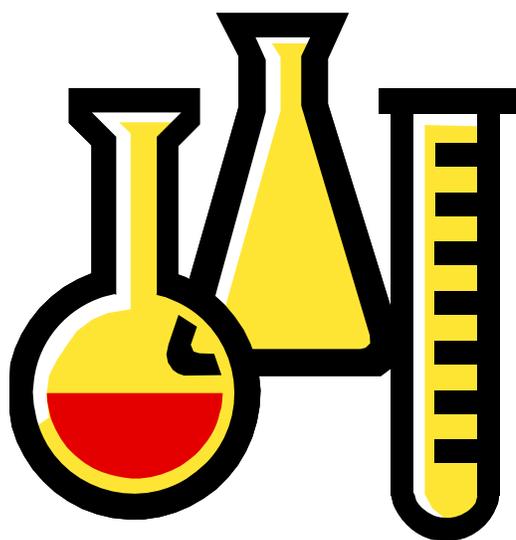


THE OHIO STATE UNIVERSITY

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39th Annual  
Mallory-Coleman  
Resident Research Day



Friday, June 10, 2011

Ohio Union  
US Bank Conference Theater

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## PROGRAM

- 7:00 am     **Welcome and Introduction**
- 7:15 am     **Jonathan Gant, M.D.**  
*“Complications Associated with Intramedullary Fixation of Clavicle Fractures”*
- 7:30 am     **Michael Griesser, M.D.**  
*“Adhesive Capsulitis – A Systematic Review of the Effectiveness of Intra-articular Corticosteroid Injections”*
- 7:45 am     **Lee Rise, M.D.**  
*“Effects of Bone Morphogenetic Protein-2 on Human Osteosarcoma Cell Growth, Differentiation, and Invasion: A Pilot Study”*
- 8:00 am     **Michael Riggenbach, M.D.**  
*“Open Reduction Internal Fixation of Clavicle Nonunions with Allograft Bone Substitute”*
- 8:15 am     **Ryan Harrison, M.D.**  
*“How Effective is Orthopaedic Surgery Training in the 80-Hour Work Week Era?”*
- 8:30 am     **Vincent Ng, M.D.**  
*“Genetically Engineered Juvenile Human Neocartilage Formation In Vitro for Chondral Defect Implantation”*
- 8:45 am     **Thomas Durbin, M.D.**  
*“Multifocal Juvenile Osteochondritis Dissecans of the Knee: A Case Series”*
- 9:00 am     **Break**
- 9:15 am     **Kenneth Bono, M.D.**  
*“Septic Arthritis in Children Less Than 3 Months of Age (A Retrospective Review)”*
- 9:30 am     **Hillary Tudor, D.P.M.**  
*“A Retrospective Comparison of Hallux Valgus Recurrence in First Metarsal-Cuneiform Fusion With and Without a Distal Soft Tissue Procedure”*
-

- 9:45 am **Seth Jump, Ph.D.**  
*“Soluble Factors from Genetically Engineered Synovial Cells Enhance Aggrecan Expression And May Promote Chondrogenesis In An Autogenic Co-Culture Model”*
- 10:00 am **Brian Lewis, M.D.**  
*“A Biomechanical Comparison of Distal Clavicle Fracture Reconstructive Techniques”*
- 10:15 am **Joshua Harris, M.D.**  
*“Predictors of pain and function in patients with symptomatic, atraumatic full-thickness rotator cuff tears”*
- 10:30 am **Steven Eddy, M.D.**  
*“Airborne Bacterial Contamination in Total Knee Arthroplasty: Ultraviolet Filtration Compared with Laminar Flow”*
- 10:45 am **Break**
- 11:00 am **Henrik Malchau, M.D., Visiting Professor and Moderator**  
*“Impact From Registries on Total Hip Practice”*
- 12:00 pm **Lunch in Cartoon Room**
- 1:00 pm **Gregory Kolovich, M.D.**  
*“A Retrospective Statistical Analysis of High-Grade Soft Tissue Sarcomas”*
- 1:15 pm **Karin Ljungquist, M.D.**  
*“Prediction of coracoid thickness using a glenoid width-based model: Implications for bone transfer procedures in chronic anterior shoulder instability”*
- 1:30 pm **Michael Rerko, M.D.**  
*“Comparison of Various Imaging Techniques to Quantify Glenoid Bone Loss in Shoulder Instability”*
- 1:45 pm **Ryan Harrison, M.D.**  
*“Location dependent progression of cartilage lesions: An in vivo rat model”*
- 2:00 pm **End of Day**
-

## MALLORY-COLEMAN DAY

Mallory-Coleman resident research day was established by Drs. Thomas Mallory and Carl Coleman 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 related basic sciences.

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

### Past Visiting Professors:

2010 Freddie Fu, M.D.  
2009 James Heckman, M.D.  
2008 Cato Laurencin, M.D.  
2007 William Garrett, M.D.  
2006 Peter Stern, M.D.  
2005 James Goulet, M.D.  
2004 Steven Arnoczky, D.V.M.  
2003 Joseph Buckwalter, M.D.  
2002 Victor Goldberg, M.D.  
2001 James Urbaniak, M.D.  
2000 Douglas Jackson, M.D.  
1999 Douglas Dennis, M.D.  
1998 Thomas Einhorn, M.D.  
1997 Larry S. Matthews, M.D.  
1996 Gary Friedlander, M.D.  
1995 James Herndon, M.D.  
1994 Clement B. Sledge, M.D.  
1993 Eric L. Radin, M.D.

## 2011 MALLORY-COLEMAN VISITING PROFESSOR AND MODERATOR:

### HENRIK MALCHAU, M.D, PH.D.



Dr. Henrik Malchau graduated from the Medical School at Aarhus University, Denmark 1977. He received his PhD in 1995 from Göteborg University, Sweden 1995. He was Chief for Department of Orthopedics, Göteborg 1993-2004 and one of the founders of the Swedish Hip Registry and its Director for many years. Since 2004, he has been Attending Surgeon at the Department of Orthopaedics, MGH, Co-Director for the Harris Orthopaedic Lab. In 2010, he was promoted to Professor of Orthopaedic Surgery at Harvard Medical School.

His clinical and research interest has been focused on documentation of primary and revision hip replacements. For the clinical research, Radiostereometric Analysis has been a key instrument that he has developed to even further sophistication in collaboration with research groups in Göteborg and Boston.

With continuing focus on improving outcome after THR, an algorithm for introduction of new hip implant technology was developed and presented in his PhD thesis: *On the Importance of Stepwise Introduction of New Hip Implant Technology*. The overall aim for the research effort is to prevent marketing of inferior implant designs and surgical techniques, and thus to improve the clinical outcome for the patients.

Dr. Malchau has been an active clinician, and during the past 21 years performed numerous primary and revision hip arthroplasties. The results from the Swedish National Registry have clearly demonstrated the importance of the surgical technique for long-term clinical results. He has stressed this in his postgraduate educational activity and traveled internationally to share these observations with the orthopedic community.

He has taken an active part as a course organizer for postgraduate courses on practical and theoretical aspects of primary and revision THR. On an international level, he has actively participated with either oral presentations, posters, scientific exhibits or instructional courses, in all ORS and AAOS meeting since 1986.

In addition, he has tutored several PhD students with the intention of continuing these extremely important educational activities for coming generations of orthopaedic surgeons.



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## COMPLICATIONS ASSOCIATED WITH INTRAMEDULLARY FIXATION OF CLAVICLE FRACTURES

Authors: Jonathan Gant, M.D., Joseph Mileti, M.D.

Presenter: Jonathan Gant, M.D.

### **INTRODUCTION:**

Clavicle fractures have a very high incidence with approximately 80% occurring at the middle one-third of the bone. Traditionally, clavicle fractures have been treated non-operatively with exceptionally good healing and functional outcomes. However, more recent randomized clinical controlled trials have suggested operative intervention as a superior technique compared to conservative management for significantly shortened and displaced fracture patterns<sup>1</sup>. Along with the accepted treatment of plate fixation, intramedullary fixation of clavicle fractures is gaining popularity. Advantages of intramedullary fixation include smaller skin incisions, less soft-tissue stripping at the fracture site, easier hardware removal, better cosmesis, and less weakness of bone after hardware removal<sup>2</sup>. However, historical references have documented high complication rates in small cohorts associated with intramedullary fixation<sup>3,4</sup>. We hypothesize that the risk of complication associated with intramedullary fixation utilizing a Rockwood Clavicle Pin will be low.

### **METHODS:**

Data collection was approved by Riverside Methodist Hospital Institutional Review Board. Our study consisted of a retrospective chart review of consecutive patients who underwent intramedullary clavicle fixation using the Rockwood Clavicle Pin (Depuy, Warsaw, IN) 2004-2008. Fifty-eight patients were identified (42 males, 16 females). All patients had a type 2 (middle one-third) clavicle fracture with at least 10mm of shortening and greater than 100% displacement at initial xray evaluation. All patients were treated with a pin measuring 2.5mm-3.8mm based on anatomical size. Patients were excluded if they had previous clavicle surgery or were being treated for a nonunion. Data collected included age, gender, fracture location, duration of pin placement, type of complication, future surgery. Complications were grouped into major and minor based on severity of the problem. Major complication included: nonunion, deep infection, refracture, permanent nerve injury. Minor complications included: delayed union (greater than 4 months), superficial infection, pin failure with union, skin erosion with pin exposure, temporary brachial plexus palsy. Univariate analysis was performed.

### **DATA AND RESULTS:**

Of the 58 patients, there were 13 complications (22.4%) in 13 patients. Five (8.6%) were classified as major requiring revision surgery. Three were nonunions requiring revision open reduction and internal plate fixation and iliac crest bone grafting. All went on to union. The other 2 major complications were superficial infections that required a return trip to the operating room for formal irrigation and debridement. Intraoperative biopsy did not yield growth at culture in either case. Both cases were treated as a presumptive infection with a 10-day course of PO antibiotics and healed uneventfully. Eight (13.7%) were classified as minor, including 1 delayed union, 4 skin irritations, 2 pin erosions through the skin, and 1 superficial infection. No neurovascular complication was noted. Average age of the patient was 34.6 (14-67). Average duration from surgery to pin removal was 101.6 days (45-273).

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## COMPLICATIONS ASSOCIATED WITH INTRAMEDULLARY FIXATION OF CLAVICLE FRACTURES, CONTD

Presenter: Jonathan Gant, M.D.

### **DISCUSSION:**

In our series, we had an 8.6% (5/58) major complication rate and 13.7% (8/58) minor complication rate, with an overall rate at 22.4% (13/58). This large cohort has superior results to previously documented results for intramedullary fixation with hagio or steinmann pins<sup>3,4</sup>. Our rate is superior to the complication rate noted by the Canadian Orthopaedic Trauma Society utilizing plate fixation at 37.1%<sup>1</sup>. Our complication rate is very similar to a recently published results by Millet et al. utilizing the Rockwood Pin at 25.8% in their cohort<sup>5</sup>. This study has significant limitations including bias inherent in any retrospective analysis. We also did not use a validated outcomes measure to assess patient function. However, our data does elucidate a unique complication profile for the Rockwood Clavicle Pin. This information will assist upper-extremity surgeons in their implant selection as well as improve their ability to properly counsel patients about potential risks associated with intramedullary fixation.

### **REFERENCES:**

1. *Canadian Orthopaedic Trauma Society. JBJS Am.* 2007 Jan;89(1):1-10.
2. Andermahr et al. *Clin Anat.* 2007; 20:48-56
3. *Grassi et al. J Trauma* 2001 Jun;50(6):1096-100.
4. *Strauss et al. J Shoulder Elbow Surg.* 2007 May-Jun;16(3):280-4.
5. *Millet et al. J Shoulder Elbow Surg.* 2011 Jan;20(1):86-91

### **ACKNOWLEDGEMENTS:**

Lindsay Arnott, Research Coordinator at Ohio Orthopaedic Center of Excellence.  
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### **DISCLOSURES:**

None of the authors have any financial interests to disclose.



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## ADHESIVE CAPSULITIS—A SYSTEMATIC REVIEW OF THE EFFECTIVENESS OF INTRA-ARTICULAR CORTICOSTEROID INJECTIONS

Authors: Michael Griesser, M.D., Joshua Harris, M.D., Jonathan Campbell, B.S., Grant Jones, M.D.

Presenter: Michael Griesser, M.D.

### INTRODUCTION:

Primary adhesive capsulitis (frozen shoulder) is a common cause of acute shoulder pain and global limitation of both active and passive shoulder motion. We conducted a systematic review to determine the effectiveness of intra-articular corticosteroid injection for the treatment of adhesive capsulitis compared to all other known treatments. Our hypothesis was that intra-articular steroid injection would result in improved short-term outcome in pain and range-of-motion (ROM), but show no difference in long-term outcome.

### METHODS:

Multiple medical databases were searched for Level I and II evidence with specific study inclusion and exclusion criteria. Minimum follow-up was 6 months. Clinical outcome measures included Constant scores, SPADI (Shoulder Pain and Disability Index), VAS (visual analog scales), and SF-36 scores (PCS [Physical component score] and MCS [Mental component score]), and range-of-motion.

	Pubmed	CINAHL	EMBASE	SportDiscus	MEDLINE	Cochrane
Adhesive + Capsulitis	4269	94	48	77	173	29
Adhesive + Capsulitis + Shoulder	1547	34	*	65	83	7
Adhesive + Capsulitis + Injection	418	4	*	14	9	0
Frozen + Shoulder	4737	101	54	161	263	46
Frozen + Shoulder + Injection	436	1	*	9	2	0
Stiff + Shoulder	194	21	3	45	28	15
Stiff + Shoulder + Injection	17	0	*	0	0	0
Periarthritis + Shoulder	820	5	*	11	130	36
Periarthritis + Shoulder + Injection	60	0	*	1	3	0
Duplay + Disease	36	0	*	0	0	0
Duplay + Disease + Injection	1	0	*	0	0	0

932 studies were identified after initial searches – 8 met inclusion criteria (Level I and Level II evidence). There were 406 subjects and 409 shoulders (3 bilateral cases).

### DATA AND RESULTS:

Eight studies were included (406 subjects). Study quality was poor via modified Coleman Methodology Scores and Quality Appraisal Tool Scores. Mean subject age was 55 years. When staging was known (Neviaser), all subjects were Stage II (frozen), with pre-treatment duration of symptoms of 182 days. All treatments resulted in subjective and objective improvements at 1-2 year follow-up, with no significant ( $p > .05$ ) differences identified among intra-articular steroid versus manipulation versus saline hydrodilatation versus oral steroid, except for SF-36 PCS and MCS where intra-articular steroid was significantly better than manipulation and for SPADI pain scores where intra-articular steroid was significantly better than intra-articular saline (control).

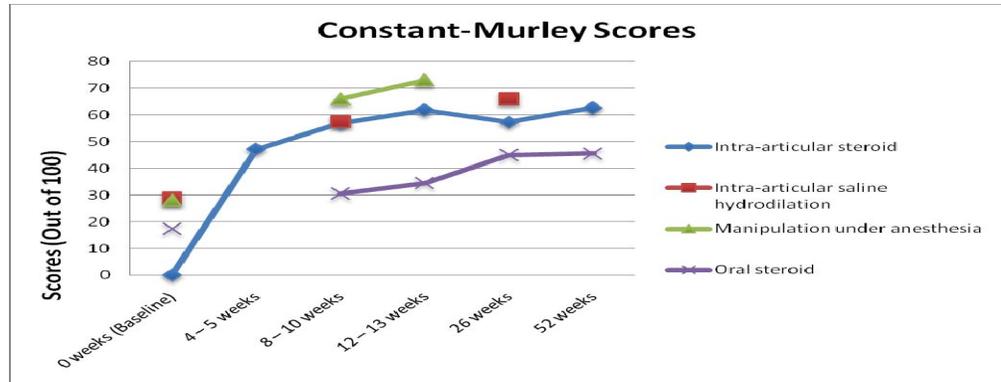
Constant-Murley Scores showed no significant difference ( $p > .05$ ) in the amount of improvement between all treatment groups at final follow-up and interim follow-up.

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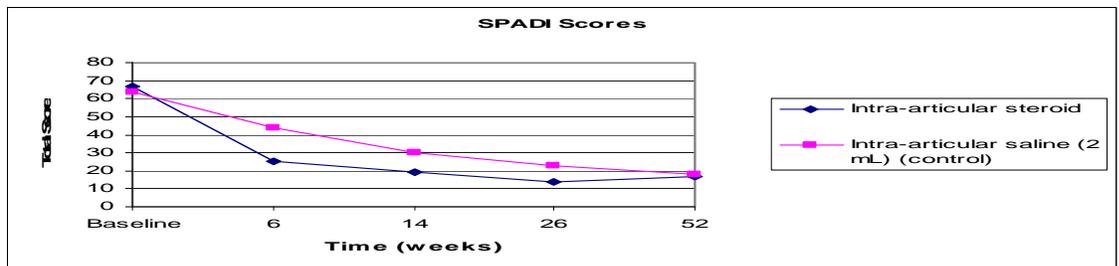


## ADHESIVE CAPSULITIS—A SYSTEMATIC REVIEW OF THE EFFECTIVENESS OF INTRA-ARTICULAR CORTICOSTEROID INJECTIONS, CONTD....

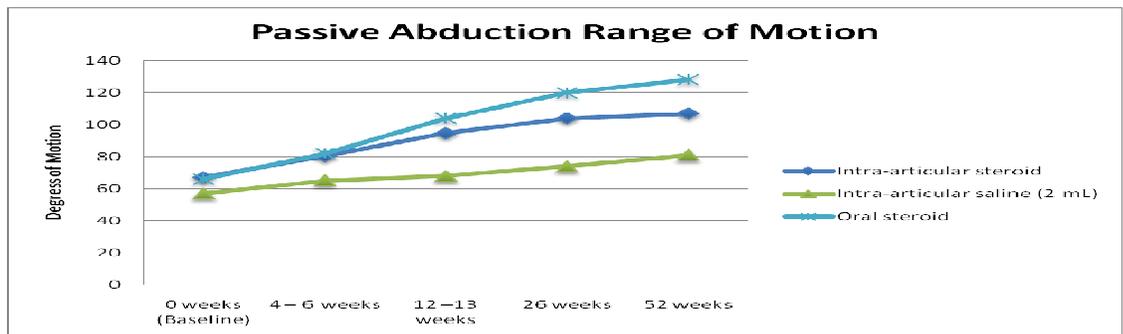
Presenter: Michael Griesser, M.D.



The 6 week follow-up SPADI scores were significantly better for steroid injection compared to saline control. However, SPADI scores showed no significant difference in improvement between intra-articular steroid and intra-articular saline at long-term follow-up.



Intra-articular and oral steroid significantly improved range of motion (ROM) at 6 weeks over intra-articular lidocaine or saline. However, there was no significant difference in ROM at long term follow-up between treatments.





## ADHESIVE CAPSULITIS—A SYSTEMATIC REVIEW OF THE EFFECTIVENESS OF INTRA-ARTICULAR CORTICOSTEROID INJECTIONS, CONTD....

Presenter: Michael Griesser, M.D.

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### **DISCUSSION:**

Most treatments resulted in improved clinical outcomes and improved range-of-motion measures. At early follow-up, both intra-articular steroid and oral steroid showed significantly greater improvements in abduction and forward elevation versus intra-articular lidocaine and intra-articular saline. Most treatments resulted in significant pain improvements without any significant difference between groups, except for better pain relief in intra-articular steroid versus intra-articular saline (control). These significant improvements do appear to be short lived, as all treatments resulted in improved passive ROM and pain at final follow-up, with no one treatment reaching a consistent significant difference ( $p < .05$ ) versus another. The poor methodological characteristics of the studies analyzed in this review warrants an overall need for improvement in study quality in the future.

### **REFERENCES:**

- 1) Lorbach et al. J Shoulder Elbow Surg. 2010; 19 (2): 172-179.
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- 6) Rizk et al. Arch Phys Med Rehabil. 1991; 72 (1): 20-22.
- 7) Dacre et al. Ann Rheum Dis. 1989; 48 (4): 322-325.
- 8) Bulgen et al. Ann Rheum Dis. 1984; 43 (3): 353-360

**DISCLOSURES:** The authors have no financial incentives to disclose.



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## **EFFECTS OF BONE MORPHOGENETIC PROTEIN-2 ON HUMAN OSTEOSARCOMA CELL GROWTH, DIFFERENTIATION, AND INVASION: A PILOT STUDY**

Authors: Lee Rise, M.D., Joel Mayerson, M.D., Gary Bos, M.D., Jason Calhoun, M.D., Alicia Bertone, D.V.M., Ph.D.

Presenter: Lee Rise, M.D.

### **INTRODUCTION:**

Recombinant human bone morphogenetic proteins (rhBMP) can induce the proliferation and differentiation of pluripotent progenitor cells, thereby serving as robust osteoinductive agents. Bone morphogenetic protein-2 (BMP2) and bone morphogenetic protein-7 (BMP7) are FDA approved and commercially available for use as bone healing adjuncts in adults without a history of malignancy.

BMPs could be particularly useful in the setting of bone tumor resection surgery where there is an inherently increased risk of nonunion. However, it is unknown whether BMP2 or 7 increase the risk of tumor recurrence and/or metastasis. Studies have suggested that cancer patients not only have elevated expression of BMPs, but also that BMP levels may correlate with aggression.

We hypothesized that BMP2, in human osteosarcoma cells would induce signs of differentiation and there would be no increase in cancer cell growth or invasion.

### **METHODS:**

Three human osteosarcoma cell lines (Saos-2, U-2OS, & TE85) were cultured according to standard protocol. Four experimental groups were run in duplicate with data collected at 3 and 9 days. 1) The rhBMP2 group was treated with recombinant human BMP2. 2) The adBMP2 group was transduced with an adenoviral human BMP2 vector. 3) The adGFP group was transduced with an adenoviral green fluorescent protein vector 4) The control group had no treatment.

Cell growth was determined by hemacytometer cell count. Von Kossa staining of calcium deposits and staining of alkaline phosphatase were used as a gauge of differentiation. A Matrigel invasion assay was used to characterize the "aggressiveness" of each treatment group and the internal control (plain-gel) measured mobility. The supernate BMP2 concentration was quantified by an ELISA immunoassay at each data point.

### **DATA AND RESULTS:**

Osteosarcoma cells proliferated on the wells with no significant difference among groups at any time points in the cell counts, number/size of Von Kossa-positive nodules, or alkaline phosphatase staining intensity.

The number of migrated cells at Day3 in plain-gels was significantly ( $P=0.033$ ) less in the BMP2 groups compared to the non-BMP2 groups (Fig1, Left). The number of migrated cells was not significantly different among groups in Matri-gel at Day3 (Fig1, right) or both plain- and Matri-gels at Day9.

*Continued on Next Page*



## EFFECTS OF BONE MORPHOGENETIC PROTEIN-2 ON HUMAN OSTEOSARCOMA CELL GROWTH, DIFFERENTIATION, AND INVASION: A PILOT STUDY, CONTD.

Presenter: Lee Rise, M.D.

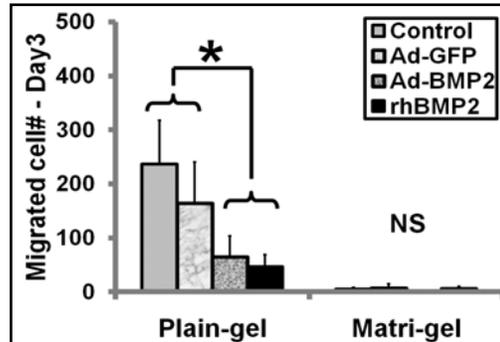


Figure 1 – Number of migrated cells at 3-days after cell-seeding.

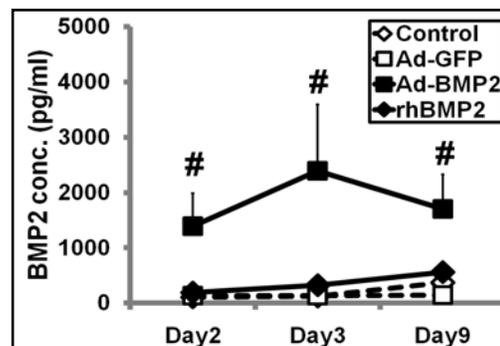


Figure 2 – The concentration of hBMP2 per well at Day2, 3, and 9.

### DISCUSSION:

The results of this study suggest that BMP2 does not promote invasive properties or proliferation in some lines of human osteosarcoma(HOS) and may even decrease mobility. However, the BMP2 did not cause an increase in alkaline phosphatase or calcium excretion of these HOS cells typically seen in osteoprogenitor cells, suggesting that the above noted effects are not the result of a push towards differentiation.

### REFERENCES:

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### ACKNOWLEDGEMENTS:

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**DISCLOSURES:** None



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## **OPEN REDUCTION INTERNAL FIXATION OF CLAVICLE NONUNIONS WITH ALLOGRAFT BONE SUBSTITUTE**

Authors: Michael Riggenbach, M.D., Grant Jones, M.D., Julie Bishop, M.D.

Presenter: Michael Riggenbach, M.D.

### **INTRODUCTION:**

Biologic augmentation with allograft has shown equivalent healing rates to autograft in several nonunion models. No literature exists clearly demonstrating this in the clavicle. The purpose of this study was to evaluate the healing and complication rates of clavicle nonunions treated solely with ORIF and allograft.

### **METHODS:**

Twenty clavicle nonunions treated with ORIF and allograft were evaluated retrospectively to assess healing rates and complications based on clinical symptoms and radiographic findings. Statistical calculations were performed using Microsoft Excel (Redmond, WA 2007).

### **RESULTS:**

For the twenty patients included and treated with ORIF and allograft, clinical follow-up averaged 15 months. Eight patients were smokers. While complete radiographic healing was achieved in only 65% of patients, clinical success occurred in sixteen (80%) patients who demonstrated full range of motion and strength without pain. The three patients who did not demonstrate full radiographic healing were completely pain free. Six patients experienced complications (30%). Two underwent hardware removal due to persistent irritation after union. Four had a persistent painful nonunion. Each of these four patients was a smoker ( $p=0.08$ ). Two proceeded to union after revision fixation. One had a persistently painful nonunion, but intact hardware and desired no further treatment. The other had hardware failure, which was removed, with a persistent nonunion and did not wish any further treatment.

### **DISCUSSION:**

Open reduction and internal fixation with allograft bone substitute is an acceptable treatment alternative to ICBG for clavicle nonunions. Smokers were identified to have a trend toward higher failure rates with ORIF augmented with allograft and therefore these patients may be better served by augmenting fixation with autograft.

### **ACKNOWLEDGEMENTS:**

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### **DISCLOSURES:**

The authors have no financial interests to disclose



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## HOW EFFECTIVE IS ORTHOPAEDIC SURGERY TRAINING IN THE 80-HOUR WORK WEEK ERA?

Authors: Ryan Harrison, M.D., Michael Quackenbush, D.O.  
Presenter: Ryan Harrison, M.D.

### **INTRODUCTION:**

Almost a decade has passed since major changes were made in the way we train residents. July 1, 2003 marked the beginning of the 80-hour work week in academic medicine<sup>1</sup>. The effect of this change on patient safety, resident and faculty job satisfaction, and the quality of education provided is still being actively debated in the literature. We developed a survey intended to examine how currently practicing physicians and trainees perceive the effect of the 80-hour work week on the ability of a graduating orthopedic resident to practice as an independent surgeon.

### **METHODS:**

We invited orthopaedic surgery trainees and attending surgeons from each of the residency programs in the US to participate in an online survey. Data were collected using the Survey Monkey tool over the course of a 4 month period (October 2010 – February 2011). Responses were analyzed and tabulated using the Survey Monkey system. When necessary, paired t-tests were performed using the JMP Statistical Software for Windows.

### **DATA AND RESULTS:**

277 people responded to the survey, 167 trainees (PGY-1=24, 2=23, 3=25, 4=33, 5=25 and 6=4) and 110 attendings. Eighty-seven per cent of the attendings who responded were fellowship trained and 62% had been in practice for greater than 10 years.

In general, residents are satisfied with their training. They report they prepare for cases (68.9% had a pre-operative plan and 83.4% read up on relevant anatomy) and are confident they will be able to pass their boards after graduation.

When asked how prepared they are to practice independently, 89% of residents believe they will be competent to practice independently as a general orthopaedic surgeon. 93% of residents surveyed, however, plan to complete a fellowship at the conclusion of their training (31.9% want a career in academics, 19.3% to augment a weakness in their training, 52.9% based on location of planned practice).

When asked about the 80 hour work week, residents report that hour restrictions do not negatively impact their training. They feel the 80 hour work week gives them time to pursue interests outside of medicine and spend time with their families. Only 13.8% of residents felt the 80 hour work week will limit their training. 32% of residents felt that the 80 hour work week restrictions will eventually result in the extension of the orthopaedic surgery residency by an additional year.

Attendings are not as comfortable with the current training environment. Although 71% of attendings feel that their residents will be able to pass their boards after graduation, only 20% of attendings would trust a newly graduating orthopaedic surgeon to operate on one of their family members. In contrast to the resident response, only 22% of attendings feel that residents come to the OR having reviewed relevant anatomy ( $p < 0.0001$ ).

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## HOW EFFECTIVE IS ORTHOPAEDIC SURGERY TRAINING IN THE 80-HOUR WORK WEEK ERA?, CONTD...

Presenter: Ryan Harrison, M.D.

When asked if residents are more prepared as a result of the 80 hour work week, only 12.7% of attendings agreed. 56.9% of attendings feel the work week severely limits residents' operative exposure. Two percent of attendings reported that the 80 hour work week results in better patient care. Twenty percent of attendings believe that the 80 hour work week is responsible for a morbidity or mortality in one of their patients. Forty-five percent of the attendings who responded are in favor of extending orthopaedic surgery training to 6 years.

### DISCUSSION:

The 80 hour work week was first implemented as a means of decreasing resident fatigue with the hope of increasing patient safety. Although residents and attending surgeons agree that resident academic education is adequate, attendings are not as comfortable with their residents' surgical skills. How these findings translate to actual patient outcomes and safety is still a subject of debate. While one study found an increase in morbidity after hip fracture surgery in teaching institutions<sup>2</sup>, a more recent study found a decrease in mortality in teaching institutions after the implementation of the 80 hour work week<sup>3</sup>.

July 1, 2011, will mark the implementation of further restrictions on duty hours<sup>4</sup>. These further restrictions have left institutions across the country scrambling for solutions to ensure safe and competent care for their patients. The expense of these changes is not insignificant. One study estimated that the cost of these changes would be just over 1 million dollars per year per training hospital, or almost seventy dollars per admission<sup>5</sup>. Additional work is needed to determine how further changes will affect orthopaedic surgery training in the US.

### REFERENCES:

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### ACKNOWLEDGEMENTS:

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DISCLOSURES: No disclosures.



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## **GENETICALLY ENGINEERED JUVENILE HUMAN NEOCARTILAGE FORMATION IN VITRO FOR CHONDRAL DEFECT IMPLANTATION**

Authors: Vincent Ng, M.D., Seth Jump, Ph.D., Joel Mayerson, M.D., David Flanigan, M.D., Alicia Bertone, D.V.M., Ph.D.

Presenter: Vincent Ng, M.D.

### **INTRODUCTION:**

Articular cartilage injuries can cause pain, effusions, and premature degenerative joint disease in active individuals. Unlike most tissues, hyaline cartilage is relatively avascular and has a limited ability to self-repair. Current treatment modalities such as microfracture and autologous chondrocyte implantation (ACI) result in fibrocartilaginous repair tissue that has suboptimal long-term results. Significant drawbacks associated with osteochondral autograft and early generation ACI such as donor-site morbidity and two-stage surgery have spawned efforts to create a superior off-the-shelf product for chondral defects.

This two-part in-vitro project represented the integration of multiple cutting-edge ideas in cartilage tissue engineering. Our principle objective was to determine the in-vitro ability of genetically engineered juvenile human chondrocytes (jCh) to form scaffold-free neocartilage for potential implantation and produce elevated levels of a beneficial soluble chondrogenic growth factor, bone morphogenetic protein 2 (BMP2), for a possible paracrine effect. Our hypothesis for part one of the experiment was that chondrogenic media and BMP2 engineering of jCh would produce superior neocartilage. Based on our findings in part one, we hypothesized in part two that modifying the proportion of BMP2 engineered jCh in neocartilage would optimize chondrogenesis and maintain increased production of soluble BMP2.

### **METHODS:**

Articular cartilage was harvested from individuals (<7yo) undergoing routine amputation. Juvenile chondrocytes were isolated and expanded in monolayer. Adenoviral vectors for BMP2 (AdBMP2) were proliferated, purified, titered and used to transduce jCh. The jCh were suspended, centrifuged and grown for two weeks to form neocartilage. For part one, the four treatment conditions compared transduction vs. no transduction (naïve) and standard media vs proprietary chondrogenic differentiation media (CDM, Lonza corp). For part two, the ratio of transduced to non-transduced jCh was varied across a spectrum (0:100%, 10:90%, 25:75%, 50:50%, 75:25%, 100:0%) to form neocartilage. Outcome measures included physical parameters, cell viability, soluble BMP2 production, gene expression, and histology. Statistics were performed with repeated measures and one-way ANOVA, and significance was set at  $p < 0.05$ .

### **RESULTS:**

In part one, AdBMP2-transduced jCh resulted in larger diameter ( $p=0.002$ ), heavier ( $p=0.0035$ ) and histologically superior ( $p=0.0024$ ) neocartilage than naïve jCh when grown in standard media. When compared to standard media, CDM improved diameter ( $p < 0.0001$  to  $0.0002$ ), weight ( $p < 0.0001$ ), histological findings ( $p < 0.001$  to  $0.0081$ ) and collagen type II expression ( $p=0.003$  to  $0.0043$ ). Full AdBMP2 transduction decreased chondrocyte viability regardless of media ( $p < 0.0001$  to  $0.0007$ ).

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## GENETICALLY ENGINEERED JUVENILE HUMAN NEOCARTILAGE FORMATION IN VITRO FOR CHONDRAL DEFECT IMPLANTATION, CONTD.

Presenter: Vincent Ng, M.D.

In part two, AdBMP2-transduction of 10%, 25% or 50% of jCh produced heavier ( $p < 0.0001$  to  $0.0099$ ) neocartilage than naïve jCh and 75% or 100%-transduced jCh, and all proportions of AdBMP2-transduced jCh resulted in larger diameter neocartilage than naïve jCh ( $p < 0.0001$  to  $0.0354$ ). Chondrocyte viability was reduced in neocartilage with <sup>3</sup>50% proportion of transduced jCh ( $p = 0.0018$  to  $0.035$ ). Histology ( $p = 0.01$  to  $0.044$ ) and collagen type II expression ( $p = 0.0001$  to  $0.027$ ) were best in neocartilage with 10%, 25% or 50%-transduced jCh. Soluble BMP2 production tended to increase with greater proportions of AdBMP2-transduced jCh ( $p = 0.03$  to NS).

### **DISCUSSION:**

Our outcomes demonstrate that jCh genetically engineered to produce BMP2 and grown in CDM can produce potential neocartilage allografts after a short incubation period. Modifying the proportion of AdBMP2-transduced jCh to 10% or 25% results in larger, heavier, and histologically superior neocartilage with maintained cellular viability and elevated levels of soluble BMP2 production. These findings provide the basis for further development of a novel scaffold-free construct that could be used as an off-the-shelf allograft for chondral restoration.

### **DISCLOSURES:**

Vincent Ng, M.D.—No relevant financial disclosures

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## MULTIFOCAL JUVENILE OSTEOCHONDRITIS DISSECANS OF THE KNEE: A CASE SERIES

Authors: Thomas Durbin, M.D., Kevin Klingele, M.D.

Presenter: Thomas Durbin, M.D.

### **INTRODUCTION:**

Osteochondritis Dissecans (OCD) is an acquired condition involving the subchondral bone of joint surfaces. Juvenile OCD (JOCD) refers to lesions which occur in individuals with open physes and is associated with better prognosis than the adult form.<sup>1</sup> JOCD most commonly occurs in the knee with the medial femoral condyle (MFC) being involved in the majority of cases (70-80%).<sup>1-6</sup> Multifocal JOCD (MJOCD) defines a subset of patients with more than one identified lesion occurring in the same or the contralateral knee. Most case series of knee JOCD report bilateral knee lesions in approximately 15-30% of cases, however, the prevalence of multiple lesions in a single knee has not been reported.<sup>1-4,7,8</sup> The purpose of this retrospective case series is to report a large group of patients with MJOCD of the knee and discuss demographic data, lesion location, stage, and treatment results.

### **METHODS:**

Records of patients identified with MJOCD of the knee between August 2004 and February 2011 at a single institution were retrospectively reviewed. Inclusion criteria included any skeletally immature patient with more than one OCD lesion within a single or both knees, identified either radiographically or surgically. Demographic data was collected and radiographic and intra-operative findings were reviewed. The descriptive classification described by Cahill and Berg was used to define lesion location.<sup>9</sup> Lesions undergoing arthroscopic treatment were graded into either stable (stage I and II) or unstable lesions (stage III and IV).<sup>10</sup> Patients undergoing operative treatment were defined as non-operative failures. Patients undergoing a revision procedure were defined as having failed surgical intervention. Nonoperative management included at least 4-6 months of activity restriction following an initial period of rest and restricted weight bearing. All data was collected and statistical analysis was performed.

### **RESULTS:**

Fifty-nine lesions were identified in 28 patients who met the inclusion criteria. There were 22 males (78.6%) with an average age of 11.9 years and six females with an average age of 12 years. Three patients had 3 lesions and the remaining patients each had two. Twenty-four patients had bilateral lesions whereas the remaining four patients had ipsilateral lesions. Thirty-four (57.6%) lesions were on the MFC, 21 (35.6%) on the LFC, two (3.4%) on the trochlea, one (1.7%) on the patella, and one (1.7%) on the anteromedial tibial plateau. Twenty-eight (71.8%) were stable (18 Stage I and 10 Stage II), and eleven (28.2%) were unstable lesions (3 Stage III and 8 Stage IV). Twenty (33.9%) lesions successfully healed with nonoperative management. Thirty-nine (66.1%) lesions required operative treatment. Four patients required secondary procedures. Of the 28 stable lesions assessed, 27 (96.4%) achieved healing with operative treatment. Additional findings included discoid lateral meniscus (n=7), bipartite patella (n=3), genu valgum (n=1), and ACL cyst (n=1).

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## MULTIFOCAL JUVENILE OSTEOCHONDRITIS DISSECANS OF THE KNEE: A CASE SERIES, CONTD.

Presenter: Thomas Durbin, M.D.

### **DISCUSSION:**

Multifocal JOCD (MJOCD) of the knee defines a subset of patients with more than one identified lesion occurring in the same or the contralateral knee. Prevalence of MJOCD of the knee is unknown. A high percentage of these patients require surgical intervention: approximately two-thirds of lesions in our population failed nonoperative management. Excellent healing rates are seen with standard operative treatments, especially in stable lesions. In addition, atypical lesion locations occurred more frequently than previously reported for patients with single JOCD lesions in the knee.

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### **ACKNOWLEDGEMENTS:**

Teaya Rough and Leisel Willis

### **DISCLOSURES:**

None



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## SEPTIC ARTHRITIS IN CHILDREN LESS THAN 3 MONTHS OF AGE: A RETROSPECTIVE REVIEW

Authors: Kenneth Bono, M.D. Erik Kroger, M.D., Kevin Klingele, M.D.

Presenter: Kenneth Bono, M.D.

### **INTRODUCTION:**

Septic arthritis in the very young child (less than 3 months of age) is a rare condition that can be difficult to diagnose. Immune systems in children this age often mount an insufficient response to be detected (fever, elevated WBC, elevated ESR, elevated CRP).<sup>1</sup> Early intervention is required to avoid potentially devastating sequelae including joint destruction and limb length inequality.<sup>2</sup> This study set out to identify factors to assist in future early diagnosis and guide the method of treatment.

### **METHODS:**

A query of hospital records from 1994 through 2010 was performed to identify all patients less than 3 months of age at the time of diagnosis of septic arthritis. Medical records were retrospectively reviewed to analyze birth history, joint involvement, physical exam findings, lab work, imaging results, method of treatment, and outcome.

### **DATA AND RESULTS:**

Our query identified 14 children that met the criteria that had complete hospital records for review. Average age was 42.2 days at time of concern for septic arthritis. The joints involved included the knee (8), hip (3), and shoulder (3). The most common physical exam findings were tenderness (100%), decreased ROM (100%), swelling (71.4%), and erythema (35.7%).

Average findings included temperature of 38.5° Celsius, WBC of 18.5 (34.8% neutrophils, 11.1 bands), ESR of 48.9, and CRP of 6.1. 57.1% of joint aspirates had positive cultures, 41.7% of blood cultures were positive. Of the joint cultures that did not grow an organism, 66.7% had received an antibiotic prior to aspiration. Causative organisms included Group B Strep (5), MSSA (4), H. influenza (1), Strep. pneumo (1), Salmonella (1), Candida albicans (1), and unknown (1).

A review of the imaging used during diagnostic workup revealed 50% of x-rays, and 28.6% of ultrasounds were read as normal. 28.6% had osteomyelitis adjacent to the joint of involvement. Initial method of treatment included I&D (5), aspiration (7), and observation (2).

71.4% of initial treatments were definitive. 20% of initial I&D's required repeat I&D. 42.9% of initial aspirations required later I&D. 50% of initial observation required later I&D.

### **DISCUSSION:**

Children less than 3 months of age have traditionally been described as mounting insufficient immune responses to meet the established laboratory cutoffs to support the diagnosis of septic arthritis. We compared our data to the criteria of Kocher<sup>3</sup> and Eich<sup>4</sup> and found the following:

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## SEPTIC ARTHRITIS IN CHILDREN LESS THAN 3 MONTHS OF AGE: A RETROSPECTIVE REVIEW, CONTD.

Presenter: Kenneth Bono, M.D.

Established Criteria	Our Study Average	Met Established Criteria in Our Study
Temp >38.5° C	38.5	53.8%
WBC > 12.0	18.5	92.9%
ESR > 40	48.9	53.8%
CRP > 2.0	6.1	77.8%

When evaluating a child under 3 months of age for septic arthritis, one should remember the most common physical exam findings (tenderness, decreased ROM, swelling), as well as the labs most likely to be elevated (WBC >12.0, CRP >2.0). One should never put aside clinical judgment and rely solely upon laboratory values as they can be lower than might be found in an older child with septic arthritis.

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### **ACKNOWLEDGEMENTS:**

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### **DISCLOSURES / FUNDING:**

None



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## **A RETROSPECTIVE COMPARISON OF HALLUX VALGUS RECURRENCE IN FIRST METARSAL-CUNEIFORM FUSION WITH AND WITHOUT A DISTAL SOFT TISSUE PROCEDURE**

Authors: Hillary Tudor, D.P.M., Christopher Hyer, D.P.M.

Presenter: Hillary Tudor, D.P.M.

### **INTRODUCTION:**

The Lapidus bunionectomy (1<sup>st</sup> metatarsal cuneiform fusion) is long-standing procedure for the correction of hallux valgus<sup>(1)</sup>. Adequate improvement of hallux valgus is often based on radiographic measurements<sup>(3-5)</sup>.

In order to obtain optimal correction, the procedure is routinely performed with an accompanying distal soft tissue procedure (DSTP). The DSTP is not a benign procedure. Risks include AVN of the metatarsal head, neuritis<sup>(4)</sup>, and decreased range of motion of the MTPJ<sup>(2)</sup>. This study aims to determine if DSTP is necessary to obtain adequate correction of hallux valgus, based on radiographic angles. It also proposes to determine if the DSTP is needed to maintain correction of that deformity.

The hypothesis tested was that the initial radiographic measurements following a Lapidus bunionectomy with and without a DSTP would be similar. However, the correction would not be maintained at later post-operative visits in those patients who did not undergo a DSTP.

### **METHODS:**

Patients included in this retrospective study were those who had a Lapidus bunionectomy performed as an initial hallux valgus correction. Retrospective data collected included the following radiographic measurements: intermetatarsal 1-2 angle, 1<sup>st</sup> metatarsal-cuneiform angle, tibial sesamoid position, and hallux abductus angle. All measurements were taken pre-operatively, at the 1<sup>st</sup> post-operative visit, and at the patient's final visit. Patients were divided into two groups, those with a DSTP and those without. Collected data were then compared between the two groups to determine any statistical significance using the t-test.

### **DATA AND RESULTS:**

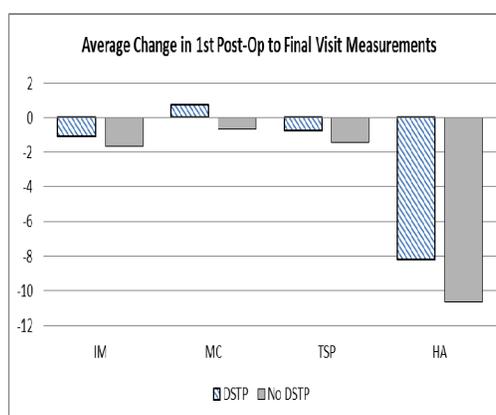
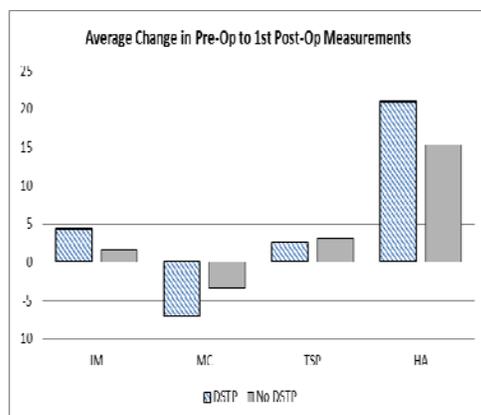
The group with the DSTP (Group A) had an average pre-op IMA of 13.17 while the non-DSTP group (Group B) had an average pre-op IMA of 9.44. At the first post-op visit, the IMA changed to 8.55 (difference of 4.62) and 7.78 (1.67) respectively. At the final visit, the average IMA of Group A was 9.6 (-1.05) and was 9.4 (-1.62) for Group B. Group A showed a pre-op 1<sup>st</sup> MT-MC angle of 155.1 and a post op angle of 162.5 (-7.4). The average 1<sup>st</sup> MT-MC angle was 156.7 pre-op and 160.1 post-op (-3.4) for Group B. 1<sup>st</sup> MT-MC angle was 161.8 (0.7) and 160.8 (-0.7) at final visit. Group A had an average pre-op TSP of 5.3 while Group B had an average pre-op TSP of 5.2. At the first post-op visit, the TSP changed to 2.75 (2.55) and 2.2 (3) respectively. At the final visit, the average TSP of Group A was 3.4 (-0.65) and was 3.7 (-1.5) for Group B. Group A showed a pre-op HA angle of 32.8 and an average post-op angle of 11 (21.8). The average HA angle was 29.3 pre-op and 14 post-op (15.3) for Group B. The HA angle was 19.4 (-8.4) and 24.7 (-10.7), respectively, at final visit. The average measurement change between pre-op and the first post-op is shown in figure 1, and the changes between the first post-op and final visit are seen in figure 2.

*Continued on Next Page*



## A RETROSPECTIVE COMPARISON OF HALLUX VALGUS RECURRENCE IN FIRST METARSAL-CUNEIFORM FUSION WITH AND WITHOUT A DISTAL SOFT TISSUE PROCEDURE, CONTD.

Presenter: Hillary Tudor, D.P.M.



### DISCUSSION:

Lee et al. performed a comparison of distal chevron osteotomies with and without the DSTP. They concluded that the DSTP may not be needed in correction of mild or moderate hallux valgus deformities<sup>(4)</sup>. In this study, it was determined that initial correction of the hallux valgus deformity is similar with and without an accompanying DSTP. However, a tendency towards recurrence was noted in patients without the DSTP. This result was found to be most significant in regards to the HA angle. Results of this study conclude that better correction of a hallux valgus procedure is achieved when a Lapidus bunionectomy is performed in conjunction with a DSTP.

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### DISCLOSURES:

None



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## **SOLUBLE FACTORS FROM GENETICALLY ENGINEERED SYNOVIAL CELLS ENHANCE AGGREGAN EXPRESSION AND MAY PROMOTE CHONDROGENESIS IN AN AUTOGENIC CO-CULTURE MODEL**

Authors: Seth Jump, Ph.D., Vincent Ng, M.D., Eric Skinner, B.S., David Flanigan, M.D., Alicia Bertone, D.V.M., Ph.D.

Presenter: Seth Jump, Ph.D.

### **INTRODUCTION:**

Articular cartilage defects are commonly found in athletes with joint pain and effusion. Cartilage lacks an intrinsic ability to heal, and surgical intervention is required for its restoration. Growth factors are known to have beneficial effects on cartilage healing, but direct intra-articular injection has limited therapeutic application due to a short biologic half-life. Our hypothesis was that genetically engineered human synovial-derived mesenchymal stromal cells (SDMSCs) could effectively deliver chondrogenic growth factors and support extracellular matrix production by autogeneic chondrocytes.

### **METHODS:**

In this co-culture experiment, SDMSCs were transduced with adenovirus (Ad) containing bone-morphogenetic protein 2 (AdBMP2), bone morphogenetic protein-14 (AdBMP14), fibroblast growth factor 18 (AdFGF18), or green fluorescent protein (GFP) as a control gene. SDMSCs were grown alone or in co-culture with chondrocytes. Media was harvested at 7 and 14 days, and cells were harvested at day 14. Outcome measurements included cell proliferation, morphology and viability, ELISA for selected proteins, and RT-PCR for selected chondrogenic markers.

### **RESULTS AND DISCUSSION:**

In SDMSCs, the proportion of GFP<sup>+</sup> cells was between 71-84% indicating efficient transduction by adenovirus. Chondrocytes proliferated greater than 6-fold ( $p < 0.001$ ) in culture and remained > 85% viable through day 14. Media interleukin-1 $\beta$  and -6 and matrix metalloproteinase-1 protein concentration were not different among treatments showing lack of activation of catabolic, inflammatory, or degradative pathways. SDMSCs produced hyaluronic acid and engineered gene in co-culture demonstrating sustained phenotype and functional vector delivery. Aggrecan mRNA was upregulated in chondrocytes exposed to soluble BMP2, BMP14, or FGF18 ( $p < 0.001$ ). Interestingly, only transduced SDMSC co-cultures had increased collagen type I alpha expression in chondrocytes suggesting this is induced by Ad-transduction and mediated by a soluble factor. We have demonstrated that genetically-engineered SDMSCs produce chondrogenic growth factors that stimulate the production of extracellular matrix in co-cultured chondrocytes. Our data support the potential clinical use of SDMSCs to deliver therapeutic proteins for cartilage restoration in vivo.

### **ACKNOWLEDGEMENTS:**

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### **DISCLOSURES:**

Dr. Flanigan is a consultant for Genzyme and Smith & Nephew. He is also involved in cartilage restoration clinical research trials with DePuy Mitek and Zimmer. There are no disclosures from any other author.



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## **A BIOMECHANICAL COMPARISON OF DISTAL CLAVICLE FRACTURES RECONSTRUCTIVE TECHNIQUES**

Authors: Michael Roesch, Brian Lewis, M.D., Alan Litsky, M.D., Sc.D., Grant Jones, M.D., Julie Bishop, M.D.

Presenter: Brian Lewis, M.D.

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### **INTRODUCTION:**

Unstable fractures of the distal clavicle (type IIB fractures) are often encountered in high-demand, young athletes involved in contact sports, and due to the high rate of nonunion, many have advocated surgery for treatment of this injury. Numerous operative techniques have been described, but a gold standard has yet to be defined, as many of these techniques have a substantial complication rate. Times New Roman, 10 font.

The purpose of this study was to evaluate the biomechanical performance and mode of failure of four different treatment methods for the unstable distal clavicle fracture; 1. suture fixation, 2. locking distal clavicle plates, 3. locking plate plus suture fixation, 4. distal clavicle hook plate.

Our hypotheses were that there would not be a significant difference in the load to failure among fixation techniques, but that the mode of failure would be less catastrophic with suture fixation.

### **METHODS:**

A Neer Type IIB unstable distal clavicle fracture was created in 20 fresh-frozen human cadaveric shoulders. Five fractures were reduced with suture: a No. 5 Fiberwire cerclaged in figure of eight fashion around the fracture as well as a No. 5 Fiberwire placed under the coracoid and up through 2 drill holes in the clavicle. Five fractures were reduced and plated with a distal clavicle locking plate that accommodates a 1.5 cm cluster of distal locking screws. Five fractures were reduced and plated with similar distal clavicle locking plates augmented with a No. 5 Fiberwire placed under the coracoid and up through drill holes in the clavicle. Lastly, five fractures were reduced and plated using a distal clavicle hook plate. A superiorly directed load-to-failure protocol was performed.

### **Statistical Analysis**

The mean load to failure and standard deviation for each reconstruction group was calculated. One-way analysis of variance with post hoc pairwise comparisons was calculated to compare the different reconstruction methods. Significance was set at P less than 0.05.

### **DATA AND RESULTS:**

Statistical analysis of our tests showed no significant difference in strength of fixation between any of the techniques used. A summary of the mean load to failure as well as the mode of failure is presented in the on the following page.

*Continued on Next Page*



## A BIOMECHANICAL COMPARISON OF DISTAL CLAVICLE FRACTURES RECONSTRUCTIVE TECHNIQUES, CONTD.

Presenter: Brian Lewis, M.D.

Method of Fixation	Load to Failure (N)	Mode of Failure
Suture technique	488 +/- 230	2: Significant fracture displacement with intact suture, 2: Suture failure, 1: Coracoid fracture
Distal Clavicle Locking Plate	502 +/- 288	3: Pull out of distal locking screws, 1: fracture medial to plate, 1: fracture through medial locking screw
Locking plate + suture	647 +/- 149	4: Clavicle fracture through medial locking screw hole, 1: Fracture medial to plate
Hook Plate	602 +/- 271	3: Fracture medial to plate, 1: Acromion fracture, 1: Hook and medial screw pullout

### **DISCUSSION:**

Distal clavicle fractures have always been a notoriously difficult fracture to treat and thus there has been a lot of debate as to the proper treatment technique. Distal clavicle fractures are known to have high rates of non-union and this appears to be independent of operative technique. Our study has shown that between the 4 fixation methods we have evaluated for the fixation of the unstable distal clavicle fractures (suture fixation, distal clavicle locking plate with and without augmentation and the hook plate) there is no significant difference in the biomechanical strength of the fixation techniques. However, we did find the worst complications in the hook plate and suture augmented plate group, in which a secondary fracture almost always occurred. These types of complications would necessitate removal of hardware and likely fixation of the new fracture site. Failure of the non-augmented distal clavicle plate would still require return trip to the operating room to remove the hardware, but would not in all cases absolutely require revision fixation. Because of the lower complication risk of suture fixation and the comparable strength of fixation it is our belief that it is at least the safest type of fixation, especially if the fracture fragment is small, < 1.5 cm.

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### **ACKNOWLEDGEMENTS:**

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### **DISCLOSURES:**

None



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## **PREDICTORS OF PAIN AND FUNCTION IN PATIENTS WITH SYMPTOMATIC, ATRAUMATIC FULL-THICKNESS ROTATOR CUFF TEARS**

Authors: Joshua Harris, M.D., Angela Pedroza, M.P.H., Grant Jones, M.D.

Presenter: Joshua Harris, M.D.

### **INTRODUCTION:**

The prevalence of full-thickness rotator cuff tears increases with age. Many patients are asymptomatic. Thus, not all of these patients require surgical repair. It is unclear which factors definitively contribute to patients' pain and function. The purpose of this study was to determine what non-modifiable and non-surgically modifiable factors contribute to pain and function with symptomatic, atraumatic full-thickness rotator cuff tears.

### **METHODS:**

A prospective, non-randomized cohort study reporting time-zero data of patients enrolled in a non-operative treatment program for symptomatic, atraumatic rotator cuff tears by the Multicenter Orthopedic Outcomes Network (MOON) shoulder group. Based on patient demographics, Western Ontario Rotator Cuff Index (WORC) and American Shoulder and Elbow Surgeons (ASES) scores, several variables were analyzed.

### **DATA AND RESULTS:**

A total of 389 subjects were enrolled. Mean ASES score was 53.9; mean WORC score was 46.9. The following variables significantly affected the WORC and ASES scores: Sex (females had higher score;  $p=.001$ ), education level (higher education, higher score;  $p<.001$ ), active abduction (degrees;  $p=.021$ ), strength in forward elevation ( $p=.002$ ) and abduction ( $p=.007$ ), scapulothoracic dyskinesia ( $p<.001$ ), atrophy of supraspinatus ( $p=.04$ ) and infraspinatus ( $p=.003$ ). Tear size was not a significant predictor (WORC) unless comparing isolated supraspinatus tears to supraspinatus, infraspinatus and subscapularis tears ( $p=.004$ ). Age, tear retraction, duration of symptoms and humeral head migration were not statistically significant.

### **DISCUSSION:**

Non-surgically modifiable factors, such as scapulothoracic dyskinesia, active abduction, strength in forward elevation and abduction, were identified that could be addressed non-operatively with therapy. This could turn a symptomatic patient into a less symptomatic or asymptomatic patient. A larger tear size with retraction may not necessarily be a contraindication to initial non-operative management with physical therapy.

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## **PREDICTORS OF PAIN AND FUNCTION IN PATIENTS WITH SYMPTOMATIC, ATRAUMATIC FULL-THICKNESS ROTATOR CUFF TEARS, CONTD.**

Presenter: Joshua Harris, M.D.

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### **ACKNOWLEDGEMENTS:**

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## **AIRBORNE BACTERIAL CONTAMINATION IN TOTAL KNEE ARTHROPLASTY: ULTRAVIOLET FILTRATION COMPARED WITH LAMINAR FLOW**

Authors: Steven Eddy, M.D., Richard Fankhauser, M.D.

Presenter: Steven Eddy, M.D.

### **INTRODUCTION:**

Infection in total joint arthroplasty is a devastating and even life threatening complication. The prevention of such sequela is of paramount importance to both surgeon and patient when planning and discussing the surgical treatment of hip and knee arthrosis. Many efforts have been made to reduce the rate of infection following total joint arthroplasty including laminar air flow, ultraviolet lighting, exhaust gowns, and antibiotics, each with evidence of their benefit.<sup>1-10</sup>

Prior to this study, all total knee and total hip arthroplasty procedures in our facility were performed in either vertical or horizontal laminar flow environments. Recently, advocates of ultraviolet lighting for reducing bacterial contamination have shown excellent results with direct exposure in the operative theatre.<sup>11-13</sup> Additionally, ultraviolet germicidal irradiation filtration air handler systems are commercially available and designed to decrease circulating microorganisms.<sup>14-15</sup> By irradiating the air before it enters a room, these systems have shown a reduction in airborne microorganisms and infection rates on hospital wards including intensive care units. To our knowledge, there have been no studies that have compared the effect of laminar flow to this indirect UVGI filtration on the bacterial contamination rate in the operating room, or in total joint arthroplasty. This prospective trial was designed to compare the ability of a UVGI filtration system to maintain a clean air environment in the operative field versus the currently utilized vertical and laminar flow systems.

### **METHODS:**

This study examined three airflow environments during unilateral primary total knee arthroplasties (TKA): one vertical laminar flow system, one horizontal laminar flow system, and one mixed airflow system with a UV filtration air handler system. One hundred consecutive operative cases were assessed in each room for 60 minutes from the start of the incision. During each case one irradiated tripticase soy agar (Hardy Diagnostics) settle plate was placed on the patient's upper abdomen (plate A) and a second on the scrub technician's instrument table (plate B). The lids were removed at the start of the incision and replaced after one hour of elapsed time. One group of agar plates from the UVGI room was lost between collection and culture leaving only ninety-nine results for this environment.

### **DATA AND RESULTS:**

Cultures were obtained in 100 total knee arthroplasties performed in vertical laminar flow, 100 TKA's in horizontal laminar flow, and 99 TKA's in mixed airflow with filtration ultraviolet germicidal irradiation. The rate of positive cultures in either plate A or plate B was 66% for VLF, 21% for HLF, and 71.7% for UVGI. Using chi-squared analysis (SPSS v18, IBM Inc.), there were no statistically significant differences in positive culture rates in the VLF or UVGI rooms. The HLF room did show a significantly ( $p < .01$ ) lower positive culture rate. The positive culture rate was not significant between plates A and plates B in the same room for any of the environments evaluated.

The overall hospital rate of clinical infection requiring a return to surgery for primary total knee arthroplasty performed during this study was 4 of 631 procedures equaling 0.6%. Evaluating for originating airflow environment; this was 0.6% (1/180) for HLF, 0.9% (3/325) for VLF, and 0% (0/126) for UVGI.

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## AIRBORNE BACTERIAL CONTAMINATION IN TOTAL KNEE ARTHROPLASTY: ULTRAVIOLET FILTRATION COMPARED WITH LAMINAR FLOW, CONTD.

Presenter: Steven Eddy, M.D.

### DISCUSSION:

Our results indicate that the conventional airflow room with UVGI provides a similar rate of bacterial contamination at the surgical field as vertical laminar flow. Additionally, there was a statistically significant reduction in the positive culture rate with the use of horizontal laminar flow compared to the other two environments. The clinical infection rate for total knee arthroplasty was not statistically significant between the three rooms, with an acceptable rate of less than 1% for all environments studied.

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Charnley J. *Clin Orthop Relat Res.* 1972;**87**:167-87.

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## A RETROSPECTIVE STATISTICAL ANALYSIS OF HIGH GRADE SOFT TISSUE SARCOMAS

Authors: Greg Kolovich, M.D, Adam Wooldridge, B.S., Jonathan Christy, M.D., Martha Crist, Thomas Scharschmidt, M.D.

Presenter: Greg Kolovich, M.D.

*Greg Kolovich, M.D. is a resident in Orthopaedics at The Ohio State University*

### **INTRODUCTION:**

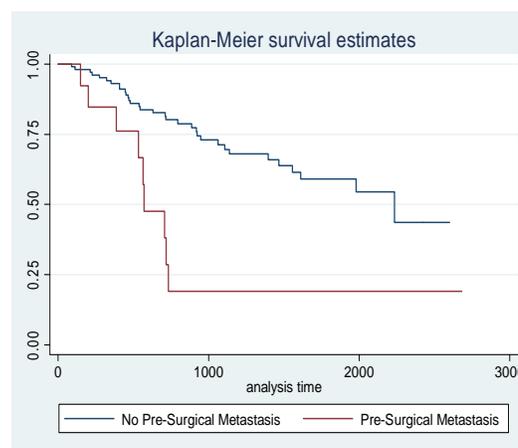
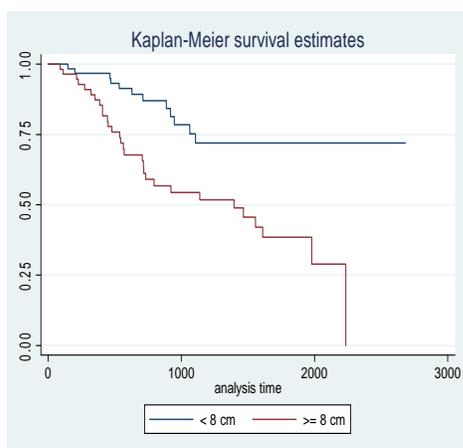
Soft tissue sarcomas are rare malignancies of mesenchymal origin with 10,520 new cases and 3,920 deaths per year in the U.S. The mortality rate ranges from 40 - 60% and known predictors for post-surgical mortality include tumor size, tumor grade, advanced patient age, and inadequate margins. Due to the high rate of mortality, a better understanding of additional prognostic factors is needed to guide patient counseling and treatment. Our goal was to develop a predictive model for post-surgical mortality for high grade soft tissue sarcoma patients by analyzing additional predictive variables at the time of surgical resection.

### **METHODS:**

Data was collected from 129 patients diagnosed and surgically treated for high grade soft-tissue sarcomas at the Ohio State University Medical Center between February 2002 and June 2010. The primary endpoint was death related to high grade soft tissue sarcoma. Thirteen variables were investigated including age, gender, race, tumor size, margin status, location, estimated blood loss, operative blood transfusions, pre-operative metastatic disease, pre-operative radiation, post-operative radiation, pre-operative chemotherapy, and post-operative chemotherapy. A Cox Survival Analysis model was created to determine the best predictors of survival time.

### **DATA AND RESULTS:**

Of the thirteen variables investigated, we found that tumor size and the presence of pre-surgical metastasis were statistically significant predictors of survival time. Patients with a tumor greater than 8 cm in any cross section had a 3.15 times greater chance of death. Presence of pre-surgical metastasis carried a 3.47 greater chance of death. The remaining variables did not predict patient outcomes in a statistically significant manner.



*Continued on Next Page*



## A RETROSPECTIVE STATISTICAL ANALYSIS OF HIGH GRADE SOFT TISSUE SARCOMAS, CONTD.

Presenter: Greg Kolovich, M.D.

### **DISCUSSION:**

Of the thirteen variables investigated, we found that tumor size and the presence of pre-surgical metastasis were predictors of survival time.

- Tumor size > 8 cm in any cross section carried 3.15 times greater chance of death
- Presence of pre-surgical metastasis carried 3.47 times greater chance of death.

Overall survival is no different for individuals receiving pre-operative radiation, pre-operative chemotherapy, or post-operative chemotherapy. Age, gender, and race also did not demonstrate changes in overall survival. Survival was higher for patients receiving post-operative radiation, having negative surgical margins, those not requiring blood transfusions, and those with tumors in the distal extremities. However, these variables were not statistically significant and were not included in the model.

Our results are similar to prognostic factors evaluated by the Memorial Sloan Kettering Cancer Center Sarcoma Nomogram and hazard ratios calculated from this study add new data to previously studied risk factors in soft-tissue sarcomas. These hazard ratios can be used to more effectively guide patients in prognosis and treatment regimens.

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### **DISCLOSURES:**

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## **PREDICTION OF CORACOID THICKNESS USING A GLENOID WIDTH-BASED MODEL: IMPLICATIONS FOR BONE TRANSFER PROCEDURES IN CHRONIC ANTERIOR SHOULDER INSTABILITY**

Authors: Karin Ljungquist, M.D, R. Bryan Butler, M.D., Julie Bishop, M.D.

Presenter: Karin Ljungquist, M.D.

### **INTRODUCTION:**

Bone loss on the antero-inferior glenoid due to recurrent anterior shoulder instability requires bone grafting when the amount reaches a certain threshold, generally agreed upon to be >25%. When the amount of bone required for the coracoid transfer (Latarjet procedure) is larger than the thickness of the coracoid, an Iliac Crest Bone Graft (ICBG) or allograft must be utilized. Although 3-D computed tomography (3-D CT) reconstructions can accurately predict the native width of the glenoid and the amount of anterior bone loss, it is difficult to predict if the coracoid thickness is suitable enough to recreate the A-P dimension of the glenoid and prevent recurrent instability. This study aims to define a normal ratio between glenoid width (GW) and coracoid thickness (CT) that can be used in pre-operative planning to determine if coracoid transfer will yield adequate bone to restore the glenoid contour. If it is not, the use of an ICBG or allograft is indicated. The hypothesis is that there is a predictable and reliable ratio between the glenoid and the coracoid, and if the native glenoid width is known, we can accurately predict the thickness of the coracoid and know whether it is suitable for transfer to the anterior glenoid.

### **METHODS:**

100 pairs of cadaveric scapula (200 total scapulae) from the Hamann-Todd Human Osteological Collection at the Cleveland Museum of Natural History were examined. The sample included 50 male and 50 female specimens. Glenoid length and height, and coracoid length (knee to tip) and width (A-P thickness) were measured using digital calipers accurate to 0.01mm for each scapula. Each scapula was measured independently by two of the authors and the results averaged. Measurements for each parameter were averaged with values obtained from the skeleton's contralateral scapula to obtain a single set of values for each pair of scapulae. A ratio of the coracoid thickness (CT) to glenoid width (GW) was calculated and expressed as a percentage of the glenoid width, for both males and females.

### **DATA AND RESULTS:**

The average male GW was 27.46 +/-1.93mm and the glenoid height (GH) was 37.64 +/-2.01mm, compared to the female GW of 23.11 +/- 1.53mm and GH of 32.63 +/- 1.05mm, with both differences between males and females statistically significant (p= 0.0001 and 0.0001, respectively). The corresponding average male CT was 9.69 +/-0.99mm and coracoid length (CL) was 23.07 +/-2.30mm, compared to the female CT of 7.94 +/- 0.87mm and CL of 18.45 +/- 1.61mm, with both differences between males and females statistically significant (p = 0.0001 and p = 0.0001, respectively). Utilizing the equation of CT/GW, the average male ratio was 35.4 +/-1.1%, and differed significantly from the average female ratio of 34.4 +/-3.2% (p=0.0386).

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## **PREDICTION OF CORACOID THICKNESS USING A GLENOID WIDTH-BASED MODEL: IMPLICATIONS FOR BONE TRANSFER PROCEDURES IN CHRONIC ANTERIOR SHOULDER INSTABILITY, CONTD.**

Presenter: Karin Ljungquist, M.D.

### **DISCUSSION:**

A novel biomorphological model is presented to predict coracoid thickness and the ability of the Latarjet procedure to restore stability to a given bone deficient glenoid. Using the equation of coracoid thickness to glenoid width (CT/GW), knowledge of the native glenoid width as determined from a 3-D CT can predict whether the coracoid is thick enough to restore the native A-P dimension of the glenoid. As an example, a model male patient with a glenoid width of 30 mm as determined by 3-D CT would have a predicted coracoid thickness of 10.6mm (35.4% of the glenoid width for males, 34.4% for females). If the measured glenoid bone loss was less than 10.6mm, a Latarjet transfer could be expected to be successful. If the bone loss was more than 10.6mm, another source of bone graft such as an ICBG would be necessary. Alternatively stated, a glenoid bone defect in a male of less than 35% of the total glenoid width could be managed with a Latarjet procedure, whereas one greater than 35% would require ICBG. This model may aid the shoulder surgeon in preoperative planning and help promote successful outcomes in glenoid reconstruction surgery by determining if a Latarjet or ICBG is the most appropriate procedure given the predicted amount of coracoid bone graft available.

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### **DISCLOSURES:**

None to report.



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## COMPARISON OF VARIOUS IMAGING STUDIES TO QUANTIFY GLENOID BONE LOSS IN SHOULDER INSTABILITY

Authors: Michael Rerko, M.D., Xueling Pan, Ph.D., Christopher Donaldson, M.D., Grant Jones, M.D., Julie Bishop, M.D.

Presenter: Michael Rerko, M.D.

### INTRODUCTION:

The purpose of this study was to determine the most accurate imaging modality to quantify glenoid bone loss in recurrent anterior shoulder instability. This will allow the best preoperative prediction of the patients needing a bone grafting procedure. The study sought to compare 3D-CT, MRI, CT, and X-Ray in terms of prediction error as well as intraobserver and interobserver reliability.

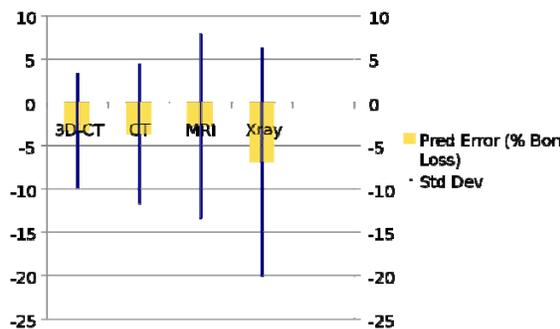
### METHODS:

7 fresh-frozen shoulder cadavers were imaged with radiographs(x-ray), magnetic resonance imaging(MRI), CT, and 3-D CT. 3 sequential glenoid defects were created, measured and re-imaged. The defect sizes were in the range of: 0;< 12.5%;12.5% - 27%;and>27%. 4 independent blinded evaluators (2 radiologists, 2 surgeons) reviewed the 112 random image sets and estimated the percent glenoid bone loss (to determine interobserver reliability), with repeated sets reviewed 3 months later (to determine intraobserver reliability).

The agreement of the estimated percentage and the actual bone loss were summarized using the prediction error for each imaging techniques, and the correlation between the estimated percentage vs the actually bone loss. Linear mixed models with repeated measurement were used to identify the influence of rater, defect size, for different imaging techniques. The reliability of each imaging technique was also summarized using the intraobserver intraclass correlation coefficients.

### DATA AND RESULTS:

The Pearson correlation coefficients between the predicted bone loss vs. the true loss across all four raters are: 0.875 (3-D CT), 0.831 (CT), 0.693 (MRI) and 0.457 (X-ray). The prediction errors (PE) (mean+/- Standard Deviation(StD), in %) are: 3-D CT (-3.3+/-6.6), CT (-3.7+/-8.0), MRI (-2.75+/-10.6) and X-ray (-6.9+/-13.1).



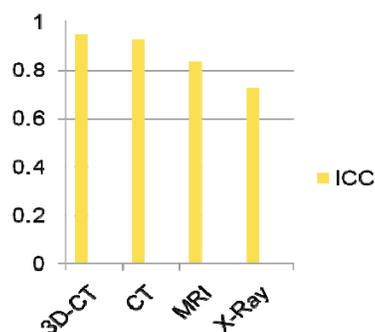
The means of the PE are not significantly different among 3-D CT, CT and MRI, but the StD of the PE are similar among all four evaluators for 3-D CT and are statistically lower than all other three imaging techniques (p value = 0.05, <0.001, <0.001 for CT, MRI and Xray respectively). The prediction based on x-ray has the largest error and StD. Covariance parameters also revealed large variances for shoulders on MRI and x-ray.



## COMPARISON OF VARIOUS IMAGING TECHNIQUES TO QUANTIFY GLENOID BONE LOSS IN SHOULDER INSTABILITY, CONTD.

Presenter: Michael Rerko, M.D.

The intraobserver intraclass correlation coefficients based on the two-way mixed model with random evaluator effect and fixed measurement effect were 0.947 (3-D CT), 0.927 (CT), 0.837 (MRI), and 0.726 (X-ray).



### **DISCUSSION:**

3-D CT was the most accurate imaging modality in predicting glenoid bone loss among 4 blinded independent evaluators. It was the most consistent and reproducible among evaluators with the smallest degree of error. The authors would recommend 3-D CT to evaluate the need for a bone grafting procedure when glenoid bone loss is a concern.

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### **DISCLOSURES:**

None of the authors has any financial interest or disclosures related to this work.



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## LOCATION DEPENDENT PROGRESSION OF CARTILAGE LESIONS: AN IN VIVO RAT MODEL

Authors: Ryan Harrison, M.D., Derrick Knapik, B.A., Robert Siston, Ph.D., Sudha Agarwal, D.D.S., Ph.D., Harsh Phuloria, David Flanigan, M.D.

Presenter: Ryan Harrison, M.D.

### INTRODUCTION:

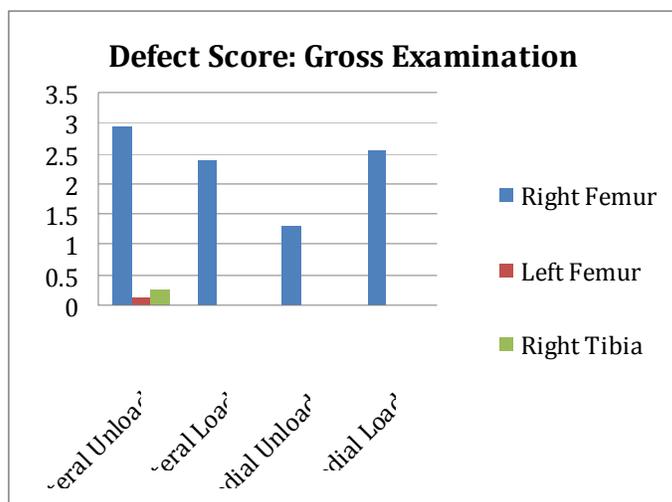
Articular cartilage lesions are common among symptomatic and asymptomatic knees and lead to degeneration of the focal chondral surface, surrounding cartilage and subchondral bone.<sup>1-3</sup> The degenerative process differs between medial and lateral femoral condyles due to dissimilar joint surface characteristics and is impacted by defect size.<sup>4-8</sup> Our study investigates possible differences in the degenerative process based on lesion location in the knee and the presence of loading.

### METHODS:

We randomly divided 20 rats into two groups. In Group 1 (n=10), 1mm articular cartilage lesions were created in the right medial femoral condyle. Group 2 (n=10) received 1 mm lesions in the right lateral femoral condyle. Five rats from each group exercised on a treadmill for 45 minutes per day for 41 consecutive days. The remaining rats were left in their cages. On day 42, rats were sacrificed and both knees were dissected and fixed in formalin. Lesion progression was examined grossly using a high-resolution digital camera and microscopically using H&E, Safranin O and Ag-grecan stains. Both gross and histopathologic scoring was completed in a blinded, randomized fashion by the research team using previously described methods<sup>9, 10</sup>.

### DATA AND RESULTS:

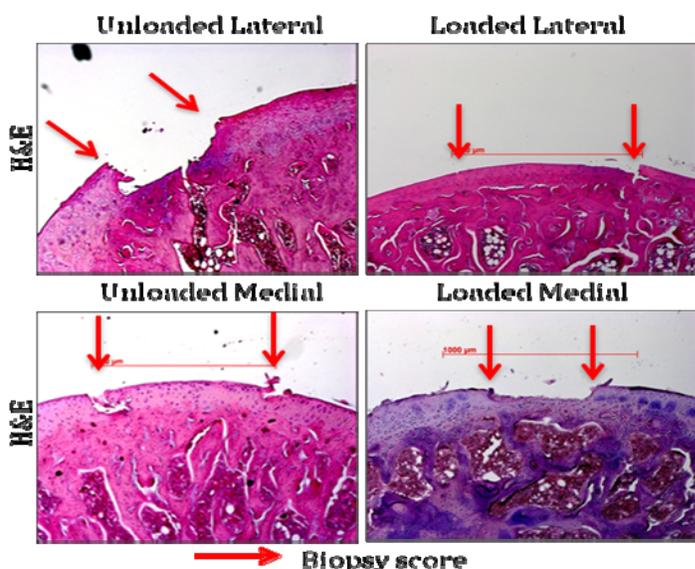
We found that, on average, unloaded condyles with primary lesions on the lateral condyle had more than a two fold increase in cartilage damage score compared to unloaded medial lesions. Loading on primary lateral lesions led to decreased cartilage damage compared to lateral unloaded lesions. Conversely, loading on medial lesions did not protect against primary lesion progression. Statistical analysis did not show a statistical significance. Immunohistochemical analysis revealed secondary cartilage loss in the weight-bearing portion of the condyle was independent of loading and primary lesion location.



Continued on Next Page

## LOCATION DEPENDENT PROGRESSION OF CARTILAGE LESIONS: AN IN VIVO RAT MODEL, CONTD.

Presenter: Ryan Harrison, M.D.



### DISCUSSION:

This pilot study suggests that cartilage lesion progression is location dependent and that loading impacts the extent of this progression. Lesions in lateral unloaded knees were on average more severe compared to similar lesions on the medial condyle while loading protected against further cartilage damage in lateral, but not medial lesions. These results give insight into the incongruity of the knee joint and how lesion location and loading impact cartilage degeneration and development of osteoarthritis. Further work is necessary to examine secondary cartilage lesion development in the human knee and subsequent progression of osteoarthritis.

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